INFORMATION BULLETIN

ICAR's AllIndiaCompetitiveExaminationfor Admission to 25% Seats (100% Seats of Dr. RPCAU, Pusa) in Doctoral Degree Programmes of Agricultural Universities under ICAR-AU system (*except 4 ICAR-DUs*) and Award of ICAR-JRF/SRF(PGS) in Agriculture & Allied Sciences for the Academic Session2018-19

AICE-JRF/SRF(PGS)-2018

Agricultural Education Division
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan-II, Pusa
New Delhi-110 012

Websites:www.icar.org.in/www.aieea.net
Help Desk No.:7835097766/67/68/69 (9.00 AM-6.00 PM)
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Important Information at a Glance

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
(AGRICULTURAL EDUCATION DIVISION)
KRISHI ANUSANDHAN BHAVAN-II, PUSA, NEW DELHI-110 012

The Deputy Director General (Agril. Education)
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan-II
Pusa, New Delhi- 110 012

Assistant Director General (HRD)/
Controller of Examinations (Agril.Edn) - COE
Agril. Education Division
Indian Council of Agricultural Research
Krishi Anusandhan Bhavan-II
Pusa, New Delhi- 110 012

ALL CORRESPONDENCEREGARDING ADMISSION SHOULDBEADDRESSEDTOTHEASSISTANT DIRECTOR GENERAL (HRD)/CONTROLLEROFEXAMINATIONS (AGRIL. EDN.),AGRICULTURAL EDUCATION DIVISION, INDIAN COUNCIL OF AGRICULTURAL RESEARCH, KRISHI ANUSANDHAN BHAVAN-II, PUSA, NEW DELHI-110 012

(*ThisInformationBulletinshouldnotbe treatedasaLegalDocument*)

MODE OF APPLICATION

Application will be received through **ONLINE** mode only. In no other form, the applications will be entertained. For details, please refer to Item No. 8.0 of the Information Bulletin. Application FeeofRs.1,400/-forGeneral, OBC (NCL)&UPSandRs.700/-for SC, ST and PCcategorieswithadditional Payment Gateway charges plus GST, as applicable, will be chargeable.

IMPORTANTDATES

Event	Date
Date and Time of Examination	22.06.2018 (Friday) 10:00 A.M to 01:00 P.M. (3 hrs)
Commencement of Online Application submission	18.05.2018(Friday)
Last date of online application	31.05.2018 (Thursday,up to 11.59 P.M.)
e-Admit card information (on ICAR websites)	14.06.2018 (Thursday) onwards
Online Mock Test	14.06.2018 (at www.aieea.net)
Declaration of result	Last week of June, 2018
Schedule for Online Counseling	
Choice Filling	01.07.2018 to 03.07.2018
1st Counseling Result	06.07.2018
1st Round Reporting	06.07.2018 to 10.07.2018
2nd Counseling Result	12.07.2018
2nd Round Reporting	12.07.2018 to 16.07.2018
3rd Counseling Result	18.07.2018
3rd Round Reporting	18.07.2018 to 22.07.2018
4th Round (if needed)	

[*There will be online examination(CBT) and online Counseling only*]

All announcements including e-Admit Card information, Mock Test, CBT, Declaration of Result, Online Counseling Schedule,General Notices, etc. will be available on the ICAR websites(www.icar.org.inor www.aieea.net). Candidates are advised in their own interest to keep in touch with the websites.

DirectionstoCandidates

1. Dayanddateofexamination : **22.06.2018 (Friday)**
2. Duration : **10.00A.M.to01.00P.M.(3 hrs)**
3. Online application and downloadable Information Bulletin will be available on ICAR websites (www.icar.org.in or www.aieea.net).
4. e-Admit Card containing information regarding Roll Number, Centre and Venue of Examination, etc. would be downloadable 14.06.2018 onwardsfrom the ICAR website by providing the Login details. Login ID is the Application No. of the candidate.
5. A candidate is allowed to submit one application only. If a candidate submits more than one application, his/her candidature shall be cancelled.
6. Incompleteapplication with unclearphotograph, non-payment of requisite fee amount or amount lesser than prescribed fee or without a valid Govt. identity number (Aadhaar number or 28 digit Aadhaar Enrolment ID or passport number or ration card number or driving license number or any other valid Govt. ID card number)shall be summarily rejected and no correspondence shall be entertained in this regard.
7. After first step of online registration, the candidate will get the Login details (Application No. and Password) on computer screen and also through SMS at his registered mobile number. Every candidate has to fill his/her own mobile number and e-mail ID.
8. Once the application fee has been paid and the applicationhas been finally submitted online by the candidate, any request for change in any particular(s) in the applicationshall not be entertained.
9. The candidate shall be able to take the print-out of application form only after all the steps of online registratrion process have been completed and the application fee has been successfully paid.
10. The applicants are advised that since the form filling as well as e-admit cards shall be available through the online mode only, they must keep the details regarding their Login ID and password secure and safe.
11. If a candidate belonging to General/OBC (NCL)/UPS category by mistake or otherwise mentions his/her category as SC/ST/PC in the application, and later on after closure of the last date of online application process claims that he/she actually belongs to General/OBC (NCL)/UPS category, then the claim of such candidate shall not be entertained and his/her application shall be summarily rejected on the grounds of underpayment of fee.***In the event of rejection of the application due to non-payment/underpayment of the application fee or any other reason(s) specified elsewhere in the Information Bulletin, the application fee paid shall not be refunded.***
12. Admission of a candidate to the entrance examination is provisional subject to his/her being found otherwise eligible for admission to the programme/course concerned by the admitting university.
13. Use or attempt to use unfair means of any kind for this examination including impersonation will automatically lead to the cancellation of candidature at any stage besides attracting legal action as deemed fit.
14. Candidates are advised to retain (i) at least three printouts of online application form(ii) Three identical copies of recent passport size colour photographs (with name and date)that was scanned anduploaded with the online application, for subsequent use at the time of examination and admission (iii) Copy of proof of payment of application fee
15. **The Candidates are not required to send the hard copy of Online Application Form to the ICAR**. However, he/she is advised to preserve sufficient copies of the Online Application Form along with the proof of fee paid for any future reference.
16. Candidate may seek any information as per scheduled date and time only. Changes, if any, in the scheme of examination will be notified on the ICAR website.
17. In all communications regarding submission of application or otherwise related to admissions, the copy of the online application form, payment receipt and valid Govt. ID proof must be submitted,otherwise, the communication would be deemed incomplete and no processing would be performed on the communication, without any notice to the applicant.
18. Ragging in any form inside or outside the campus is strictly prohibited.
19. **The records of the AICE-JRF/SRF (PGS)-2018 shall be preserved for the period as specified in the Record Retention Schedule of the Council.**

ICAR's AllIndiaCompetitiveExaminationfor Admission to 25% Seats (100% seats of Dr. RPCAU, Pusa)in Doctoral Degree Programmes of Agricultural Universities under ICAR-AU system (*except the four ICAR-DUs*) and Award of ICAR-JRF/SRF(PGS) in Agriculture & Allied Sciences for Academic Session 2018-19

1.0INTRODUCTION

The Indian Council of Agricultural Research (ICAR) is the apex body for coordinating, guiding, and managing research and education in agriculture in the entire country under the aegis of DARE, Ministry of Agriculture and Farmers Welfare. Agricultural education plays an important role in the overall development of the country. Considering the importance of agriculturaleducation,theEducationCommissionin1948recommendedtheestablishmentof Rural Universities in the country.As a result of the recommendation made under the Chairmanship of Dr.S.Radhakrishnan,thefirstStateAgriculturalUniversitywasestablishedin1960atPantnagaronthepattern oftheLandGrantCollegesoftheUnitedStates.Today,thecountryhasa large ICAR-AU system with a total of 75 Agricultural Universites comprising of 64StateAgricultural, Veterinary, Horticultural and FisheriesUniversities (SAUs),4 ICAR-Deemed-to-be-Universities (DUs), viz. IARI, IVRI, NDRI and CIFE, 3Central Agricultural Universities (CAU, Imphal, Dr. RPCAU, Pusa and RLB CAU, Jhansi), 4 Central Universities (CUs) having faculty of agriculture (BHU, AMU, Viswa Bharati and Nagaland University) and 1 Sam Higginbottom University of Agriculture, Technology & Sciences (SHUATS), Allahabad, hereinafter referred to as the Agricultural Universities (AUs).Thus,theNational AgriculturalResearchandEducationSystem (NARES)ofIndiaisoneofthelargestinthe world,admittingmorethan15,000graduates,11,000post-graduates,and2,500Ph.Dsannually,indifferentdisciplines ofagricultureandalliedsciences.

In order to make the NARES more responsive, reduce academic inbreeding, increase mobility among students, encourage national integration, infuse merit and uniform examination standards leading to overall improved standards and quality of higher agricultural education, the ICAR has been conducting the All India Competitive Examination for the award of 202. ICAR's Senior Research Fellowship [AICE-SRF(PGS)], to pursue Ph.D. degree programmes in the universities under ICAR-AU system. However, centralized admission to 25 % of the seats (subject to at least one seat for each discipline having Ph.D. degree programme in the University) of PhD degree programmes in the universities under ICAR-AU system was introduced from the Academic Session 2015-16.From the Academic Session 2016-17, AICE-SRF(PGS) examination is being conducted for all the accredited AUs under the ICAR-AU system, except the 4 ICAR-DUs, where 100% seats arefilled through their own separate national level entrance examination(as approved by GB, ICAR in 235th Meeting on 01.12.2015).

It has been decided by the Council w.e.f. Academic Session 2017-18 that filling of ICAR quota seats in Ph.D. programmes in Agricultural Universities through ICAR's Entrance Examination will not be allowed for non-accredited programmes, colleges and the Universities. For the academic session 2018-19, admissions to accredited doctoral degree programmes will be granted in 42(tentative) accredited Agricultural Universities under ICAR-AU system.

The examinationwill beconductedin 16 Major Subject Groups comprising 60 sub-subjects/disciplines atdifferent centres acrossthecountrytoenablealargenumberofstudentstoappearindifferentdisciplinesofAgricultureand AlliedSciences.Based on merit in this examination, the Council shall award 202Junior/Senior Research Fellowships (erstwhile SRF) to the candidates as per their overall merit rank and availability of seat in a particular subject/discipline opted in the desired University. Fellowship would be granted only when the candidate, after undergoing counseling, gets admitted and pursues Ph.D degree in an AU other than the one from where he/she has passed Bachelor's or Master's degree i.e. not more than two degrees (including Ph.D.) should be from the same AU. The other candidates who are declared/notified as qualified for counseling will be eligible as per their merit rank and availability of seat for admission to Ph.D. degree programme, without fellowhip,in the specific subject in the AUs. Candidates qualified for counseling will be considered for allocation of subject and the AU as per the online counseling procedure described hereinafter under Item 11.0.**There isno direct nomination through ICAR in any Doctoral degree programme without qualifying in this examination.** No further entrance examination shall be conducted by the AUs (100 % seats of ICAR-DUs shall be filled-up through their own separate national level entrance examination) for the candidates who have already qualified for centralized admission against 25% seats (100% seats of Dr. RPCAU, Pusa) of Ph.D. programmes and the award of ICAR-JRF/SRF(PGS)in the Universities under ICAR-AU system through centralized admission conducted by ICAR.

The award of Junior Research Fellowship/Senior Research Fellowship [JRF/SRF(PGS)] shall be governed by the rules and regulations/guidelines issued by the Council and as amended from time to time in this regard.

2.0 DEGREE PROGRAMMES AVAILABLE FOR ADMISSION

2.1Major Subject Groups, Sub-subjects and ICAR-JRF/SRF(PGS)

Doctoral degree programmesare offered by AUs in 60 sub-subjects under 16 Major Subject Groups, viz. (1) Crop Sciences-I, (2)Crop Sciences-II, (3) Crop Sciences-III, (4) Horticulture, (5) Veterinary and Animal Sciences-I, (6) Veterinary and Animal Sciences-II, (7) Veterinary and Animal Sciences-III, (8) Dairy Science, Dairy Technology & Food Technology, (9) Agricultural Engineering and Technology, (10) Community Science (erstwhile Home Science), (11) Fishery Sciences, (12) Natural Resource Management-I, (13) Natural Resource Management-II, (14) Agricultural Economics & Agri-Business Management, (15) Agricultural Extension and (16) Agricultural Statistics. Based upon compatibility with his/her own subject area at post-graduation level, the candidate should select one Major Subject Group and from the following Table for appearing in the Competitive Examination. **The candidateis required to attempt questions from all of the Sub-subjects listed under a Major Subject Group**. The syllabus for the examination is given at **Annexure-I**. Category-wise ICAR-JRF/SRF(PGS) in various sub-subjects are given below in Table 1; the number being tentative at present and the final position will be known at the time of online counseling only.

Table 1:Sub-subject and Category-wiseJRF/SRF(PGS)throughAICE-JRF/SRF(PGS)-2018

Major Subject Group Code	Major Subject Group	Sub-subject Code	Sub- subject for Ph.D.	No. of ICAR-JRF/SRF(PGS)				
				General/ OBC (NCL) /UPS	SC	ST	PC*	Total
01	Crop Sciences-I	1.1	Genetics & Plant Breeding	15	3	2	1	20
		1.2	Seed Science & Technology	2	1	0	0	3
			Total	**17**	**4**	**2**	**1**	**23**
02	Crop Sciences-II	2.1	Plant Pathology	9	2	1	0	12
		2.2	Nematology	1	0	0	0	1
		2.3	Agricultural Entomology/Entomology	11	2	1	1	14
		2.4	Agricultural Chemicals	0	0	0	0	0
			Total	**21**	**4**	**2**	**1**	**27**
03	Crop Sciences-III	3.1	Plant Biochemistry/Biochemistry	2	0	0	0	2
		3.2	Plant Physiology/Crop Physiology	2	1	0	0	3
		3.3	Agricultural Biotechnology/Biotechnology/Molecular Biology & Biotechnology	9	2	2	1	13
		3.4	Agricultural Microbiology/Microbiology	2	1	0	0	3
			Total	**15**	**4**	**2**	**1**	**21**
04	Horticulture	4.1	Vegetable Science/Olericulture	7	2	1	1	10
		4.2	Fruit Science/Pomology	6	1	1	0	8
		4.3	Floriculture & Landscaping/Floriculture & Landscape Architecture	3	1	0	0	4
		4.4	Spices, Plantation, Medicinal & Aromatic Plants	1	0	0	0	1
		4.5	Horticulture	3	0	0	0	3
		4.6	Post Harvest Technology (Horticulture)	1	0	0	0	1
			Total	**21**	**4**	**2**	**1**	**27**
05	Veterinary and Animal Sciences-I	5.1	Animal Genetics & Breeding	2	0	0	0	2
		5.2	Animal Nutrition	2	0	0	1	2
		5.3	Livestock Production Management	1	1	0	0	2
		5.4	Livestock Products Technology	1	0	0	0	1
		5.5	Poultry Science	1	0	0	0	1
		5.6	Veterinary Physiology	1	0	0	0	1
			Total	**8**	**1**	**0**	**1**	**9**

Major Subject Group Code	**Major Subject Group**	**Sub-subject Code**	**Sub- subject for Ph.D.**	**No. of ICAR-JRF/SRF(PGS)**				
				General/ OBC (NCL) /UPS	**SC**	**ST**	**PC***	**Total**
06	**Veterinary and Animal Sciences-II**	**6.1**	Veterinary Parasitology	1	0	0	0	1
		6.2	Veterinary Public Health/Veterinary Public Health & Epidemiology	0	0	1	0	1
		6.3	Veterinary Biochemistry	1	0	0	0	1
		6.4	Animal Biotechnology	1	0	0	0	1
		6.5	Veterinary Microbiology	1	1	0	1	2
		6.6	Veterinary Pathology	2	0	0	0	2
			Total	**6**	**1**	**1**	**1**	**8**
07	**Veterinary and Animal Sciences-III**	**7.1**	Veterinary Medicine	2	0	0	0	2
		7.2	Veterinary Pharmacology & Toxicology	1	0	0	0	1
		7.3	Vety. Gynaecology & Obstetrics/Animal Reproduction, Gynaecology & Obstetrics	1	1	0	0	2
		7.4	Veterinary Surgery & Radiology/Veterinary Surgery	1	0	1	0	2
		7.5	Veterinary Anatomy/Veterinary Anatomy & Histology	1	0	0	0	1
			Total	**6**	**1**	**1**	**0**	**8**
08	**Dairy Science, Dairy Technology & Food Technology**	**8.1**	Dairy Chemistry	0	0	0	0	0
		8.2	Food Technology	3	1	1	0	5
		8.3	Dairy Microbiology	0	0	0	0	0
		8.4	Dairy Technology	1	0	0	0	1
			Total	**4**	**1**	**1**	**0**	**6**
09	**Agricultural Engineering and Technology**	**9.1**	Farm Machinery and Power Engineering	3	0	0	0	3
		9.2	Soil and Water Conservation Engineering/Soil and Water Engineering	0	1	0	0	1
		9.3	Agricultural Processing and Food Engineering	2	1	0	1	3
		9.4	Renewable Energy Engineering	1	0	0	0	1
		9.5	Irrigation Water Management Engineering/Irrigation & Drainage Engineering	0	0	0	0	0
			Total	**6**	**2**	**0**	**1**	**8**
10	**Home Science (Currently renamed as Community Science)**	**10.1**	Family Resource Management	1	0	0	0	1
		10.2	Textiles and Apparel Designing	1	0	0	0	1
		10.3	Human Development and Family Studies/Human Development	1	0	0	0	1
		10.4	Foods and Nutrition/Human Nutrition	1	1	0	0	2
		10.5	Home Science Extension and Communication Management	0	0	0	0	0
			Total	**4**	**1**	**0**	**0**	**5**
11	**Fishery Sciences**	**11.1**	Aquaculture	1	0	0	0	1
		11.2	Fisheries Resource Management	1	0	0	0	1
		11.3	Fish Process Technology	1	0	0	0	1
		11.4	Fish Nutrition & Feed Technology	0	0	0	0	0
			Total	**3**	**0**	**0**	**0**	**3**
12	**Natural Resource Management -I**	**12.1**	Forestry/ Agroforestry	2	0	0	0	2
		12.2	Agricultural Meteorology	1	1	0	0	2
		12.3	Environmental Sciences	1	0	0	0	1
			Total	**4**	**1**	**0**	**0**	**5**

13	**Natural Resource Management –II**	**13.1**	Agronomy	15	2	1	1	18
		13.2	Soil Sciences/Soil Science & Agricultural Chemistry	10	2	1	1	13
			Total	**25**	**4**	**2**	**2**	**31**
14	**Agricultural Economics & Agribusiness Management**	**14.1**	Agricultural Economics	5	1	1	0	7
		14.2	Agribusiness Management	2	0	0	0	2
			Total	**7**	**1**	**1**	**0**	**9**
15	**Agricultural Extension**	**15.1**	Agricultural Extension/Extension Education/Communication	8	1	1	1	10
			Total	**8**	**1**	**1**	**1**	**10**
16	**Agricultural Statistics**	**16.1**	Agricultural Statistics	2	0	0	0	2
			Total	**2**	**0**	**0**	**0**	**2**
			G. Total	**157**	**30**	**15**	**10**	**202**

*5% reservation in ICAR-JRF/SRF(PGS) for Physically Challenged (PC) category will be horizontal across all the categories, i.e. such candidates would draw JRF/SRF from the GEN/SC/ST category to which they belong.If ICAR-JRF/SRF(PGS) is not available in a particular category to which the PC candidate belongs, then the same would be drawn from General Category depending upon availability.

**Seats in some of the Sub-subjects under some Major Subject Groups if not received in the Council from accredited universities at the time of counseling, then in the event of some candidates qualifying in such Sub-subjects, it shall not be the responsibility of the Council to give them admission.

Note:

1. The admission would be granted under accredited programme(s) of an accredited college(s) under an accredited university except for Dr. RP CAU, Pusa, Bihar where 100% seats (both accredited and non-accredited programmes) will be filled up through ICAR.
2. The exact title/nomenclature of the degree programme might vary from one university to another. Candidates are advised to enquire the nomenclature of degree programme from the Registrar of university concerned (for contact details, please refer **Annexure-IV**) at the time of counseling/while seeking admission.
3. From Academic Session 2017-18, the criteria for ICAR-JRF/SRF (erstwhile ICAR-SRF) distribution, based on total number of seats in each subject, has been changed to average number of aspirants actually appeared in the AICE-JRF/SRF(PGS) in a particular Sub-subject in the preceding three years. The number of fellowships is tentative and may vary depending upon the number of candidates actually appeared in the examination in a particular Sub-subject. It will finally be known only at the time of counseling.
4. ICAR-JRF/SRF(PGS) shall be awarded only after the completion of online counseling.
5. **The award of fellowship shall be considered valid only if the candidate actually seeks admission in a particular University, failing which itshall be deemed to have been withdrawn and shall automatically become infructous.**
6. If a candidate finally awarded ICAR-JRF/SRF(PGS) at thecompletionof counseling seeks admission in auniversity and subsequently leaves the degree programme for any reason, there will be no transfer of such fellowship to the candidate next in merit rank.
7. There is no reservation of ICAR-JRF/SRF(PGS) for candidates of OBC (NCL)and UPS category. They would be entitled for ICAR-JRF/SRF(PGS) based on overall merit.
8. Candidates qualified for counseling or allotted the seat, may seek admission only during the session for which the examination has been conducted. They are not entitled to claim for admission in other academic sessions/subsequent years based on this year's examination.
9. For admission to Ph.D. degree programmes through the entrance examination, only the candidates having passed graduation with 4/5(B.V.Sc.&A.H.)/6(10+6,BSc. Ag.) degree programme from any recognized University will be eligible. The candidates having passed with Bachelor's degree of 3 years' duration are not eligible with the proviso that such candidates if already enrolled for Masters degree

programme may seek admission to Ph.D. degree programme in respective ICAR-DU in accordance with its prescribed eligibility criteria.

3.0 UNIVERSITY-WISE AND SUB SUBJECT-WISE NUMBER OF SEATS AVAILABLE FOR ADMISSION

Number of ICAR seats available for admission through this examination in Doctoral degree in different Sub-subjects at accredited Agricultural Universities for the academic session 2018–19 will be displayed at the time of counseling.

4.0 RESERVATION OF SEATS AND FELLOWSHIPS FOR SC, ST, PC, UPS AND OBC (NCL)

4.1 Scheduled Caste, Scheduled Tribe, Physically Challenged and Other Backward Classes (NCL)

(i) There would be reservation of seats as well as Junior/Senior Research Fellowships [ICAR-JRF/SRF(PGS)] to the extent of 15% for Scheduled Caste and 7.5% for Scheduled Tribe candidates in different disciplines. The reservation of seats among SC/ST categories is interchangeable, i.e. if sufficient number of candidates are not available to fill-up seats as well as ICAR-JRF/SRF(PGS) reserved for ST candidates, these can be filled-in from among suitable SC candidates and vice-versa in a given subject as per merit rank in examination. The original SC/ST certificate in prescribed form **(Annexure-V)** is required to be produced for verification at the time of admission. Depending on merit and choice, such candidates can also take seat from the General Category.

(ii) Five percent seats are reserved, **horizontally across all the categories,** in different subjects, for Physically Challenged (PC) candidates suffering from low vision, hearing impairment, locomotor disability or cerebral palsy with appropriate medical certificate mentioning at least 40% disability and found suitable by the Counseling Committee/University official. The candidate applying for admission under this category should submit a copy of the certificate about being physically challenged/disabled from a Govt. Hospital/Medical Board (duly attested by a Gazetted Officer), as per **Annexure-III,** for verification at the time of admission. The criteria for assessing the degree of physical disability may vary from one subject to another. The decision of the admitting University will be final in this regard. If ICAR-JRF/SRF is not available in a particular category to which the PC candidate belongs, then the same would be drawn from General Category depending upon availability.

(iii) Reservation of seats for candidates belonging to Central OBC (NCL) (Non-creamy layer) category would be available at BHU, SASARD Nagaland University, CAU Imphal and Dr. RPCAU, Pusa, Bihar as per the latest Government of India directives applicable at the time of counseling and Hon'ble SC Judgment dated 18th August, 2011 and communication of seats by these universities at the time of counseling. Candidates claiming admission under this category have to produce a Central OBC (NCL) (Non-creamy layer) certificate at the time of admission as per specimen given in **Annexure-VI.**

4.2 Reservation for Remote and Under Privileged States/UT (UPS)

Two percent seats under each discipline would be reserved, horizontally, across categories for the candidates of the remote and Under Privileged States/UTs namely (i) Andaman & Nicobar Island, (ii) Arunachal Pradesh, (iii) Dadra and Nagar Haveli, (iv) Daman & Diu, (v) Goa, (vi) Lakshadweep, (vii) Manipur, (viii) Meghalaya, (ix) Mizoram, (x) Nagaland, (xi) Sikkim and (xii) Tripura where educational facilities in agriculture and allied science subjects either do not exist or have no SAU(s) and who qualify this

examination. UPS candidates will have to produce domicile certificate issued by the competent authority at the time of admission. There will not be any State quota within this quota.

The responsibility for verification of the genuineness of SC/ST/OBC (NCL) (Non-creamy layer), PC and UPS certificate will be of the concerned AU where the candidate has been granted admission on the basis of counseling.

5.0 CONDITIONS FOR THE AWARD OF ICAR-JRF/SRF(PGS)

(i) ICAR-JRF/SRF (PGS) will be awarded on the basis of merit secured in the AICE-JRF/SRF(PGS)-2018 examinationleading toadmission in Ph.D. degree programme inAUs, viz. State Agricultural, Veterinary, Horticultural and Fisheries Universities (SAUs), Central Agricultural University, viz. CAU Imphal, Manipur, Dr. RPCAU, Pusa and Central Universities havingfaculty of agriculture, viz. Banaras Hindu University (BHU), and Nagaland University (School of Agricultural Sciences and Rural Development).**The fellowship will NOT be available for admission in any university other than the AUs as mentioned above.** The admissions to the four ICAR-Deemed-to-be-Universitites, viz. IARI, IVRI, NDRI and CIFE will not be made through AICE-JRF/SRF(PGS)-2018 examination as 100 % seats for Ph.D. programme in these ICAR-DUs will be filled-up through their own national level entrance examination.

(ii) ThefellowshipwillbeadmissibletopersonsofIndianNationalityasdefinedintheConstitutionof IndiaorpersonsdomiciledinIndia.

(iii) The admission and fellowship would be granted only when the candidate seeks admission through counseling conducted by ICAR and pursues Ph.D. degree in anAU. Further, for seeking admission with ICAR-JRF/SRF(PGS),as well as without fellowship, it would be mandatory for the candidate to pursue Ph.D. degree in an AUother than the one from where he/she has obtained Bachelor's or Master'sdegree, i.e. the candidate should not have obtained more than two degrees (includingpursuing of Ph.D.) from the same Institute/AU.

(iv) The fellowship will take effect from the date the fellow joins the course or the start of academic session for which fellowship has been offered, whichever is later. Students must take admission for the relevant degree program within the same academic session failing which admission and fellowship shall stand withdrawn automatically.It will not beextended under any circumstances.

(v) A fellow will not be allowed to avail any other scholarship/fellowship during the tenure of fellowship of the Council. In case a candidate is already receiving any other scholarship/fellowship, it will be surrendered by him/her before accepting the ICAR fellowship.
Duration of ICAR-JRF/SRF (PGS) will be normally for three years and may be extended for one more year (total duration not exceeding 4 years under special circumstances) in accordance with the rules and regulations/guidelines issued by the Council from time to time in this regard.

(vi) If an existing ICAR-SRF (PGS) holder seeks fresh admission, the entire amount of fellowship received by him/her shall have to be refunded with interestand he/she will not be entitled for fresh ICAR-JRF/SRF(PGS), however, admission would be granted as per his/her merit rank.

(vii) Ifalreadyregisteredas a fulltimePh.D.Scholar,he/sheshouldnothavecompletedtwoyears on thedate of examination. The candidate should ensure this at the time of applying for the examination. The onus of verification shall lie with the admitting University.The duration of fellowship in such cases, however, normally shall not exceed 3 years, including the period of study already availed for Ph.D.

(viii) Admission and JRF/SRF willbeawarded subject to verification of credentialsbytheUniversitywherethecandidateseeksadmission.

(ix) NoTAandDAwillbepaidtothecandidateforappearingintheExaminationattheCentreor forjoining the University.

(x) Incaseofin-servicecandidates,admission and fellowship will be granted provided the candidatejoinstheUniversity**other than wherehe/she isworking**. For such candidates,inreceiptoffull/partialleave salaryfromtheirparentorganization,theamountofICAR-JRF/SRFshallbelimitedtoRs.3,000/- p.m.inadditiontotheresearchcontingencyasapplicabletofreshcandidates.

(xi) The fellowship will be tenable only attheUniversitywherePh.D.programmeconsistsofboth courseandresearch work.

(xii) The JRF/SRF(PGS) holder will be required to maintain an OGPA/CGPA of 7.00 out of 10.00 (6.50/10.00 for SC/ST/PC) at the end of each year of the study.

6.0ELIGIBILTYREQUIREMENTS

Indian nationals having passed Master's Degree programme securing an Overall Grade Point Average(OGPA) of at least 6.50/10.00 scale, 3.25/5.00 scale, 2.60/4.00 scale for General,OBC (NCL)and UPS Categories and 5.50/10.00, 2.75/5.00, 2.20/4.00 scale for SC/ST/Physically Challenged (PC) categories, respectively from any recognized University in India and abroad would be eligible. In other cases, where grade-points are not awarded

and only marks are awarded, the candidate must have secured at least 60% marks for General, OBC (NCL) and UPScategory. For SC/ST/PC candidates, the minimum percentage of marks will be 50%.Where OGPA is awarded, equivalence between OGPA and % marks will not be acceptable.There will be no rounding-off of the OGPA/percentage of marks of qualifying examination while deciding the basic eligibility of any candidate for admission e.g. if a candidate obtained 49.99% marks in his/her qualifying examination, then it will not be rounded-off to 50%. The candidates must complete the postgraduate degree in all respects and should haveall the degree-completion requirementson the date of Counseling failing which they will not be considered for admission and the award of fellowship.The admission and fellowship would be granted only when the candidate seeks admission through counseling conducted by ICAR and pursues Ph.D. degree in an AU, except an ICAR-DU, where 100 % seats will be filled-in through its own separate national level entrance examination. Further, for seeking admission with ICAR-JRF/SRF(PGS),as well as without fellowship, it would be mandatory for the candidate to pursue Ph.D. degree in an AU other than the one from where he/she has obtained Bachelor's or Master's degree, i.e. the candidate should not have obtained more than two degrees (including pursuing of Ph.D.) from the same AU. The above eligibilityconditions will also apply to in-service candidates. **It is the sole responsibility of the candidate to check his/her eligibility for AICE-JRF/SRF(PGS) examination before applying. ICAR will not be held responsible for refusing admission and/or ICAR-JRF/SRF(PGS)to any ineligible candidate**.The candidates please note that:

(i) Senior Research Fellowship is a financial assistance given by ICAR for pursuing Ph.D. degree in the field ofAgriculture and Allied sciences.

(ii) Merely qualifying the examination will not guarantee JRF/SRF. Only those candidates will be eligible for JRF/SRF who come in the merit list and after counseling join the University within stipulated time.

(iii) Based upon his/her merit and choice of seat in a particular University, the candidate shall receive a letter of recommendation from ADG(HRD) for admission to Ph.D. degree programme, indicating the award of JRF/SRF(PGS), if applicable, at the time of online counseling.**The Council does not issue a separate certificate to the candidates for the award of JRF/SRF(PGS).**

(iv) Forcertainsubjects/courses, the Universities may have different/additional eligibility conditions/criteria than those listed in the following Table. It is the responsibility of the candidate to check his/her eligibilityat the time of counseling with the official(s)of the University where admission is desired. The list of accredited Universities along with the contact details of Registrars for seeking admission to Ph.D. programmes is given at **Annexure-IV**.

(v) The in-service candidates qualifying for admission will arrange for study leave/leave of the kind due from their respective organizations themselves and ICAR will not intervene in this regard.

(vi) The in-service candidates must be working in ICAR Institutes, DUs, SAUs, CAUs, CUs having faculty of agriculture, Central Government/State Government Departments dealing in Agriculture and Allied Sectors and Public Sector Undertakings dealing with Agriculture and Allied Sectors**(AnnexureVII)**.In-service candidates desirous of admission in ICAR-DUs should appear in the national level entrance examination conducted by the respective DU.

Table 2: Eligibility qualifications at Master's level for Ph.D. admission and award of JRF/SRF(PGS) in different subjects/disciplines

Major Subject Group Code	Major Subject	Sub-subject in Ph.D. programme	Eligibility Qualifications* for SAU/CAU,etc. (Master's Degree in)
01	**Crop Sciences-I**	1.1 Genetics & Plant Breeding	Master's degree in Genetics & Plant Breeding.
		1.2 Seed Science & Technology	Master's degree in Seed Science & Technology
02	**Crop Sciences-II**	2.1 Plant Pathology	Master's degree in Plant Pathology/Plant Protection with specialization in Plant Pathology
		2.2 Nematology	Master's degree in Nematology/Plant Protection with specialization in Nematology
		2.3 Agricultural Entomology/Entomology	Master's degree in Agricultural Entomology/ Entomology/Plant Protection with specialization in Entomology
		2.4 Agricultural Chemicals	Master's degree in Agricultural Chemicals
03	**Crop**	3.1 Plant Biochemistry/Biochemistry	Master's degree in Plant

	Sciences-III		Biochemistry/Biochemistry
		3.2 Plant Physiology/Crop Physiology	Master's degree in Plant Physiology/Crop Physiology
		3.3 Agricultural Biotechnology/Biotechnology/Molecular Biology & Biotechnology	Master's degree in Agricultural Biotechnology/Biotechnology/Molecular Biology & Biotechnology
		3.4 Agricultural Microbiology/Microbiology	Master's degree in Agricultural Microbiology/ Microbiology
04	**Horticulture**	4.1 Vegetable Science/Olericulture	Master's degree in Vegetable Science/Olericulture/Horticulture with specialization in Vegetable Science
		4.2 Fruit Science/Pomology	Master's degree in Fruit Science/ Pomology/Horticulture with specialization in Fruit Science
		4.3 Floriculture & Landscaping/Floriculture & Landscape Architecture	Master's degree in Floriculture & Landscaping/ Floriculture & Landscape Architecture /Agriculture / Horticulture with specialization in Floriculture and Landscape Architecture
		4.4 Spices, Plantation & Medicinal & Aromatic Plants	Master's degree in Spices, Plantation, Medicinal & Aromatic Plants/ Agriculture/Horticulture with specialization in Spices/Plantation Crops /Medicinal and Aromatic Plants
		4.5 Horticulture	Master's degree in Agriculture with specialization in Horticulture/Master's degree in Horticulture
		4.6 Post Harvest Technology (Horticulture)	Master's degree in Agriculture with specialization in Horticulture OR Master's degree in Horticulture/Fruit Science or Pomology/Vegetable Science or Olericulture/Floriculture or Floriculture & Landscaping /Spices/Plantation Crops/Medicinal & Aromatic Plants OR Master's degree in Post-harvest Technology with specialization in Horticultural Crops
05	**Veterinary and Animal Sciences-I**	5.1 Animal Genetics & Breeding	Master's degree in Veterinary Sciences with specialization in Animal Genetics and Breeding
		5.2 Animal Nutrition	Master's degree in Veterinary Sciences with specialization in Animal Nutrition
		5.3 Livestock Production Management	Master's degree in Veterinary Sciences with specialization in Livestock Production Management
		5.4 Livestock Products Technology	Master's degree in Veterinary Sciences with specialization in Livestock Products Technology
		5.5 Poultry Science	Master's degree in Veterinary Sciences with specialization in Poultry Science
		5.6 Veterinary Physiology	Master's degree in Veterinary Sciences with specialization in Animal Physiology/Veterinary Physiology
06	**Veterinary and Animal Sciences-II**	6.1 Veterinary Parasitology	Master's degree in Veterinary Parasitology
		6.2 Veterinary Public Health/Veterinary Public Health & Epidemiology	Master's degree in Veterinary Public Health/ Vety. Public Health & Epidemiology/Vety. Epidemiology
		6.3 Veterinary Biochemistry	Master's degree in Veterinary Sciences with specialization in Vety. Biochemistry
		6.4 Animal Biotechnology	Master's degree in Veterinary Sciences with

			specialization in Animal Biotechnology
		6.5 Veterinary Microbiology	Master's degree in Veterinary Sciences with specialization in Microbiology/Bacteriology/Virology/Immunology
		6.6 Veterinary Pathology	Master's degree in Veterinary Pathology
07	**Veterinary and Animal Sciences-III**	7.1 Veterinary Medicine	Master's degree in Veterinary Medicine/ Preventive Veterinary Medicine/ Veterinary Clinical Medicine
		7.2 Veterinary Pharmacology & Toxicology	Master's degree in Veterinary Pharmacology and Toxicology/Veterinary Pharmacology
		7.3 Vety. Gynaecology & Obstetrics/Animal Reproduction, Gynaecology & Obstetrics	Master's degree in Vety. Gynaecology & Obstetrics/Animal Reproduction, Gynaecology & Obstetrics/Animal Sciences with specialization in Animal Reproduction and Gynaecology
		7.4 Veterinary Surgery & Radiology/Veterinary Surgery	Master's degree in Veterinary Surgery & Radiology/Veterinary Surgery
		7.5 Veterinary Anatomy/Veterinary Anatomy & Histology	Master's degree in Veterinary Anatomy/Vety. Anatomy & Histology
08	**Dairy Science, Dairy Technology & Food Technology**	8.1 Dairy Chemistry	Master's degree in Dairy Chemistry/ Veterinary/Animal Sciences with specialization in Dairy Chemistry
		8.2 Food Technology	Master's degree in Food Science/ Food Technology/Food Science and Technology/ Post Harvest Technology
		8.3 Dairy Microbiology	Master's degree in Dairy Microbiology/ Veterinary/Animal Sciences with specialization in Dairy Microbiology
		8.4 Dairy Technology	Master's degree in Dairy Technology or Dairy Science/Dairy Engineering/Livestock Products Technology/Food Technology with specialization in Dairy Technology
09	**Agricultural Engineering and Technology**	9.1 Farm Machinery and Power Engineering	Master's degree in Agricultural Engineering/Mechanical Engineering with specialization in Farm Machinery and Power/Renewable energy
		9.2Soil and Water Conservation Engineering/Soil and Water Engineering	Master's degree in Agricultural Engineering with specialization in Soil and Water/Soil and Water Conservation/Civil Engineering /Irrigation and Drainage Engg./Water Resources /Water Science and Technology
		9.3Agricultural Processing and Food Engineering	Master's degree in Agricultural Engineering with specialization in Agricultural Processing Engineering/Processing & Food Engg./ Food Process Engineering/Dairy Engineering/Post Harvest Technology/Renewable Energy Engg.
		9.4 Renewable Energy Engineering	Master's degree in Agricultural Engineering with specialization in Renewable Energy/ Farm Machinery and Power Engg./Processing & Food Engg.
		9.5 Irrigation Water Management Engineering/Irrigation & Drainage Engineering	Master's degree in Agricultural Engineering with specialization in Soil and Water/ Soil and Water Conservation/Irrigation and Drainage/Hydrology/Water Resources/Water Science and Technology

10	**Home Science (Currently renamed as Community Science)**	10.1 Family Resource Management	Master's degree in Home Science with specialization in Family Resource Management
		10.2 Textile and Apparel Designing	Master's degree in Home Science with specialization in Textile and Clothing/Textile and Apparel Designing
		10.3 Human Development and Family Studies/Human Development	Master's degree in Home Science with specialization in Child Development/Human Development and Family Studies
		10.4 Foods and Nutrition/Human Nutrition	Master's degree in Home Science with specialization in Foods and Nutrition
		10.5 Home Science Extension and Communication Management	Master's degree in Home Science with specialization in Home Science Extension/Home Science Extension and Communication Management
11	**Fishery Sciences**	11.1 Aquaculture	Master's degree in Fisheries Science with specialization in Aquaculture/Mariculture/Aquatic Environmental Management/ Inland Aquaculture
		11.2 Fisheries Resource Management	Master's degree in Fisheries Science with specialization in Fisheries Resource Management/AquaticEnvironmental Management
		11.3 Fish Process Technology	Master's degree in Fisheries Science with specialization in Fish Processing Technology/Post Harvest Technology
		11.4 Fish Nutrition & Feed Technology	Master's degree in Fisheries Science with specialization in Fish Nutrition/Fish Physiology & Biochemistry/ Feed Technology/Fish Nutrition and Biochemistry
12	**Natural Resource Management -I**	12.1 Forestry/ Agroforestry	Master's degree in Forestry/Agroforestry/ Agronomy/Horticulture with specialization in Agroforestry
		12.2 Agricultural Meteorology	Master's degree in Agricultural Meteorology/ Agricultural Physics with specialization in Agricultural Meteorology
		12.3 Environmental Sciences	Master's degree in Environmental Science/ Agroforestry/Agricultural Physics/Agriculture/Forestry with specialization in Environmental Science
13	**Natural Resource Management -II**	13.1 Agronomy	Master's degree in Agriculture with specialization in Agronomy/Soil Water Management/Forage Production/ Water Science and Technology
		13.2 Soil Sciences/Soil Science & Agricultural Chemistry	Master's degree in Agriculture/Horticulture with specialization in Soil Sciences/Soil Science & Agricultural Chemistry/Agricultural Physics with specialization in Soil Physics and Soil and Water Conservation/Water Science and Technology
14	**Agricultural Economics & Agri-Business Management**	14.1 Agricultural Economics	Master's degree in Agricultural Economics/Dairy/Animal Husbandry Economics/ Veterinary Economics/Fisheries Economics
		14.2 Agribusiness Management	Master's degree in Agribusiness Management/Agricultural Marketing & Co-operation/Agricultural Economics/Business Management with specialization in Agriculture

15	**Agricultural Extension**	15.1 Agricultural Extension/Extension Education/Communication	Master's degree in Agricultural Extension/ Extension Education/Communication/Veterinary Extension/Dairy Extension/Fisheries Extension
16	**Agricultural Statistics**	16.1 Agricultural Statistics	Master's degree in Agricultural Statistics/Statistics/Computer Application in Agriculture/Bioinformatics

***NOTE**:

1. Candidate must fulfill the eligibility conditions as indicated above. The candidates are generally eligible for pursuing Doctoral degree in the subject in which they have passed their postgraduation.
2. The candidates should note that 4/5(BVSc & AH)/6 (10+6, BSc. Ag.) years' UG degree and 2 years' PG degree with thesis workare the essential requirements for admission to doctoral degree programmes in the AUs.**The candidates having passed with 3 years' UG degree programme are not eligible for Ph.D. admission through AICE-JRF/SRF(PGS)**. ICAR will not be responsible for denial of admission by the AUs to candidates withoutthese qualification(s).

6.1 Ensuring Eligibility Requirements are Satisfied

Candidateshould fill in the online applicationwithduecare andmustensurethathe/shefulfillstheeligibilityrequirementsfortheexamination aswellasadmissionas detailedin this Information Bulletin. Applying for AICE-JRF/SRF(PGS), appearing in the examination and qualifying the same does not necessarily mean acceptance of eligibility. The applicant for a particular Sub-subject must satisfy the eligibility criteria as specified in this Information Bulletin (or its amendments/corrections). **Nocertificatesarerequiredtobeattachedatthetimeofonline submission ofapplication**.Theeligibilityofthecandidatefortheexaminationandadmissionisnotcheckeduntil thedate of personal appearance of the candidate in the allotted university when the related documents will be checked and verified. It means the documents/certificates etc., will be checked directly at the time of admission by the admitting university. Incasethecandidateisfoundnot eligible atanystage,his/her candidaturewouldbesummarilyrejected and admission will be cancelled.

7.0 AGE

Indian Nationals of at least 20 years of age as on 22.06.2018(i.e. the date of examination) are eligible to apply for the examination. No relaxation is admissible regarding the minimum age limit.

8.0 INSTRUCTIONS TO CANDIDATES

8.1 Instructions for Online Application

All candidates desirous of seeking admission to any programme of study through AICE-JRF/SRF(PGS) shall be bound by the conditions as laid down in this Information Bulletin; and the rules and regulations as enshrined in the admitting University Act, Statutes, Ordinances, notifications and guidelines issued from time to time.

Application will be allowed to be submitted **ONLINE** only. **No application will be accepted in any other format/mode and summarily rejected.**

The candidate should visit www.icar.org.in or www.aieea.netand click the option of filling online application for AICE-JRF/SRF(PGS)-2018. **The candidate should download the Information Bulletin, study it carefully before proceeding to fill in theonline application.**Each item of application has to be attended and carefully filled-in before final submission of the online application.

Before starting to fill in the application form, the candidate should have a scanned image of:

(i) Recent, clear, colour photograph bearing his/her name and date.
(ii) Signature
(iii) Thumb impression (his left/her right hand)
(iv) Declaration in his/her handwriting as under:

"I agree to abide by the rules and regulations governing the examination as contained in the Information Bulletin, which I have duly studied and understood thoroughly".

These scanned images are to be uploaded during the filling up of application form. The photograph should be in colour indicating name of the candidate and date of taking the photograph as shown in the image below. The photograph should be taken by the candidate without wearing cap and/or goggles/sunglasses. Spectacles are allowed. Candidates with unclear photograph are liable to be rejected. Candidates may keep 3 extra identical photographs in reserve for use at the time of entrance examination and admission in the allotted university.

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The candidate is also required to keep in mind the following instructions while filling up of online application.

(i) Write the complete e-mail address and phone number in the form carefully. Please note that this email address and phone number may be used by the Council for future communication.

(ii) It is mandatory to provide **Aadhaar number or 28 digit Aadhaar Enrolment ID or passport number or ration card number or driving license number or any other valid Govt. identity card number while filling the online application form.**

(iii) The candidates are not required to upload any certificates/marks sheet etc., with the application. It is the sole responsibility of the candidate to ensure that he/she fulfills the specified eligibility in toto before appearing in the examination.

(iv) The candidates appearing in the final qualifying examination are also eligible to apply and may appear in this entrance examination, but they must produce documentary evidence of their acquiring eligibility on the date of admission in the allotted university.

(v) A candidate can apply for taking examination in only one Major Subject Group. However, the candidate is required to attempt questions from all of the Sub-subjects listed under a Major Subject Group

(vi) The candidate is required to give the option of degree programme (**Sub-subject**) for admission at the time of filling online application form as his/her merit will be drawn in the Sub-subject opted by him/her. No change in the opted Sub-subject would be allowed thereafter.

(vii) The candidate is not required to give any option for Agricultural Universities for admission at the time of filling up online application form. The admission/allotment of seat in the Agricultural University will be made through online counseling on the basis of Sub-subject opted by him/her at the time of filling online application and depending upon the availability of seat at his/her merit-rank in the opted Sub-subject and fulfilment of other eligibility requirements.

(viii) The reservation category being claimed by the candidate must be filled in correctly. Selection should be made as under:

SC - for Scheduled Caste
ST - for Scheduled Tribe
PC - for Physically Challenged
UPS - for Under Privileged States
OBC (NCL) - for Other Backward Classes having Central OBC certificate
GEN - for General category

In the event of leaving the reservation category column blank, the candidate would be considered under General Category.

(ix) The candidate should submit Online application, filled-in correctly and complete in all respects, including payment of prescribed fee, and after downloading should preserve three hard copy of computer generated online application, for the purpose of any future correspondence, counseling and admission in the event of his/her being declared qualified on the basis of CBT. Any incomplete application or application without prescribed fee payment will not be considered and no claim/correspondence shall be entertained by the Council in this regard.

(x) If a candidate at any stage is found to have furnished wrong information or deliberately suppressed any maerial information, his/her candidature/admission will be rejected/cancelled as soon as it comes to the notice of either ICAR or the university concern.

(xi) **For any future correspondence, the candidate must quote his/her name, sex, the name of examination i.e. AICE-JRF/SRF(PGS)-2018, Major Subject Group (with code), Sub-subject (with code), Application number, Examination City Centre chosen (three choices, in order of priority to be given), Aadhaar Number or applicable ID proof Number.**

(xii) In all communications regarding submission of application or otherwise related to admissions, the copy of the application form must be submitted, as otherwise the communication would be deemed incomplete and no processing would be performed on the communication, without any notice to the applicant.

8.2 Making payment through Credit/Debit card/Netbanking using online Payment Gateway

During online filling of the form, candidate can opt for making fee payment through Credit/Debit card/Netbanking using online Payment Gateway. **Any refund related to registration fee of online counseling (in case of non-allotment of seat) or fee of ₹1,000/- to challenge the answer keys (for details refer Item No. 10.5) etc., will be made online to the concerned Credit/Debit card/Net banking account. The candidates/parents are, therefore, advised to use their own credit/debit card/Net banking for making above payment.**

8.3 e-Admit Card

e-Admit Card can be downloaded from www.aieea.net from 14.06.2018 onwards. This copy of e-Admit Card must be self-attested by the candidate and brought to the Examination Hall for appearing in the examination. **Candidate may note that without self-attestation of photo as well as signature and thumb impression of the candidate on e-admit card, he/she will not be allowed to appear in the examination.** Candidate is advised to preserve this e-Admit card till completion of counseling and admission process in the allotted AU. In case of any difficulty in obtaining the Roll No./examination venue from www.aieea.net, the candidate is advised to contact the Helpline Nos. two days before the scheduled date of examination.

9.0 VALUEANDTENUREOFFELLOWSHIP

TheFellowshipwillbeawardedtothe candidatesseekingadmissionintheListedSAUs, CAU,CUshaving faculty of agricultureoranyotherapprovedUniversity/Institute under the ICAR-AU system (except the four ICAR-DUs), wherePh.D.degreeprogrammeconsistsofcourseworkwith definitecredithoursandresearchwork with thesis. Therates of fellowshipwillbeas under:

Postgraduate other than in Veterinary Science ₹ 15,000/- p.m. (fixed) for 1st & 2nd year
₹17,500/- p.m. (fixed) for 3rdyear

Postgraduate in Veterinary Science ₹17,500/- p.m. (fixed) for 1st & 2nd year
₹ 18,750/- p.m. (fixed) for 3rd year

Contingentgrantof₹10,000/-peryearforprocurementofessentialchemicals,books,andtravelconnected withresearchworkwillbeuniformly paidtoalltheawardees including in-service candidates. Not more than 50% of the contingent grant will be spent for purchase of books. All purchases are to be made with the approval of the Major Advisor/Chairman of Student Advisory Committee. All the candidates who have been awarded ICAR-JRF/SRF (PGS) will have to execute a surety bond of appropriate amount as per University rules and regulations at the time of registration in the University to ensure completion of the program undertaken with scholarship/fellowship support. The AU will ensure that if the candidate leaves before completion of the program, he/she refunds the scholarship/fellowship amount drawn by him/her to the Council.

In case of in-service candidates, the fellowship will be awarded, provided the awardee joins the University/Institute other than where he/she is working. For such candidates, in receipt of full/partial leave salary from their parent organization, the amount of ICAR-JRF/SRF(PGS) shall be limited to Rs.3,000/- p.m. in addition to the research contingency as applicable to fresh candidates.

10.0 GENERAL SCHEME OF ONLINE ENTRANCE EXAMINATION

10.1 (a) Guidelines for Candidates

1. The issuance of e-Admit Card to the candidate is provisional subject to his/her satisfying the eligibility requirements.
2. Candidates are advised to reach the venue at least 1½ hours before the examination so as to complete the frisking and registration formalities well before the time. Gates will be closed 15 minutes prior to the examination.
3. **The candidate who does not possess both e-Admit Card and a valid Govt. ID (Aadhaar card or 28 digit Aadhaar Enrolment ID proof or a passport or ration card or driving license or any other valid Govt. Identity proof) will not be admitted to the Examination Hall under any circumstances.**
4. ICAR reserves all rights to verify the identity and genuineness of each candidate by any means that is considered appropriate. For verification, candidate may be searched at any time during the examination.
5. The examination will start strictly on time and an announcement to this effect will be made by the Invigilator.
6. The candidate must show, on demand, the e-Admit Card for admission in the examination room/hall. A candidate who does not possess the e-Admit Card issued by the ICAR shall not be permitted for the examination under any circumstances by the Centre Incharge.
7. A candidate claiming relaxation under PC category must carry with him/hera copy of PC certificate [for details refer para 4.1 (ii)].
8. No candidate, under any circumstances, will be allowed to enter the Examination Centre after the commencement of examination.
9. A seat indicating roll number will be allocated to each candidate. The candidate should find out and occupy the allotted seat only. If a candidate is found to have changed room or the seat on his/her own other than the allotted one, his/her candidature shall be cancelled and no plea would be accepted for it.
10. No candidate will be allowed to carry any baggage inside the Examination Centre. Council will not be responsible for loss of any belongings at the premises.
11. Candidates are not allowed to carry any textual material, Calculators, Docu Pen, Slide Rules, Log Tables, Electronic Watches with facilities of calculator, printed or written material, bits of papers, mobile phone, pager or any other device, except the e-Admit Card, AADHAAR Card or applicable ID proof, as described under Item 2. above, inside the Examination Room/Hall. If any candidate is in possession of any of the above items, such items will be seized, his/her candidature treated as unfair means, current examination cancelled and he/she will also be debarred for future examination(s).
12. Smoking and eating is strictly prohibited in the examination room.
13. Tea, coffee, cold drinks or snacks are not allowed to be taken into the examination room during examination hours.
14. The candidate may approach the Centre Incharge/Invigilator in the room for any technical assistance, first aid emergency or any other information during the course of examination.
15. No candidate, without the special permission of the Centre In-charge /Invigilator will leave his/her seat or Examination Room until the full duration of the exam is over i.e. 10.00 A.M. to 01.00 P.M. The candidate must follow the instructions strictly given by the Centre In-charge/Invigilators.
16. For any queries or issues regarding computer-based examination, the candidates may contact the Helpline Nos.
17. Online Mock Test will be available at www.aieea.net from 14.06.2018 onwards.
18. The candidates, suffering from diabetes, are allowed to carry the eatables like sugar tablets/fruits (like banana/apple/ orange) and transparent water bottle inside the examination hall. However, they are not allowed to carry packed foods like chocolate/candy/sandwich in the examination hall.

10.1 (b) Code of Conduct for Candidates during CBT

Candidates shall maintain perfect silence and attend to their Question Paper only. Any conversation or gesture or disturbance in the Examination Room/Hall shall be deemed as misbehaviour. If a candidate is found using unfair means or impersonating, his/her candidature shall be cancelled and he/she will be liable to be debarred for taking examination either permanently or for a specified period according to the nature of offence.

Candidates are not allowed to carry any textual material, Calculators, Docu Pen, Slide Rules, Log Tables, Electronic Watches with facilities of calculator, printed or written material, bits of papers, mobile phone, pager or any other device, except the e-Admit Card, AADHAAR Card or applicable ID proof inside the Examination Room/Hall. If any candidate is in possession of any of the above items, such items will be seized, his/her candidature treated as unfair means, current examination cancelled and he/she will also be debarred for future examination(s).

10.2Instructions for Computer Based Test

The Computer Based Test will be conducted as per the following schedule.

1. To give the candidate a look and feel of the Computer Based Test (CBT), a sample/mock test will be available for practice purpose at www.aieea.net from 14.06.2018 onwards.
2. The test will start exactly at the time as mentioned in the e-Admit Card and an announcement to this effect will be made by the invigilator.
3. The test will be of 3 hrs duration (10.00 A.M. to 01.00 P.M.).
4. For subjects to be attempted in the Entrance Examination, please refer toItem 2.0 (Degree programmes available for admission).
5. Syllabus for the Examination is given at **ANNEXURE-I.**
6. The candidate should ensure that the Question Paper available on the computer is as per choice of the Sub-subject (under the specified Major Subject Group) exercised by him/her at the time of filling-in of application form. If different, the same should immediately be brought to the notice of the invigilator concerned.
7. The format for the question paper carrying maximum 200 marks will be as under:
   Section A – This section on General Knowledge, common to all the major subjects, will comprise 20 MCQs (Sr. No. 1-20) of one mark each carrying a total of 20 marks. The questions will be designed to test the ability of candidate's awareness of the environment around him/her and its application to the society and will contain questions on General Knowledge in Agriculture, Animal Husbandry, Dairying, Fisheries and Allied Sciences, etc. including current events and such matters of everyday observation and experience as may be expected to be known to a research scholar.
   Section B – This section will comprise of 180 MCQs (Sr. No. 21-200), of one mark each, on a specific Major Subject Group (Code No. 1-16, as applicable, and including syllabus of different sub-subjects listed under that Major Subject Group) chosen by the candidate, carrying a total of 180 marks.There will be negative marking of (-)0.25 marks for each wrong answer.
8. There is only one correct response for each question out of four responses given.Question with no response indicated will not be awarded any mark and there will be no negative marking for that question. The candidates are advised not to attempt such questions, for which they are not sure of the correct answer.
9. The Ball Pens will be supplied to the candidates in the examination hall, so they should not bring any type of Pen/Ball pens with them.
10. All calculations/writing work are to be done only in the rough sheet provided at the centre and on completion of the test, candidates must hand over the rough sheets to the invigilator(s) on duty in the Room/Hall.

11. During the examination time, the invigilator will check e-Admit Card and applicable Identity proof (Matching the candidate's face with colour photo on the attendance sheet) of the candidate to satisfy himself/herself about the identity of each candidate.
12. The candidates are governed by all Rules and Regulations of the Council with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per rules.
13. The candidates must sign and put thumb impression on the Attendance Sheet at the appropriate place.
14. A visually challenged (blind) candidate or a candidate having locomotor disability, can request for the services of amanuensis (Scribe) who must be one grade junior in academic qualification, i.e. not more than graduate in the present case, and should not be related to the candidate. For amanuensis, the candidate must submit a separate request letter, at least one week in advance, to the concerned Centre Incharge giving a copy of the Physical Disability/PC Certificate issued by a competent authority. The services of amanuensis (Scribe), who should be from academic discipline other than that of the candidate, shall be provided free of cost by the Centre Incharge. The scribe will have to give a suitable undertaking, confirming that he/she fulfils all the stipulated eligibility criteria for a scribe as mentioned above. In case, later on, it is proved that the candidate has suppressed material facts, the candidature of the applicant will stand cancelled, irrespective of the outcome of result of the written test. Such candidates who use a scribe shall be eligible for extra time of one hour during examination.

10.3 Examination City Centres

(i) While applying, candidates must select three Examination City Centres in order of their preference. Since the seating capacity at each centre is limited, they will be considered for the allotment of the examination city centresbased upon first come-first served basis.

(ii) **The Examination City Centre, once opted, shall not be changed. The e-admit card will be uploaded on ICAR website www.icar.org.in or www.aieea.net. Please check the e-admit card carefully for your Name, Major Subject Group, Sub-subject, Date of Birth, Gender, Examination Centre Name, City, State Code of Eligibility and Category, etc. In case of any discrepancy, communicate to Helpline immediately for necessary correction.**

Note:

(i) The exact name/location of Examination venue in the Examination city centre will be notified later along with the Roll Number in accordance with the Application Number and password and shall be available on ICAR website www.aieea.net 14.06.2018 onwards.

(ii) ICAR may change/shift the examination city center opted by the candidate to another nearby centre, if number of candidates are more at any city center.

10.4 Evaluation and Declaration of Result

(i) The candidate's responses in CBT will be matched with Major Subject Group-wise Answer Key template and marks shall be generated for the candidates as per specified marking scheme and the cutoff decided. The overall merit-rank list shall be prepared separately for every Sub-subject under each Major Subject Group. The result will also be prepared Roll number-wise indicating the category. The ranks of candidates who do not qualify in AICE-JRF/SRF(PGS)-2018 will not be declared.

(ii) In the event of candidates getting equal marks in the Competitive examination, relative merit will be determined on the basis of OGPA/% of marks obtained in the qualifying Master's degree examination. In the event of tie again, a candidate, higher in age, would be rated higher in merit. **Category-wise final merit list for counseling shall be prepared strictly based on the reservation category information given by the candidate in the online application**. The in-service candidates will qualify for admission only if they come in the overall merit list of their concerned Sub-subject and produce the Sponsorship Certificate/Declaration by the employer of the candidate for verification at the time of

counseling.For any wrong information given by the candidate with regards to age, Sub-subject, reservation category etc., the Council shall not be responsible for any loss to him/her on this account.

(iii) The result of the AICE-JRF/SRF(PGS)-2018 is likely to be declared in the last week of June, 2018 and will be placed on the ICAR website (www.icar.org.in or www.aieea.net). No separate intimation will be made to those candidates who fail to qualify in this examination. No queries in this regard, whatsoever, will be entertained from such candidates.

(iv) Only the Overall Merit Rank will be used for admissions in AUs through Online Counseling to be done by ICAR, while other ranks are for information purposes only.

(v) All announcements related to the conduct of competitive examination including issue of examination notification, e-Admit card information, CBT, examination result, schedule of online counseling, general notices, etc., would be posted and available on the ICAR website. The candidates are advised to be vigilant about the announcements on the ICAR website, as the ICAR would not be held responsible for non-receipt of any information/letter by e-mail/SMS.

(vi) No separate intimation about non-selection of the candidate in AICE-JRF/SRF(PGS)-2018 examination and marks obtained therein (marks can be displayed with result), will be sent to the candidate and no correspondence (Letter/Fax/e-mail, etc.) will be entertained in this regard. The result shall be uploaded on ICAR website www.icar.org.inor www.aieea.netand kept till the counseling in a particular programme is over. Along with result, the linkup will be provided to download the schedule of online counseling containing relevant instructions.

10.5 Challenging of Answer Keys

The answer keys of CBT will be displayed on the website www.icar.org.inor www.aieea.netgiving sufficient time (to be notified later on the ICAR website/through public notice in newspapers). The candidates, who are not satisfied with the captured response, may challenge by filling online application form and paying a sum of ₹1,000/- per question. The challenge of answer keys will also be accepted online only through the link available on the website www.icar.org.in or www.aieea.net on payment of ₹1000/- per question. The fee can be paid by credit/debit card/Net banking. The fee once paid is non-refundable, however, in case the challenge is accepted by the Council, the fee of ₹1,000/- for each accepted challenge will be refunded to the concerned candidate. Such refund will be made online to the concerned credit/debit card/Net banking account. The candidates/parents are, therefore, advised to use their own credit/debit card for making above payment. The ICAR's decision on the challenges shall be final without entertainment of any further communication from the candidates/parents.

11.0 METHOD OF SELECTION AND ADMISSION THROUGH ONLINE COUNSELING

11.1 MethodofSelection

(i) Thecandidatesdeclared/notifiedasqualifiedforcounseling, based on their merit-rank, shall register for online counseling as per counseling instructions given at Item 11.2. Candidate shall forfeittheclaimforadmissionifhe/she,doesnotregister forcounseling within specified date and time.**Candidatewhohasnotbeendeclared/notifiedasqualifiedforcounseling,shall notbeconsideredforadmissiononICARquota seatsinanyAU atanystage.**

(ii) CandidatewillberecommendedforadmissionintheaccreditedSub-subject under the Major Subject Group at the accredited AU on the basis of merit in the competitiveexamination and availability of seats at his/her rank at the time of online counseling. ICAR-JRF/SRF (PGS)will be awarded based on merit rank in theSub-subjectoptedforadmission,andavailabilityofseatfor that sub-subject in thedesireduniversity.

(iii) Listoforiginaldocumentswithself-attestedphotocopies,photographstobeproducedatthetimeof admission in the allotted university:

(a) Proof of date ofbirth-HighSchool/ClassX/Matriculation certificate.

(b) AllCertificatesandMarksheets,/gradereportsinoriginal,relatedtoUG/Bachelor's degree.

(c) AllCertificatesandMarksheets/gradereportsinoriginal,relatedtoPG/Master's degree.

(d) Candidates reporting for the admission must have Degree/Provisional Degree Certificate (PDC) of completion of Master's degree programme. The candidates who do not have the Degree/PDC, have to mandatorily produce a certificate from the Registrar of the concerned university specifically indicatingthat ***the candidate has fulfilled all the requirements for the award of Masters degree including thesis submission andcompletion of viva-voce and his/her Final OGPA/Percentage of marks at the end of final semester/year along with mentioning the likely date of issuance of PDC/Degree***.The candidates should note that the university may deny admission in case the PDC/Degree is not produced at the time of admissionwith the university. No correspondence shall be entertained by the Council in this regard.

(e) E-admit Card, hard copy of online applicationform, counseling letter and provisional allotment letter issued by the ICAR to qualified candidates related to admission.

(f) Threerecentandclearpassportsizecolourphotographs (bearing name of the candidate and date) sameasuploaded with online application form.

(g) Aadhaar card or 28 digit Aadhaar Enrolment ID proof/copy of passport/ration card/bank passbook or any other valid Govt. Identity proof as applicable.

(h) Domicile certificate in case of candidates from States/Union Territories,viz. Andaman & NicobarIslands, Arunachal Pradesh, Dadra & Nagar Haveli, Daman and Diu, Goa, Lakshadweep, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura for UPS categories.

(i) IncaseofcandidatesfromSC,ST, UPSandOBC (NCL)categories,originalcertificatesas perCentralGovt.requirementsandissuedbyCompetentAuthority.

(j) MedicalcertificateincaseofPhysicallyChallenged(PC)candidateissuedbyMedicalOfficerof anyGovernmentHospitalalongwithdescriptionofthekindandthedegreeofdisability.

(k) Sponsorship Certificate/Declaration by Employer of the Candidate (for in- service candidates).

11.2 AdmissionthroughOnline Counseling

There will be online counseling only. The candidates declared qualified for counseling for consideration of admission to the Agricultural Universities would be generally larger than the number of seats available, provided they have achieved a minimum of 50% marks for General and UPS categories and a minimum of 40% marks for SC/ST/PC categories in the Entrance examination. For OBC (NCL), it will be as per Supreme Court directives in this regard. The competent authority (DDG, Agril. Edn.) may relax the minimum qualifying marks in case the required number of candidates to be called for counseling are not available.

The Tentative online counseling process involves:

1. For Online Counseling, qualified candidate will have to get registered by paying ₹2,000/- through online payment gateway of ICAR by using Credit/Debit card/Net banking.
2. Only the notified candidate will be able to log on to online counseling page. He /she will be able to access the website from any place of his/her convenience like mobile/home/office, etc.
3. If the candidate does not remember his/her login ID and password, then the login ID/password will be recoverable by input of some personal parameters.
4. Details of available seat matrix (with reservation category), eligibility requirements, process of Online counseling, helpline numbers, parameter based Online search system for previous year admission cut-offs will be available on the home page of the portal. Some other parameters related to accredited universities like course fee, date of registration, hostel facility, etc., will be displayed to facilitate the candidates.
5. The candidates notified for counseling after the entrance examination under different categories shall be permitted to make choice of Courses/University in stipulated time period.
6. Only those accredited programmes shall be displayed whose eligibility qualificationsare fulfilled by the candidate. Similarly, list of only those Universities will be displayed where the accredited programme desired by the candidate is offered.
7. Candidate will be able to select the courses and university one by one in combination to select multiple choices for the courses. There will be provision to add/modify/delete choices during the stipulated time period. Further, provision for interchange/upward movement/downward movement will also be available and permissible any number of times.

8. The procedure for exercising choices or seeking other information will be menu-driven and guide the candidates through appropriate messages on the computer screen.
9. After completion of choice selection, the candidate will save the choices. He/she will be able to take a draft printout, with lock status, so that he/she can discuss the choices filled-with his/her mentors and update the same, if desired.
10. Candidate can update his/her choices any number of times before the last date/until the choices are locked by the candidate. If by the last date and time, the choices are not locked by the candidate, then the last saved choices will be automatically locked.
11. Login ID will be provided to all the accredited AUs to provide access through their login ID and password. The Universities should be able to see the number and details of candidates who have chosen a particular course as their first/second/third choice, etc.
12. The locked choices shall be processed according to merit and available seats on a scheduled date for the allotment of seats. The candidates will be intimated through e-mail/SMS about the University and Course allotted. The list of allotted candidates will be updated in the relevant database.
13. The candidates then will download the provisional allotment letter in PDF format from the portal.
14. For admission, the successful candidates will report to the allotted University. The University will check online details of provisional admission offer (from ICAR) downloadable by the candidates for verification. After checking the original documents of the candidates, the university will issue the **final admission letter online** to the admitted candidates. As a consequence of this, the university will update the database of the Admissions Given/Admission Denied (with reason)/Auto up-gradation requested by the candidate. If admission is given, then the final admission letter will be generated. If admission is denied, then a regret letter will be generated and all such letters will be in pdf format and ready to print.
15. Subsequent round of online counseling will be conducted immediately after the reporting is complete. The Auto-up-gradation requests to be first tried to give them their better choice. Then the next round shall be started.
16. Thereafter, the same process for subsequent rounds of counseling (if the need arises) will be followed.
17. Candidate, not fulfilling the eligibility condition(s) at the time of admission in the allotted university, will forfeit claim for admission and will not be considered for seat allocation. Candidature in such cases shall be rejected summarily. No correspondence shall be entertained thereafter in this regard.
18. Against total number of ICAR seats available for a particular degree programme in a university, not more than 40% of ICAR seats from one State would be allocated to any one university in that Sub-subject under a particular category. While computing 40% number, mathematical method of rounding to the nearest integer would be adopted except where there is only one seat, in which case, the whole seat would be allocated. While rounding off, the number might exceed 40% to that extent.
19. It should be noted carefully that ICAR allocates the University, whereas the choice of the accredited College within the University allotted shall be regulated by the University itself. **The university will admit and place the candidates in accredited colleges and programmes only.** Candidate may not approach ICAR, thereafter, for any specific College within the allotted University.
20. In case a candidate has been admitted in a university and the subject, after the counseling, any request for change/transfer of subject/university thereafter, will not be entertained by ICAR. The candidate, once admitted in a degree programme as per his/her merit-rank and availability of seat at the time of counseling, will not stake claim for change of subject/University later on after his/her admission is over.
21. All admitted candidates will be required to submit original certificates and mark sheets to the Registrar of the allotted University, otherwise admission may not be granted. All original certificates submitted by the candidates may be sent to their respective Boards and Universities for verification. In case a candidate wishes to withdraw the original certificates after the admission, he/she shall directly request the allotted University for the same if the university rules permit so.
22. If any candidate fails to deposit the prescribed admission fee and original certificates as required by the university, the admission may not be granted and candidate would forfeit his/her claim for admission.
23. In case any degree from a particular college/university is not considered for admission by an Agricultural University or any particular college/university has been derecognized by VCI/UGC, ICAR will not be responsible for admitting students of that college/university in the Universities not willing to admit such candidates.

11.3Registration and admission fee

(i) For online counseling, candidates will be charged one-time registration fee of ₹ 2,000/- by the ICAR which will be non-refundable to the candidates. The University, at the time of final admission, shall charge the admission fee as applicable at the AU minus ₹2,000/- from the allotted candidate. The University shall send a list of admitted candidates to ICAR with the request along with RTGS details (Name of beneficiary, Name of Bank Branch, Bank A/c No., IFSC Code) to transfer ₹2000/- to the University account for the adjustment against the admission fee of the admitted candidates.

(ii) When the candidates report for admission, they shall deposit the fee. Some of the candidates, after depositing the fee, may request for **auto-upgradation** of the University allotted during the previous round of counseling. If admission is given, then provisional admission letter will be generated through online reporting module accessible by the AU through Login ID and password.

(iii) In case, after depositing the admission fee at the AU, the candidate wants to forego his admission due to certain reasons, then, in such cases, the refund policy of the admitting university would prevail.

11.4 Auto up-gradation

A candidate who does not get his/her first choice (in case of multiple choices) may opt for auto-upgradation. A candidate who has applied for auto-upgradation need not report to the university and deposit the admission fee. He/she has to wait for result of the next round of counseling.If the candidate does not get a better seat after auto up-gradation, then his/her previous seat allotment will remain unchanged.

11.5 FillingofVacantseatsafterthe counseling

(i) The ICAR quota seats **after the final round of online** counseling, if remain vacant, shall automatically stand released to the Agricultural University concerned for filling up at their level and as per the procedure in vogue at the respective university. **These seats will no more be called as ICAR seats and treated as university seats**. Once the counseling/admission process is over, filling up of any subsequent vacancies created due to any reasons, shall not be the responsibility of ICAR. No correspondence in this regard will be entertained neither from the universities nor from any candidate.

(ii) The candidate allotted seat through online counseling in a Agricultural University through ICAR examination, shall have to report to the concerned Agricultural University within the given time period for admission to the concerned university. Before proceeding for admission, candidates must enquire about the fee, etc. and carry the same.

(iii) No correspondence from the candidates/guardians/parents will be entertained by the Council for seeking permission for late registration/admission in the universities or issuing any direction in this regard.

12.0 ADMISSION THROUGH ICAR EXAMINATION

(i) Based on the overall merit-rank, the candidate is allowed to take admission in a specific degree programme at an AU as per his/her choice and the availability of seat at that merit rank through the process of counseling as explained at item 11.0. In the matter of allotment/admission of candidates to respective AUs, the decision of the ICAR shall be final. Once a candidate accepts admission/joins an AU, he/she will be a bonafide student of that AU and thereafter, be governed by all the academic rules/regulations including migration, as applicable at that university. ICAR will not entertain any direct request from the candidates in any such matters thereafter.

(ii) Once recommendation for admission is finalized, change in the placement of subject/university or transfer/migration would not be permissible under any circumstances. ICAR will have no responsibility for change of subject/university after the counseling. No correspondence in this respect will be entertained. Canvassing of any kind may invite cancellation of admission.

(iii) Candidate selected for admission through AICE-JRF/SRF(PGS)-2018, conducted by ICAR, may seek admission only during the session for which the examination has been conducted. He/she will not be entitled for admission in subsequent sessions based on this year's examination and thus cannot claim for seat allotment in other sessions/years based on this examination.

(iv) Female candidates admitted through this examination on ICAR seats should be accommodated, to the extent possible, in the main campus of the University or in the campus located in a major city where there are adequate facilities for the stay of female students.

(v) In case, at any stage, the documents submitted by the candidate are found to be fake/forged, admission of the candidate will be forfeited and he/she shall be liable for consequential legal action.

(vi) If the admitting University is not satisfied with the character, past behaviour or antecedents of a candidate, it can refuse to admit him/her.

(i) If any candidate/person engages in act(s) that might possibly lead to the leakage of question paper (s), or attempt to use or help in the use of unfair means in the examination, he/she will be liable to legal action under the Indian Penal Code, and his/her candidature would stand forfeited.

(vii) Any external pressure/canvassing by the candidate for admission will be treated as disqualification and his/her admission will be cancelled forthwith.

13.0 LEGALJURISDICTION

All disputes pertaining to the conduct of examination and any other issues relating to ICAR'sAll India Competitive Examination forJRF/SRF(PGS) to pursue Ph.D. degree programmes shall fall within the jurisdiction of Delhi Courts only. As per Rules and Bye-laws of ICAR Society, it may sue or be sued in the name of Secretary, ICAR.

Note: Studentsarewarnednottoindulgeinanykindofragginginsideoroutsidethecampusoftheeducational institution.AsperHon'bleSupremeCourtdirectives,severedisciplinaryactionwillbetakenbytheconcerned institutionagainstthestudents/personsfoundtobeindulginginragging.

ANNEXURE-I

SYLLABUS FOR THE ALL INDIA COMPETITIVE EXAMINATION FOR ADMISSION TO DOCTORAL DEGREE PROGRAMMES AND THE AWARD OF JRF/SRF(PGS)
[NOTE: Section Bcomprising of 180 MCQs will contain questions fromeach of the Sub-subject listed under a Major Subject Group]

01. CROP SCIENCES-I

(1.1 Genetics & Plant Breeding, 1.2 Seed Science & Technology)

1.1 GENETICS & PLANT BREEDING

Unit 1: General Genetics and Plant Breeding

Mendelian inheritance. Cell structure and division, Linkage, its detection and estimation. Epistasis. Gene concept, allelism and fine structure of gene. Extra chromosomal inheritance. DNA – structure, function, replication and repair. Genetic code. Gene-enzyme relationship. Replication, Transcription and Translation. Gene regulation in prokaryotes and eukaryotes. Nuclear and cytoplasmic genome organization. Spontaneous and induced mutations and their molecular mechanisms. Crop domestication, evolution of crops and centres of diversity. Emergence of scientific plant breeding. Objectives and accomplishments in plant breeding and the role of National and International institutes. Gametogenesis and fertilization. Modes of sexual and asexual reproduction and its relation to plant breeding methodology. Apomixes, incompatibility and male sterility systems and their use in plant breeding.

Unit 2: Economics Botany and Plant Breeding Methods

Origin, distribution, classification, description and botany of cereals (wheat, rice, maize, sorghum, pearl millet, minor millets); pulses (pigeonpea, chickpea, black gram, green gram, cowpea, soyabean, pea, lentil, horse gram, lab-lab, rice bean, winged bean, lathyrus, Lima bean; oilseeds (groundnuts, sesamum, castor, rapeseed mustard, sunflower, Niger, linseed); fibers and sugar crops, fodder and green manures; Breeding methods for self-pollinated, cross-pollinated and clonally propagated crops. Component, recombinational and transgressive breeding. Single seed descent. Populations, their improvement methods and maintenance, Hybrid breeding and genetic basis of heterosis. Ideotype breeding. Mutation breeding, Concept of tree breeding.

Unit 3: Genome Organization and Cytogenetics of Crop Plants

Chromosome structure, function and replication. Recombination and crossing over. Karyotype analysis. Banding techniques. *In situ* hybridization. Special types of chromosomes. Chromosomal interchanges, inversions, duplications and deletions. Polyploids, haploids, aneuploids and their utility. Wide hybridization and chromosomal manipulations for alien gene transfer. Pre-and post- fertilization barriers in wide hybridization. Genome organization and cytogenetics of important crop species- wheat, maize, rice, sorghum, Brassica, cotton, Vigna, potato and sugarcane. Principles and procedures of genome analysis. Cytogenetic techniques foe gene location and gene transfer, Construction and use of molecular marker based chromosome maps. Comparative mapping and genome analysis.

Unit 4: Quantitative and Biometrical Genetics

Quantitative characters. Multiple factors inheritance. Genetic control of polygenic characters. Genetic advance and types of selection and correlated response. Hardy Weinberg law. Linkage disequilibrium. Genetic load. Polymorphism. Breeding value, heritability. Response to selection, correlated response. Estimates of variance components and covariance among relatives. Mating designs with random and inbred parents. Estimation of gene effects and combing ability. Effects of linkage and epistasis on estimation of genetic parameters. Maternal effects. Genotype-environment interactions and stability of performance. Heterosis and its basis. Mating system and mating design- diallel, line X tester, NC-1, NC-II and NC-III designs, approaches to estimate and exploit component of self and cross pollinated crops. Genotype X environment interaction and stability analysis.

Unit 5: Genetic Engineering and Biotechnological Tools in Plant Breeding

Somatic hybridization, micropropagation, somaclonal variation in vitro mutagenesis. Artificial synthesis of gene. Genetic and molecular markers, generations of molecular markers and their application in genetic analyses and breeding. Molecular markers in genetic diversity analysis and breeding for complex characters. Gene tagging, QTL mapping and marker aided selection. Genome projects and utilization of sequence formation. Vectors. DNA libraries, DNA fingerprinting, DNA sequencing. Nuclei acid hybridization and immunochemical detection. Chromosome walking, Recombinant DNA technology, Gene cloning strategies. Genetic transformation and transgenics. Antisense RNA, RNAi and micro RNA techniques in crop improvement.

Unit 6: Plant Breeding for Stress Resistance and Nutritional Quality

Genetic basis and breeding for resistance to diseases and insect-pests. Breeding for vertical and horizontal resistance to diseases. Genetic and physiological basis of abiotic stress tolerance. Breeding for resistance to heat, frost, flood, drought and soil stresses. Important quality parameters in various crops, their genetic basis and breeding for these traits. Role of molecular markers in stress resistance breeding: MAS, MARS and MABB.

Unit 7: Plant Genetic Resources and their Regulatory System; Varietal Release and Seed Production

Plant exploration, germplasm introduction, exchange, conservation, evaluation and utilization of plant genetic resources. Convention on Biological Diversity and International Treaty on Plant Genetic Resources for Food and Agriculture. Intellectual Property Rights. Biodiversity Act. Plant Variety Protection and Farmers' Rights Act. System of variety release and notification. Types of seeds and seed chain. Seed production and certification.

Unit 8: Statistical Methods and Field Plot Techniques

Frequency distribution. Measures of central tendency, probability theory and its applications in genetics. Probability distribution and tests of significance. Correlation, linear, partial and multiple regression. Genetic divergence. Multivariate analysis. Design of experiments- basic principles, completely randomized design, randomized block design and split plot design. Complete and incomplete block designs. Augmented design, Grid and honeycomb design. Hill plots, unreplicated evaluation. Data collection and interpretation.

1.2 SEED SCIENCE & TECHNOLOGY

Unit 1 : Seed Biology

Floral biology, mode of reproduction, sporogenesis, pollination, fertilization, embryogenesis, fruit & seed development and physiological and harvestable maturity. Apomixis, parthenocarpy, polyembryony and somatic embryoids and synthetic seeds. Seed structure of monocot and dicot. Seed maturation and longevity in orthodox and recalcitrant seed. Chemical composition of seed. Seed dormancy - types, causes and mechanisms of induction and release, factors affecting, methods to overcome dormancy and its significance in agriculture. Seed germination - requirements, imbibition pattern, physiological and biochemical changes, and role of hormones.

Unit 2 : Seed Production

Introduction to crop breeding methods. Variety testing, release and notification. Genetic purity concept and factors responsible for deterioration of varieties. Maintenance breeding. General system of seed multiplication. Seed production agencies. Identification of seed production areas and factors affecting it. Compact area approach in seed production. Seed production planning, equipment, input and manpower requirement. Factors affecting pollination and seed set viz., temperature, humidity, wind velocity, insect pollinators, and supplementary pollination. Male sterility, self-incompatibility and their role in hybrid seed production. Heterosis and hybrid vigour. Techniques of hybrid seed production - emasculation and dusting, detasseling, male sterility, sex expression, self-incompatibility and chemical hybridizing agents. Principles and methods of seed production of varieties and hybrids of cereals like wheat, paddy, sorghum, pearl millet and maize; pulses like chickpea, pigeon pea, green gram, black gram, soybean and cowpea; oilseeds like groundnut, brassica, sesame, sunflower and castor; fibre crops like cotton and jute; vegetables crops like tomato, brinjal, okra, chilli, important cole and cucurbitaceous crops; important forage legumes and grasses and seed crop management, time of harvesting and threshing/extraction methods. Seed production technology of plantation crops like coffee, tea, rubber, cocoa,

cardamom and pepper. Disease free clonal propagation of crops like potato, sugarcane sweet potato, tapioca, colocasia, betel vine, fruit crops like mango, citrus, banana, guava, sapota, pineapple, grape, apple, pear, plum, peach, apricot and seed production and clonal propagation of annual and perennial flowers like rose, gladiolus, chrysanthemum, marigold, dahlia, phlox and petunia. Clonal standards and degenerations. Micro propagation.

Unit 3 : Seed Processing

Principles of seed processing. Seed drying principles and methods. Pre-cleaning, grading, treatment, pelleting and packaging. Harvesting and seed extraction methods. Seed invigoration and enhancement treatment and their applications. Seed processing machines like cleaner cum grader, specific gravity separator, indented cylinder, seed treater, weighing and bagging machines, their operation and maintenance. Seed quality maintenance during processing.

Unit 4: Seed Quality Control

Seed legislation - Seeds Act 1966, Seed Rules 1969 and New Seed Bill 2004, Seed Law Enforcement. Seed certification – history, concept, organization, phases and minimum certification standards. Field inspection principles and methods. Inspection at harvesting, threshing and processing. Pre-and post-quality testing or genetic purity. Seed Certification Schemes, concepts and procedures. Seed Testing concepts and objectives, its role in seed quality control. Seed sampling, seed moisture testing, purity analysis, germination testing, tolerance tests and equipment. Seed testing procedures for principal agri horticultural crops. Quick viability tests. Seed vigour, its significance and testing methods. Testing for genuineness of varieties – principles and methods based on seed, seedling and plant characters, biochemical techniques namely electrophoresis of proteins and isoenzymes and DNA fingerprinting. International Seed Testing Association (ISTA), its role in development of seed testing procedures, rules and seed quality assurance for international seed trade.

Unit 5 : Seed Storage

Requirements and types of seed storage. Factors affecting seed storage and role of moisture, temperature, RH and moisture equilibrium. Viability nomographs. Seed deterioration causes and methods of control. Physiological, biochemical and molecular changes in seed ageing. Longevity of orthodox and recalcitrant seeds. Seed drying and Packaging needs. Storage structures. Methods of stacking and their impact. Short and medium term storage. Controlled storage. Germplasm storage. Cryo preservation. Design features of short, medium and long-term seed storage buildings. Operation and management of seed stores.

Unit 6 : Seed Health

Significance of seed health. Mode and mechanism of transmission of microorganisms - fungi, bacteria and viruses. Procedures for seed health test and rules. Externally and internally seed - borne pathogens, mode of infection, development and spread, methods of detection of seed borne diseases. Important seed-borne diseases of cereals, oilseeds, pulses, fibre crops, vegetables and their control measures. Quarantine and International procedures of phytosanitary certificates. Important storage pests, their identification, monitoring and detection. ET value, nature and extent of damage, natural enemies and management. Use of pesticides, botanicals, mycotoxins for seed treatments. Carry over infestation, principles of fumigation and safe use of fumigants.

Unit 7: Seed Industry Development and Marketing

Trends in National and International seed industry development-OECD. International Seed Trade Federation (ISF) and Indian seed associations. Economics of seed production. Market survey, demand forecasting, pricing policies, marketing channels, planning and sales promotion. Buyer behavior and role of Government, semi Government, co-operative and private sectors in seed trade. Responsibilities of seed companies and dealers in Seed Act. Seed import and export.

Unit 8 : Protection of Plant Varieties

Plant Variety Protection (PVP) and its significance. Protection of Plant Varieties and Farmers' Right Act, 2001, its essential features. International Union for the Protection of New Varieties of Plants (UPOV) and its role in development of Plant breeders Rights and Seed Industry Development. Impact of PVP on seed supply system. DUS testing principles and application. Biodiversity Act. Criteria for protection of Essentially Derived Varieties (EDVs) and Genetically modified (GM) varieties.

02. CROP SCIENCES-II

(2.1 Plant Pathology, 2.2 Nematology, 2.3 Agricultural Entomology/Entomology, 2.4 Agricultural Chemicals)

2.1 PLANT PATHOLOGY

Unit 1: History and Principles of Plant Pathology

Milestones in phytopathology with particular reference to India. Major epidemics and their social impacts. Historical developments of chemicals, legislative, cultural and biological protection measures including classification of plant diseases. Physiologic specialization, Koch's postulates. Growth, reproduction, survival and dispersal of plant pathogens. Factors influencing infection, colonization and development of symptoms.

Unit 2: Laboratory and Analytical Techniques

Preparation and sterilization of common media. Methods of isolation of pathogens and their identification. Preservation of microorganisms in pure culture. Methods of inoculation. Measurement of plant disease. Molecular detection of pathogens in seeds and other planting materials: Nucleic acid probes, Southern, Northern and Western hybridization, ELISA, ISEM and PCR. Laboratory equipment and their use: autoclave, hot air oven, laminar flow, spectrophotometer, electrophoresis, light and electron microscopy, incubator, ultracentrifuge, ELISA Reader.

Unit 3: Physiological and Molecular Plant Pathology

Altered metabolism of plants under biotic and abiotic stresses. Molecular mechanisms of pathogenesis: elicitors, recognition phenomenon, penetration, invasion, primary disease determinant. Enzymes and toxins in relation to plant disease. Mechanisms of resistance, Structural and Biochemical defense mechanisms. R-Genes, Phytoanticipins. Phytoalexins. PR proteins, Hydroxyproline rich glycoproteins (HRGP). Antiviral proteins. SAR and ISR. HR and active oxygen radicals. Tissue culture. Somaclonal variation and somatic hybridization. Elementary genetic engineering. Management of pathogens through satellite, antisense - RNA. Ribozymes, coat protein, RNA interference, plantibodies, hypovirulence, cross protection. Useful genes and promoters, plant transformation techniques, biosafety and bioethics.

Unit 4: Mycology

Classification of fungi. Life cycles of important phytopathogenic fungi. Economic mycology, edible fungi and entomogenous fungi. Mycorrhizal associations. Cell organelles, their morphology, functions and chemical composition.

Unit 5: Plant Bacteriology

Identification and classification of bacteria. morphology, ultrastructure and chemical composition of prokaryotic cell in relation to function. Growth curve, nutrition and auxotrophic mutants. Resting cells in prokaryotic, elementary bacterial genetics and variability: transformation, conjugation, transduction. Biology of extra chromosomal elements: plasmid borne genes and their expression: avr, her, vie and pat genes. Bacteriophages: lytic and lysogenic cycles. Prokaryotic inhibitors and their mode of action. Economic uses of prokaryotes. Morphology, biochemical characteristics, reproduction and life cycle of phytoplasma and other fastidious prokaryotes.

Unit 6: Plant Virology

Nature, composition and architecture of viruses and viroids. Properties of viruses. Variability in viruses. Satellite viruses and satellite RNA. Assay of plant viruses including biological, physical, chemical, serological and molecular methods. Conventional and biotechnological techniques used in detection and diagnosis. Behaviour of viruses in plants including infection, replication and movement. Histopathological changes induced by viruses in

plants, inclusion bodies. Transmission of viruses: virus - vector relationships. Nomenclature and classification of viruses.

Unit 7: Plant Disease Epidemiology

Concepts in epidemiology. Development of disease in plant population. Monocyclic and polycyclic pathogens. Role of environment and meteorological factors in the development of plant disease epidemics. Survey, surveillance (including through remote sensing), and prediction and forecasting of diseases. Epidemic analysis and prediction models. Crop loss assessment: critical and multiple point models.

Unit 8: Phanerogamic Parasites and Non-parasitic Diseases

Diseases caused by Phanerogamic parasites and their management. Diseases due to unfavourable soil environment, drought and flooding stress etc. Nutritional deficiencies. Primary /secondary air pollutants and acid rain.

Unit 9: Fungal Diseases of Crop Plants

Fungal diseases of cereals, millets, oilseeds, pulses, fruits, vegetables, plantation, fiber, spices and ornamental crops with special reference to etiology, disease cycle, perpetuation, epidemiology and management. Post-harvest diseases in transit and storage; aflatoxins and other mycotoxins and their integrated management.

Unit 10: Bacterial and Viral Diseases of Crop Plants

Crop diseases of cereals, pulses, oilseeds, vegetables, fruits, plantation and fiber crops caused by bacteria, viruses, viroids, phytoplasmas and other fastidious prokaryotes. Mode of transmission and pathogen vector relationships. Epidemiology and management.

Unit 11: Management of Plant diseases

General principles of plant quarantine. Exotic pathogens and pathogens introduced into India. Sanitary and phytosanitary issues under WTO, TRIPS and PRA. Genetic basis of disease resistance and pathogenicity: gene for gene hyphothesis; parasite mediated frequency -dependent selection concept of QTL mapping; breeding for disease resistance. Production of disease free seeds and planting materials. Seed certification. Chemical nature and classification of fungicides and antibiotics: their bioassay and compatibility with other agricultural chemicals; resistance to fungicides/ antibiotics; effect on environment. Spraying and dusting equipments, their care and maintenances. Important cultural practices and their role in disease management, solarization, integrated disease management. Microorganisms antagonistic to plant pathogens in soil, rhizosphere and phyllosphere and their use in the control of plant diseases; soil fungistasis. Plant growth promoting Rhizobacteria. Biotechnology for crop disease management.

2.2 NEMATOLOGY

Unit 1: History and Economic Importance

History and economic importance of nematology; Diseases caused by plant-parasitic nematodes-symptomatology, biology, distribution and management of plant parasitic nematodes of economic importance (Pratylenchus, Radopholus, Hirschmanniella, Meloidogyne, Heterodera, Globodera, Rotylenchulus, Tylenchulus, Ditylenchus, Anguina, Aphelenchoides, Tylenchorhynchus, Helicotylenchus, Hoplolaimus, Scutellonema, Paratylenchus, etc.). Entomopathogenic nematodes. Importance of saprophytes in organic matter recycling. Nematodes as indicators of pollution and toxicity. Predacious Nematodes.

Unit 2 : Nematode Taxonomy and Morphology

Principles and concepts of taxonomy. Rules of nomenclature. Nematode phylogeny and systematics. Classification of soil and plant -parasitic nematodes and their relationships with other related phyla. Detailed classification of plant - parasitic nematodes up to generic level with emphasis on genera of economic importance. General morphology and anatomy of nematodes. Various systems: digestive,, excretory, nervous, reproductive etc., developmental biology of nematodes.

Unit 3 : Nematological Techniques

Methods of extraction of nematodes from soil and plant material. Microscopy - principles and types including electron microscopes. Methods of killing, fixing, preserving, staining, mounting and measuring of nematodes. Techniques for histopathology and culturing of nematodes - plant parasitic, entomophilic and saprophytic including axenic methods. Experimental techniques for proving pathogenicity, estimation of crop losses, nematicide screening, screening and evaluation for nematode resistance in crops. Molecular technique for nematode diagnostics. Techniques for mass culturing of entomopathogenic nematode antagonistic bioagents.

Unit 4 : Nematode Ecology

Ecological classification and distribution of nematodes. Mode of nematode dispersal. Adaptations to parasite mode of life. Soil as environment for nematodes. Effect of biotic and abiotic factors on nematode survival, activity and reproduction. Nematode population dynamics. Nematode -induced plant damage and modelling. Community analysis.

Unit 5 : Plant Nematode Relationships

Types of parasitism in nematodes. Nature of damage caused by various groups of plant parasitic nematodes and mechanisms involved. Pathotypes in nematodes. Mechanism of nematode resistance and tolerance in plants and its assessment. Physiological, biochemical and molecular changes in plants due to nematode infections.

Unit 6 : Nematode Physiology and Cytology

Chemical composition of nematodes. Principles of nematode physiology. Physiological functions of cell; organelles. Physiology of respiration, digestion, excretion, reproduction, growth and development. Physiology of muscular, nervous and sensory responses. Physiology of moulting, hatching and nematode survival. Chemoreception in nematodes. Nematode as biological models - *Caenorhabditis elegans*. Cytological changes in plants due to infection including syncytia, giant cell formation and their modification etc.

Unit 7 : Nematode Management

Principles and methods of nematode management - physical, cultural biological, chemical and legislative, Nematicides (including those of biological origin) - history, classification, formulations, application and mode of action. Host resistance for nematode management. Integrated nematode management. Role of biotechnology in nematode management.

Unit 8 : Interactions of Nematodes with Soil Organisms

Importance of interactions (interrelationships) of nematodes with soil organisms. Interactions of nematodes with bacteria, fungi, viruses, mycorrhizae and other nematodes. Nematodes as vectors of viruses and other microorganisms.

Unit 9 : Statistics

Frequency distribution. Measures of central tendency and dispersion: mean, median, mode, standard deviation etc. Population distributions : normal, binomial and Poisson. Correlations: partial and multiple. Tests of significance: t, F and Chi square and randomized block, Latin square and split plot designs, their analysis and interpretation.

2.3 AGRICULTURAL ENTOMOLOGY/ENTOMOLOGY

Unit 1: Systematics

History and development of Entomology, Evolution of insects, position of insects in the animal world, characteristics of phylum Arthropoda, structural features of important arthropod groups such as Trilobita, Chelicerata and Mandibulata, structural features of important classes of phylum Arthropoda viz. Arachnida,

Crustacea, Chilopoda, Diplopoda and Hexapoda. Classification of insects up to order level, habits, habitats and distinguishing features of different Order and important Families.

Unit 2: Morphology

Body wall, its structure, outgrowths, endoskeleton, Body regions, segmentation, sclerites and sutures, Insect Colors. Head and head appendages, types of mouth parts, antennae, their structure and types. Thorax structure, thoracic appendages and their modification. Wings, their modification and venation, Abdomen; structure, abdominal appendages both in Pterygota and Apterygota. External genitalia, general structure and modification in important insect orders.

Unit 3: Embryology, Internal Anatomy and Physiology

Embryonic and post embryonic development, types of metamorphosis, physiology of ecdysis. General features and types of larvae and pupae. Structure, function and physiology of Digestive, Circulatory, Respiratory, Reproductive, Nervous and Excretory systems, Sense Organs; structure and types. Insect food and nutrition; minerals, carbohydrates, proteins and amino acids, lipids, vitamins and their role in growth and development, artificial diets.

Unit 4: Ecology

Concept of ecology, Environment and its components-biotic and abiotic factors and their effects on growth, development, population dynamics, distribution and dispersal. Principle of biogeography and insects biodiversity. Assessment of diversity indices. Biotic potential and environmental resistance. Ecosystems, agroecosystems analysis, their characteristics and functioning. Intra and inter specific relationship; competition, predator-prey and host-parasite interactions, ecological niche. Life table studies, population models. Food chain and food web. Arthropod population monitoring, pest forecasting. Diapause and causes of pest out breaks.

Unit 5: Biological Control

Importance and scope of biological control, history of biological control: Biocontrol agents-parasites, predators and insect pathogens. Important entomophagous insect Orders and Families. Ecological, biological, taxonomic, legal and economic aspects of biological control, phenomena of multiple parasitism, hyperparasitism, superparasitism and their applied importance. Principles and procedures of using exotic biocontrol agents. Utilization of natural biocontrol agents: conservation, habitat management and augmentation. Mass multiplication techniques and economics. Effective evaluation techniques, Biocontrol organizations in world and India. Successful cases of biological control of pests. Use of biotechnological tools in enhancing the potentials of Bio-Control Agents.

Unit 6: Chemical Control and Toxicology

History, scope and principles of chemical control. Insecticides and their classification. Formulations of insecticides. Susceptibility of insects to the entry of insecticides. Physical, chemical and toxicological properties of different groups of insecticides: chlorinated hydrocarbons, organophosphates, carbamates, synthetic pyrethroids, chlordimeform, chitin synthesis inhibitors, avermectins, nitroguanidines, phenylpyrrozzoles, botanicals (natural pyrethroids, rotenone, neem products, nicotine, pongamia spp. etc). Chloronicotinyl, pyrozole, phenylpyrrozzoles, oxadiazines, benzamidazole, neristoxin, rodenticides, insect hormones, Insecticide induced resurgence. Combination insecticides. Problems of pesticide hazards and environmental pollution. Safe use of pesticides, precautions and first aid treatments. Insecticides Act 1968, registration and quality control of insecticides. Evaluation of toxicity, methods of toxicity testing, determination of LD 50, LT 50, RL 50 etc. Pesticides residues in the environment and their dynamics of movements, methods of residue. Pharmacology of insect poisons. Mode of action of different groups of insecticides; neuroactive (axonal and synaptic) poisons, respiratory poisons, chitin synthesis inhibitors. Metabolism of insecticides; activative and degradative metabolism, detoxification enzymes and their role in metabolism. Selectivity of insecticidal actions; insecticide resistance; mechanism, genetics and management of insecticide resistance.

Unit 7: Host Plant Resistance

Chemical ecology: mechano- and chemoreceptors. Host plant selection by phytophagous insects. Secondary plant substances and their defenses against phytophagous insect. Basis of resistance (Antixenosis, Antobiosis, Tolerance). Biotypes development and its remedial measures. Tritrophic interactions, induced resistance. Breeding for insect resistant plant varieties. Resistance development and evaluation techniques. Genetics of Resistance: vertical resistance, horizontal resistance, oligogenic resistance, polygenic resistance. Biotechnological approaches and development of transgenic insect resistant plants, its advantages and limitations. Case histories. Insect resistance to transgenic plants and its management.

Unit 8: Innovative Approaches in Pest Control

Behavioral control: pheromones-types and uses, advantages and limitations. Hormonal control: types and function of insect hormones, insect hormone mimics, advantages and limitations. chemosterilants, antifeedants, attractants, repellents; their types, method of applications, advantages and limitations. Genetic control: concepts and methods, case histories, advantages and limitations. Potentialities of IPM.

Unit 9: Integrated Pest Management

History, concept and principles of IPM. Components of IPM: Host plant resistance, agronomic manipulations, mechanical and physical methods, chemical methods, biocontrol agents utilization, genetic and behavioral control strategy etc. IPM strategies for field and horticultural crops. IPM case histories. Concept of damage levels- Economic threshold levels (ETL), Economic injury levels (EIL) and their determination. System approach, Agro ecosystem and cropping system vs. IPM. Constraints and Strategies of IPM implementation. Plant quarantine laws and regulations.

Unit 10: Pesticide Application Equipments

Types of appliances: sprayers, dusters, fog generators, smoke generators, soil injecting guns, seed treating drums, flame throwers, etc. Power operated sprayers and dusters. Types of nozzles and their uses. Maintenance of appliances. Aerial application of pesticides, principles of aerial application, factors affecting the effectiveness of aerial application. Equipments for aerial applications. Advantages and disadvantages of aerial application.

Unit 11: Pests of Field Crops and their Management

Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests of cereals, Oilseed, pulses and fibre crops, sugarcane and tobacco. Polyphagous pests: locusts, termites, hairy catepillars, cut worms and white grubs.

Unit 12: Pests of Horticultural Crops and their Management

Distribution, host range, biology and bionomics, nature of damage and management of arthropod pests of vegetables, fruits and plantation crops, spices, condiments and ornamentals, Vertebrate Pests.

Unit 13: Pests of Stored Products and their Management

Fundamentals of storage of grains and grain products. Storage losses, sources of infestation/infection, factors influencing losses, insect and non-insect pests, their nature of damage and control. Microflora in storage environment and their control. Storage structures, bulk storage and bag storage, their relative efficacy and demerits. Grain drying methods and aeration. Non-insect pests (rodents, birds, mites) of stored products and their control. Regulated and quarantine pests. Integrated management of storage pests.

Unit 14: Arthropod Vectors of Plant Diseases

Common arthropod vectors viz., aphids, leaf hoppers, plant hoppers, whiteflies, thrips, psylids, beetles, weevils, flies, bees and mites and their relationship with the plant pathogenic fungi, bacteria, viruses, mycoplasma. Mechanism of pathogen transmission : Active mechanical transmission, biological transmission. Toxicogenic insects, mites and phytotoxemia. Some important arthropod vector transmitted diseases and their epidemiology in India. Management of vector and its effect on control of diseases.

Unit 15: Honey Bees and Bee-keeping

Honey bees and their economic importance. Bee species, their behaviour, habit and habitats. Bee Keeping: bee pasturage, hives and equipments, seasonal management. Bee enemies including diseases and their control.

Unit 16: Silkworms and Sericulture

Silkworm species, their systematic position and salient features. Rearing techniques of mulberry - muga, eri and tassar silkworms. Nutritional requirements of silkworms. Sericulture: rearing house and appliances, silkworm breeds, principles of voltism and nioultism, seed production and its economics. Different molecular approaches in developing silkworm breeds. Silkworm genomics- a model genetic system- transgenic silkworm- production of foreign proteins. Mulberry pests, diseases and their management. By products of sericulture and its value addition, uses in pharmaceutical industry. Enemies and diseases of silkworms and their management. Sericulture organization in India.

Unit 17: Lac Insect

Lac insect, its biology, habit and habitats. Host Trees: pruning, inoculation, lac cropping techniques, and harvesting. Enemies of lac insect and their control.

Unit 18:Other Useful Insects

Pollinators, biocontrol agents of weeds, soil fertility improving agents, scavengers. Use of insects and insect products in medicines. Usefulness of insects in scientific investigations, insects as food.

Unit 19: Statistics and Computer Application

Frequency distribution, mean, mode and median. Standard, normal, bionomial and Poisson's distribution, Sampling methods and standard errors. Correlation and regression: Partial and multiple, tests of significance; t, F, chi- square, Duncan's multiple range tests. Design of experiments: Principles of Randomized block design, Completely randomized block design, Latin square design, Split-plot designs. Probit analysis. Use of software packages like SPSS, SAS, etc. for the above tests and designs of experiments for analysis.

2.4 AGRICULTURAL CHEMICALS

Unit 1: General Chemistry

Surface chemistry, pH, Buffer solutions; Redox reactions, Chemical kinetics, Stereochemistry and chirality, diastereoisomerism, tautomerism, atropisomerism, asymmetric synthesis, nomenclature of organic molecules, displacement, elimination, addition, rearrangement, SN1 and SN2 reactions, reaction involving free radicals, and carbene intermediates, Organic reagents and catalysts in organic synthesis,. Beckmann, Claisen condensation, Hofmann-Loffler-Freytag reaction, Petrno-Buchi reaction, Curlius, Michael, Kolbes, Arndt-Eistert and Wittig reaction. Reformatsky reaction., Barton reaction, Umpolung reaction, Norrish Type I & II reactions.

Unit 2: Chromatography and Spectroscopic Techniques

Basic principles and application of chromatography; column, paper, thin layer, and ion exchange chromatography; gas liquid chromatography (GLC); high performance liquid chromatography (HPLC); UV, FT-IR; NMR and mass spectroscopy; GC-MS and LC-MS techniques and their applications.

Unit 3: Chemistry of Natural Products

Extraction of natural products; Classification, structure, chemistry, properties and function of carbohydrates, proteins, amino acids, enzymes, nucleic acids, vitamins, lipids, and polymers. Chemisty of terpenoids, alkaloids, phenolics, plant pigments, steroidal and triterpenic saponins and sapogenins; juvenile and moulting hormones; Plant derived nutraceuticals; Chemistry of natural antioxidants and food colorants and their application in human and crop health. Biosynthetic pathways of natural products.

Unit 4 : Naturally Occurring Insecticides

Natural pyrethroids, nicotine, rotenone, neem and karanj based botanical pesticides; microbial macrolides (avermectins and milbemycins), agricultural antibiotics, semiochemicals; insect pheromones-types and uses, insect hormones, insect growth regulators; Plant hormones, phytoalexins, essential oils and their pest control properties; advantages and limitations of natural pesticides; juvenile hormones, juvenile hormone mimics and anti-JH; chemosterilants, insect antifeedants, insect attractants and repellents; microbial pesticides; Application of plant biotechnology in crop protection, herbicide tolerant and insect resistant transgenic plants.

Unit 5: Synthetic Insecticides, Fungicides, Nematicides and Rodenticides

History, scope and principles of chemical insect control; Insecticides and their classification Chemistry of major groups of insecticides (organo-chlorine, organo-phosphorus, organo-carbamates, synthetic pyrethroids, neonicotinoids), fungicides (inorganics, dithiocarbamates, OP's, phenols, quinines, carboxamides, azoles, methoxyacrylates), rodenticides, Insect growth regulators; Chitin synthesis inhibitors, insecticide synergists, fumigants. Mode of action of different groups of insecticides, fungicides and nematicides.

Unit 6: Herbicides and Plant Growth Regulators

Physical, chemical and toxicological properties of different groups of herbicides (pheoxyacids, carbamates, amides, tiazines, phenyl ureas, dinitroanilines, bipyridiliums, sulfonyl ureas), Herbicide safeners, Plant growth regulators – auxins, gibberellins, cytokinins, ethylene, abscisic acid; Brassinolides; Mode of action of different groups of herbicides.

Unit 7: Agrochemical Formulations

Basic concepts of pesticide formulation - classification, solid and liquid formulations; preparation, properties, uses; controlled release formulations; Formulants - carriers/ diluents, surfactants, encapsulants, binders, anti-oxidants, stabilizers; Application - devices and quality of deposits; Types of spray appliances, seed treatment and dressing; nanotechnology in crop protection, Tools to develop and measure nanoparticles.

Unit 8: Pesticide Residues and their Dynamics in the Environment

Pesticide residues- concepts and toxicological significance; pesticide dynamics in agro ecosystem, biotic and abiotic transformations affecting fate of pesticides. Experimental design, sampling, principles of extraction and clean-up from different substrates; Application of ELISA and radiotracer techniques in pesticide residue analysis; new cleanup techniques, QUECHERS, ASE (Accelerated solvent extraction); Multi-residue methods; Bound and conjugated residues; Method validation - linearity, LOD and LOQ, microbial and photochemical degradation, adsorption/ desorption, leaching in soil.

Unit 9: Agrochemicals – Regulation and Quality Control

Production, consumption and trade statistics of pesticides and fertilizers; banned and restricted pesticides, registration and quality control of insecticides; Laws, Acts and Rules governing registration and regulations of agrochemical production and use; key provisions of the Insecticides Act (1968), Environmental Protection Act (1986). Pesticide Management Bill, EPA, Food Safety and Standards Act, WHO, FAO, CODEX and national/international guidelines; Quality Control, Sanitary/phyto-sanitary issues in relation to food safety, good laboratory practices, Accreditation certificate, Pesticide stewardship.

Unit 10: Natural Resource Management

Soil, plant and microbial biodiversity, Characteristics and classification of natural resources; Major soil groups of India their characteristics, management strategies for natural resources; integrated pest and pesticide management; Essential plant nutrients (major, secondary and micro), organic manures (farm yard, compost, sewage sludge, green manure, biogas slurries, etc); production and manufacture and uses of various nitrogenous, phosphatic, potassic and complex fertilizers and fertilizer mixtures, liquid fertilizers, biofertilizers, integrated plant nutrient systems; benefits, disadvantages and environmental toxicity. Nitrification inhibitors to

enhance nitrogen use efficiency, Hydrogels and their application in agriculture, soil conditioners and amendments, toxicity issues.

Unit 11: Environment Pollution: Implications and Remediation

Problems of pesticide hazards and environmental pollution; Adverse effects of pesticides on micro-flora, fauna and on other non-target organisms; Effect of pesticide on soil health, persistent organic pollutants, and their effect on ecosystem. Adverse effect of industrial effluent on the soil and aquatic environment; disposal of obsolete and outdated pesticides; physical, chemical and microbial decontamination and detoxification of pesticides. Agrochemicals and homeland security, misuse of agrochemicals (pesticides and fertilizers), hazard mitigation plans or strategies, analytical and bioassay techniques to assess off-farm migration of agrochemicals into natural waters, ozone depletion causing agrochemicals

Unit 12: Data Analysis

Methods of statistical analysis as applied to agricultural data – standard deviation, standard error, accuracy and precision, analysis of variance (ANOVA), correlation and regression; t-test, chi-square (X2), F test, Probit analysis.

03. CROP SCIENCES-III

(3.1 Plant Biochemistry/Biochemistry, 3.2 Plant Physiology/Crop Physiology, 3.3 Agricultural Biotechnology/Biotechnology/Molecular Biology & Biotechnology, 3.4 Agricultural Microbiology/Microbiology)

3.1 PLANT BIOCHEMISTRY

Unit 1: Basic Biochemistry and Biomolecules

Scope and importance of biochemistry and molecular biology in plants. Structural and functional organization of prokaryotic and eukaryotic cells, viruses and bacteriophages, cell organelles function and their fractionation. Chemical bonding in biological systems, pH and buffers. Thermodynamics and bioenergetics- concept of entropy, and free energy changes in biological reactions, Redox reactions, Role of high energy phosphates. Biomembranes. Classification structure, chemistry, properties and function of carbohydrates, proteins, lipids and nucleic acids. Components of immune system, Prostaglandins.

Unit 2: Intermediary Metabolism

Anabolism, catabolism and their regulation. Metabolism of carbohydrates – glycolytic pathway, HMP pathway, TCA cycle, glyoxylate pathway and gluconeogenesis. Biological oxidation- electron transfer and oxidative phosphorylation. Lipid metabolism, degradation and biosynthesis of fatty acids, ketogenesis and causes of ketosis. Biosynthesis of sterols and phospholipids. Amino acid metabolism – catabolism of amino acids, transamination and deamination, urea cycle, biosynthesis of amino acids. Conversion of amino acids into bioactive compounds. Metabolism of nucleic acids-degradation and biosynthesis of purines, pyrimidines and nucleotides. Integration of carbohydrate, lipid and amino acid metabolism. Signal transduction mechanisms. Role of G-proteins, cyclic nucleotides and calcium in transduction. Disorders of lipid, carbohydrate, nucleic acid, amino acid metabolism. Inborn errors of metabolism. Secondary metabolites, biotransformation and over expression.

Unit 3: Enzymes, Vitamins and Hormones

Major classes of enzymes, general properties, kinetics, active site and its mapping, activation energy and transition state. Mechanisms of enzyme action, inhibition and activation. Coenzymes and cofactors. Isoenzymes and immobilized enzymes. Regulation of enzyme activity, allosteric regulation. Multi substrate reactions, kinetic experiments to determine the mechanism of multi substrate reactions. Isolation, purification and measurement of enzyme activity. Enzyme units. Enzyme engineering. Role of enzymes in agriculture, industry, and medicine. Structure, mode of action and metabolic functions of vitamins. Deficiency diseases associated with vitamins. General description of nature hormones and disorders associated with endocrine glands, viz. pituitary, thyroid, adrenal, pancreas and gonads. Peptide and steroid hormones. Phytohormones – auxins, gibberellins, cytokinins, ethylene, abscisic acid and new plant bio-regulators like SA, Brassinosteroids.

Unit 4: Molecular Biology

Structure of DNA and RNA Replication, transcription and translation. Post-transcriptional and translational modifications. Transcriptional and translation control of prokaryotes and eukaryotes. Features of genetic code in prokaryotes and eukaryotes. Gene expression - operon model, induction and repression, control of gene expression in prokaryotes and eukaryotes. Chloroplast and Mitochondrial genomes. Replication of viruses. Mutagens, oncogenes and carcinogenesis. General principles of recombinant DNA technology, restriction enzymes. Methods of gene transfer-plasmid and viruses as vectors, DNA and protein sequence analysis, oligonucleotide synthesis, genomic and cDNA library construction, site-directed mutagenesis, transposon tagging, chromosome walking. Basics of genome organization and mapping, functional genomics. Gene silencing. Methods for the development of transgenic organisms. Computer application in molecular biology, primer designing, sequence analysis and phylogenetic analysis. Benefits of gene manipulation in agriculture, nanobiotechnology, bio-chips.

Unit 5: Techniques in Biochemistry

Principles of optical, phase contrast, fluorescence and electron microscopy, spectrophotometry, UV and VIS, fluorimetry, turbidometry and atomic absorption spectrophotometry. Radioisotopic techniques – scintillation counters and autoradiography and their application in biological sciences. Electrophoresis - general principles and application, gel electrophoresis, isoelectric focusing, pulsed field gel electrophoresis, immunoelectrophoresis. Chromatographic techniques - paper, thin layer, column chromatography, GC and HPLC. Centrifugation - principles of sedimentation in various rotors, differential centrifugation, density gradient centrifugation and ultracentrifugation. Cell tissue and organ culture. Cryopreservation, PCR and application of RFLP, RAPD, AFLP, microsatellite and mitochondrial and ribotyping techniques. Southern, Northern and Western blotting, ELISA. Microarray and DNA chips. Preliminary methods of statistical analysis as applied to agricultural data – standard deviation, standard error, ANOVA, correlation and regression.

Unit 6: Biochemistry of Food-grains, Fruits and Vegetables

Fundamentals of nutrition, concept of balanced diet. Nutritional quality of protein and its evaluation. Dietary fibre. Vitamins- biochemical functions and deficiency diseases. Fats and lipids-types of fatty acids and their significance in health. Biochemical composition and food value of various food grains (including cereals, pulses, oil seeds), fruits and vegetables. Biochemistry of fruit ripening, biochemical aspects of post-harvest technology, storage and preservation. Biochemical basis of quality improvement of food grains, vegetables and fruits. Antioxidants, nutraceuticals. Food toxins and anti-metabolites, food additives, storage proteins.

Unit 7: Photosynthesis

Photosynthesis – photosynthetic pigments, light reactions, photosystems. Photophosphorylation, dark reactions: C3, C4 and CAM pathways. Regulation of Rubisco. Chemisomotic coupling. Carbon cycle and its regulation, Ion fluxes and conformational changes during photosynthesis. Photorespiration. Relationship between photosynthesis, photorespiration and crop productivity. Chloroplasm morphology, structure and biochemical anatomy. Cytosolic and organelle interactions. Nature and exchange of metabolites through translocators. Seed reserve biosynthesis.

Unit 8: Plant Metabolic Processes

Uptake and metabolism of mineral nutrients in plants. Sulphur metabolism. Nitrogen cycle, nitrate and nitrite reduction, denitrification, symbiotic and non-symbiotic nitrogen fixation. Biochemical and physiological role of hydrogenase. Chemoautrotrophy in rhizobia and nitrifying bacteria. Cell cycle. Growth regulation in plants. Signal transduction and phytohormones. Molecular mechanisms of plant growth, hormone action. Role of oligosaccharides and polysaccharides in cellular metabolism. Metabolism of cyanogenic glycosides and glucosinolates.

Unit 9: Plant Molecular Biology

General organization of nuclear, mitochondrial and chloroplast genomes. Genomics and functional genomics. Tissue specific expression of genes. Molecular biology of various stresses – drought, salinity and temperature. Signal transduction and its molecular basis: molecular mechanism of plant hormone action. Structure, organization and regulation of nuclear genes. Genes involved in photosynthesis and
nitrogen fixation. Regulation of chloroplast gene expression. Mitochondrial control of fertility. Molecular markers in plants and their uses.

Unit 10: Plant Biotechnology/Genetic Engineering

Totipotency, application of tissue culture for plant improvement, cryopreservation. Protoplasm fusion. General principles of gene cloning. Isolation and characterization of plant genes and promoters. Different methods of gene transfer –direct and vector mediated. Gene silencing. Site directed mutagenesis. Molecular analysis of transformants. Potential applications of plant genetic engineering for crop improvement – insect-pest resistance (insect, viral, fungal and bacterial diseases). Abiotic stress tolerance, herbicide resistance, storage protein quality improvement, increasing shelf- life, oil quality. Biosafety and IPR issues.

3.2 PLANT PHYSIOLOGY

Unit 1: Cell Organelles and Water Relations

Cell organelles and their physiological functions Structure and physiological functions of cell wall, cell inclusions. Cell membrane structure and functions. Water and its role in plants, properties and functions of water in the cell, water relations, water potential of plant cells. Mechanism of water uptake by roots transport in roots, movement of water in plants, water loss from plants, energy balance, solar energy, input energy dissipation at crop canopy level. Evapotranspiration, plant factors influencing transpiration rate. Stomata, structure function - Mechanism of stomatal movement, antitranspirants. Physiology of water high temperature and salinity stress in plants. Influence of water stresses at cell, organ, plant and canopy levels. Indices for assessment of drought resistance.

Unit 2: Metabolic Processes and Growth Regulation

Energy and work, free energy and chemical potential, redox reactions and electrochemical potential. Enzyme classification and mechanism of action, factors affecting enzyme action. Gene expression and protein turnover. Photosynthesis, translocation and respiration as key processes regulating carbon metabolism and plant growth. Photosynthesis and bioproductivity. Photochemical process-Chloroplast, its structure, CAM plants and their significance. Rubisco structure and regulations, Photorespiration and its significance, CO2 fixation as a diffusive process, effect of environmental factors on photosynthetic rates. Synthesis of sucrose, starch, oligo and polysaccharides. Translocations of photosynthates and its importance in sink growth. Mitochondrial respiration, growth and maintenance respiration, cyanide resistant respiration and its significance. Nitrogen metabolism. Inorganic nitrogen species (N2, N03, NH3) and their reduction, protein synthesis, nucleic acids. Sulphate uptake and reduction. Lipid metabolism- storage, protective and structural lipids. Secondary metabolites and their significance in plant defence mechanism. Growth and differentiation, hormonal concept of growth and differentiation, plant growth hormones (auxins, gibberellins, cytokinins, ABA, ethylene, etc.), biosynthesis of growth hormones and their metabolism, synthetic growth regulators, growth retardant, apical dominance, senescence, fruit growth, abscission, photo-morphogenesis, photo-receptors, phytochrome, physiology of flowering, photoperiodism and vernalisation.

Unit 3: Crop Productivity and Modelling

Role of crop physiology in agriculture, crop growth and productivity, crop growth models describing yield (Duncan/Passioura), phenology-crop productivity, growth factors related to biomass - concept of growth rates-canopy photosynthesis (leaf area and net assimilation rates as determining factors). Light interception as a major function of leaf area-index, LAD canopy architecture- Light extinction coefficient relative growth rate. Net assimilation rate. Biomass and yield relations. Assimilate partitioning, yield and yield structure analysis. Concept of source and sink, factors influencing source and sink size and productivity. Environmental factors determining crop growth. Light, temperature and VPD, effect of photoperiod and thermoperiod on duration of growth stages. Ideotype concept-selection- indices for improving crop productivity.

Unit 4: Abiotic Stress Responses in Plants

Abiotic stresses affecting plant productivity. Basic principles of a crop improvement programme under stress, interactions between biotic and abiotic stresses. Drought 21 characteristic features, water potential in the soil-plant-air continuum. Development of water deficits, energy balance concept, transpiration and it's regulation – stomatal functions/VPD. Physiological process affected by drought. Drought resistance mechanisms: Escape, dehydration postponement (Drought avoidance), Dehydration tolerance, and characteristics of resurrection plants. Osmotic adjustment Osmoprotectants, stress proteins. Water use efficiency as a drought resistance trait. Molecular responses to water deficit stress perception, expression of regulatory and function genes and significance of gene products. Stress and hormones-ABA as a signaling molecule – Cytokinin as negative signal. Oxidative stress: reactive oxygen species (ROS) – role of scavenging systems (SOD, catalase etc.). High temperature stress: tolerance mechanisms- role of membrane lipids in high temperance tolerance. Functions of HSPs chilling stress; effects on physiological processes. Crucial role of membrane lipids. Salinity: species variation in salt tolerance. Salinity effects at cellular and whole plant level, tolerance mechanisms. Breeding for salt resistance. Heavy metal stress: aluminum and cadmium toxicity in acid soils. Role of phytochelatins (heavy, metal binding proteins).

Unit 5: Plant Growth Regulators and Plant Development

Plant growth regulators – Hormones, endogenous growth substances and synthetic chemicals. Endogenous growth regulating substances other than hormones. Brassinosteriods, triacontanol, phenols polyamines, jasmonates, concept of death hormone. Classification, site of synthesis, biosynthetic pathways and metabolism and influence on plant growth and development by auxins, gibberellins, cytokinins, abscisic acid and ethylene. Concept of hormone action - hormone receptors and signal transduction Hormone mutants. Hormonal regulation of gene expressions at various developmental stages of plant-flowering, seed maturity, seed dormancy. Action of hormones on cellular functions: Auxins- cell elongation, retardation of abscission of plant parts, gibberellins – stem elongation, germination of dormant seeds, cytokinins-cell division, retardation of senescence. Abscisic acid-stomatal closure and induction of drought resistance, ethylene- fruit ripening, acceleration of senescence of leaves. Interaction of hormones in regulation of plant growth and development processes. Synthetic growth regulators, growth retardants, apical dominance, senescence, fruit growth, abscission. Growth and differentiation, hormonal concept of growth and differentiations. Rooting of cuttings- flowering- physiological and molecular aspects of control of reproductive growth. Apical dominance, senescence and abscission. Fruit growth and development, physiological and molecular aspects of ripening processes and improving post-harvest life of fruits. Induction and breaking dormancy in seeds and buds. Synthetic growth regulators. Practical utility in agriculture and horticulture. Herbicides, classification and their mode of action.

Unit 6: Mineral Nutrition

Importance of mineral nutrition in plant growth. Classification and essentiality criteria. General mechanisms - concept of apparent free space and nature of bio-membranes. Dual mechanism and other concepts of ion uptake. Short distance transport-pathway from external solution (Apoplasm) to sieve across the root cortical cells-factors contributing to xylem loading. Long distance transport in xylem and phloem, xylem unloading in leaf cells. Uptake and release of mineral nutrients by foliage. Rhizosphere and root biology, root growth, influence of micro-organism in nutrient acquisition, release and uptake by plant roots. Yield and mineral nutrition-concept of nutrient use efficiency, Mineral nutrition under adverse soil situations-drought, salinity, acidity etc. Heavy metal toxicity and concept of phytoremediation. Interaction of phytohormones and nutrients. Molecular aspects- uptake and transport, role of transporter genes, genetics of nutrient uptake, identification and transfer of genes for tolerance to nutrient deficiencies, etc. Soil less culture – Hydroponics - Role of Macro, Micro and beneficial nutrients- Identification of nutrient deficiencies and toxicities.

Unit 7: Climate and Climate Change

Climate- Analytical methods to determine long term changes in environment- Tree ring, cellulose, stable carbon isotope discrimination, stable 18O discrimination for hydrological changes. Likely changes in climate in future and its impact on crop and ecosystems. The greenhouse gases and global warning. CO2 as an important greenhouses gas, global carbon deposits, fluxes in the sinks and sources. Approaches to contain atmospheric CO2 level. Effect of elevated CO2 on plant growth and development. Methane as a greenhouse gas. Prediction on global warming, GCA models, effects on climate and biota. High temperature and CO2 interaction on plant growth and productivity, ionising radiation UV-B chlorofluoro carbon (CFC)– their impact on ozone layer- ozone hole and alteration in UV-B radiation. Effects of UV-B radiation on plant ecosystem, repair and acclimation to UV-B damage. Carotenoids and their role in membrane stabilization. Air pollution, SO2, NO, methane, ozone, peroxy acetyl nitrate and their effect on ecosystem. Industrial and domestic effluent-their effect, on aquatic ecosystem, plant growth and development.

Unit 8: Seed Physiology

Structure of seeds and their storage. Seed development patterns and source of assimilates for seed development. Pathway of movement of assimilates in developing grains of monocots and dicots. Chemical composition of seeds. Storage of carbohydrates, proteins and fats in seeds. Hydration of seeds. Physiological processes. Seed respiration, mitochondrial activity Mobilization of stored resource in seeds. Chemistry of oxidation of starch, proteins and fats. Utilization of breakdown products by embryonic axis. Control processes in mobilization of stored reserves. Role of embryonic axes. Gibberellin and ?-amylase and other hydrolytic activity. Seed maturation phase and desiccation damage, role of LEA proteins. Seed viability. Seed dormancy. Means to overcome seed dormancy.

Unit 9: Physiology of Flowering and Reproduction

Evolutionary history of flowering plants (angiosperms). Semelparous and iteroparous reproduction, monocarpic and perennial life etc. Flowering phenomenon, effect of plant age, juvenility- transition to flowering. Flowering nature and classification of plants. Photoperiodic responses and the mechanisms in short and long day plants. Theories related to flowering. Endogenous substances and flowering. Gene expression in flowering. Control of flowering. Thermoperiodism - photo and thermo-period interactions. Vernalization-mechanism. Photomorphogenesis, photoreceptors, phytochrome, cryptochrome, physiology of flowering, photoperiodism and vernalization. Optimization in flowering response-to environmental features (light, temperature, stress) etc. plant reproductive physiology. Mating strategy in plants, molecular techniques to understand mating patterns, self-incompatibility responses, physiological processes mediating fertilization (pollen-stigma interactions), seed and fruit development, seed and fruit abortion and means to overcome it. Molecular biology of seed development, physiological basis of cytoplasmic male sterility and fertility restoration. Physiology of heterosis.

Unit 10: Physiology of Horticultural and Plantation Crop Species

Growth and development of horticultural and plantation crop species. Juvenility, shoot growth, types of shoots, patterns of shoot growth, cambial growth and its regulation. Physiological aspects of pruning and dwarfing. Growth measurements. Water relations of tree species. Water uptake and transport. Concepts of transpiration rate and water use efficiency. Sexual and asexual propagation. Rootstock and scion interactions. Physiology of flowering in perennial species, photoperiodism and thermoperiodism. Physiological aspects of fruit crops: mango, banana, grapes, citrus, papaya and pineapple etc. Physiological aspects of plantation crops: tea, coffee, cardamom, coconut, and black pepper. Physiological constraints and remedial measures of horticultural and plantation crops.

Unit 11: Post-Harvest Physiology

Senescence and ageing in plants. Ethylene – the senescence hormone, leaf senescence. Monocarpic plant senescence. Biochemistry and molecular biology of flower senescence. Gene expression during senescence. Concept of physiological maturity of seeds - post harvest changes in biochemical constituents in field crops - loss of viability, loss of nutritive value, environmental factors influencing post-harvest deterioration of seeds. Physiological and biochemical changes during fruit ripening and storage. Senescence and post-harvest life of cut flowers. Physical, physiological and chemical control of post - harvest deterioration of fruits, vegetables and cut flowers and its significance during storage and transport. Molecular approach in regulation of fruit ripening. Transgenic technology for improvement of shelf-life. Edible vaccine.

Unit 12: Morphogenesis, Tissue Culture and Plant Transformation

Morphogenesis; the cellular basis of growth and morphogenesis; polarity in tip growing cells and diffusive growing cells. Control of cell division and differentiation, phyto-chromes, different forms, physiological effects and gene regulation, and cellular totipotency, physiology and biochemistry of differentiation, in organ cell, tissue and cultures, micropropagation strategies, application of tissue culture in agriculture, horticulture, forestry and industry: plant transformation; transformation vectors, concept of selectable and scorable markers. Agrobacterium mediated transformation, binary vectors, biolistics. Electroporation, selection of putative transgenic plants, genetic analysis. PCR, Southern analysis evaluation of transgenic plants.

3.3 AGRICULTURAL BIOTECHNOLOGY

Unit 1: Cell Structure and Function

Prokaryotic and eukaryotic cell architecture, Cell wall, plasma membrane, Structure and function of cell organelles: vacuoles, mitochondria, plastids, golgi apparatus, ER, peroxisomes, glyoxisomes. Cell division, regulation of cell cycle, Protein secretion and targeting, Cell division, growth and differentiation. Transport across cell membrane, Cell signaling, Developmental biology of plants, programmed cell death (apoptosis).

Unit 2: Biomolecules and Metabolism

Structure and function of carbohydrates, lipids, proteins and nucleic acids, Synthesis of carbohydrate, glycolysis, HMP, Citric acid cycle and metabolic regulation, Oxidative phosphorylation and substrate level phosphorylation, Vitamins, plant and animal hormones. Functional molecules, antioxidants, nutrient precursor, HSPs, anti-viral compounds.

Unit 3: Enzymology

Enzymes, structure conformation, classification, assay, isolation, purification and characterization, catalytic specificity, mechanism of action, active site, regulation of enzyme activity, multienzyme complexes, immobilized enzymes and protein engineering, immobilized enzymes and their application.

Unit 4: Molecular Genetics

Concept of gene, Prokaryotes as genetic system, Prokaryotic and eukaryotic chromosomes, methods of gene isolation and identification, Split genes, overlapping genes and pseudo genes, Organization of prokaryotic and eukaryotic genes and genomes including operon, exon, intron, enhancer promoter sequences and other regulatory elements. Mutation – spontaneous, induced and site-directed, recombination in bacteria, fungi and viruses, transformation, transduction, conjugation, transposable elements and transposition.

Unit 5: Gene Expression

Expression of genetic information, operon concept, Transcription – mechanism of transcription in prokaryotes and eukaryotes, transcription unit, regulatory sequences and enhancers, activators, repressors, co-activators, Co-repressors in prokaryotes and eukaryotes, inducible genes and promoters, Transcription factors post transcriptional modification and protein transport, DNA-protein interaction, Genetic code. Mechanism of translation and its control, post translational modifications.

Unit 6: Molecular Biology Techniques

Isolation and purification of nucleic acids. Nucleic acids hybridization: Southern, northern and western blotting hybridization. Immune response monoclonal and polyclonal antibodies and ELISA, DNA sequencing. Construction and screening of genomic and C-DNA libraries. Gel electrophoretic techniques. Polymerase chain reactor spectroscopy, RT-PCR ultracentrifugation, chromatography, FISH, RIA, etc. Next generation genome sequencing techniques. reaction, reverse transcription PCR, real time PCR, ultracentrifugation, spectroscopy, microarray, etc.

Unit 7: Gene Cloning

Restriction enzymes and their uses. Salient features and uses of most commonly used vectors i.e. plasmids, bacteriophages, phagemids, cosmids, BACs, PACs and YACs, binary vectors, expression vectors. Gateway cloning vectors. Gene cloning and sub-cloning strategies, chromosome walking, genetic transformation, Basis of animal cloning. Biology. Risk assessment and IPR.

Unit 8: Molecular Biology

Ribosome structure and function. Protein biosynthesis in prokaryotes and eukaryotes. Post-translational modification. Gene regulation, RNA processing and Post transcriptional modifications. Bioprospecting, biofortification, gene pyramiding and gene fusion, ribozyme technology. DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics; Proteomics, Metabolomics and ionomics.

Unit 9: Plant Molecular Biology

Photoregulation and phytochrome regulation of nuclear and chloroplastic gene expression. Molecular mechanism of nitrogen fixation. Molecular biology of various stresses, viz. abiotic stresses like drought, salt, heavy metals and temperature; and biotic stresses like bacterial, fungal and viral diseases. Signal transduction and its molecular basis, molecular mechanism of plant hormone action mitochondrial control of fertility, structure, organization and regulation of nuclear gene concerning storage proteins and starch synthesis. Crop genome sequencing projects.

Unit 10: Tissue Culture

Basic techniques in cell culture and somatic cell genetics. Regulation of cell cycle and cell division. Clonal propagation. Concept of cellular totipotency. Anther culture, somaclonal and gametoclonal variations. Hybrid embryo culture and embryo rescue, somatic hybridization and cybridization. Application of tissue culture in crop improvement. Secondary metabolite production. In vitro, mutagenesis, cryopreservation and plant tissue culture repository. Synthetic seeds, Virus indexing.

Unit 11: Plant Genetic Engineering

Isolation of genes of economic importance. Gene constructs for tissue-specific expression. Different methods of gene transfer to plants, viz. direct and vector-mediated. Molecular analysis of transformants. RNAi technology. molecular pharming, bioremediation. GM detection methods. Resistance management strategies for target traits. Potential applications of plant genetic engineering for crop improvement, i.e. insect-pest resistance (insect, viral, fungal and bacterial disease resistance), abiotic stress resistance, herbicide resistance, storage protein quality, increasing shelf-life, oil quality, Current status of transgenics, biosafety norms and controlled field trials and release of transgenics (GMOs).

Unit 12: Molecular Markers and Genomics

DNA molecular markers: Principles, type and applications; restriction fragment length polymorphism (RFLP), amplified fragment length polymorphism (AFLP), randomly amplified polymorphic DNA sequences (RAPD), Simple sequence repeats (SSR), Single nucleotide polymorphism (SNP), Structural and functional genomics, gene mapping, genome mapping, gene tagging and comparative genomics and application of genomics. Development of mapping population, linkage mapping. association mapping, Phylogeography, conservation genetics.

3.4 AGRICULTURAL MICROBIOLOGY

Unit 1: History of Microbial World

History, development and scope of microbiology, evolution of microbial life. Theory of spontaneous generation. Prokaryotes, archaebacteria and eukaryotes. Techniques used in identification and classification of bacteria. Important groups of prokaryotes – photosynthetic bacteria, blue green algae, chemoautotrophic bacteria, spore forming bacteria, mycoplasma, viruses, bacteriophages and actinomycetes. Heterotrophic bacteria nitrobacteria, nitrogen-fixing bacteria and cyanobacteria, lactic acid bacteria, halophiles, thermophiles acidophiles and methanogens. Structure and classification of viruses, growth of viruses, lytic and lysogenic cycles, plant viruses, viroids.

Unit 2: Microbial Ecology and Physiology

Principles of microbial ecology, Microbiology of ecosystems - soil, rhizosphere, phyllosphere, water - fresh and marine, and air. Microbial interactions - symbiosis, synergism, commensalism, parasitism, amensalism, antagonism and predation, adoption of micro-organisms to various ecosystems. Microbial growth curve. Mathematical expression of growth -continuous and batch cultures. Diauxic and synchronous growth. Microbial nutrition. Bacterial metabolism - aerobic and anaerobic respiration, electron transport chain, microbial photosynthesis, oxidative and substrate level photo-phosphorylation. Biosynthesis of cell wall, protein breakdown by microbes.

Unit 3: Soil Microbiology

Soil microorganisms: major groups, decomposition of organic matter, soil health. Root exudates and rhizosphere effects. Manipulation of rhizosphere microflora in plant productivity. Microbial biomass. Nitrogen cycle: ammonification, nitrification and denitrification. Biological nitrogen fixation–symbiotic and asymbiotic. Biochemistry and genetics of nitrogen fixation. Microbial transformations of phosphorus, sulphur and minor nutrients. Role of bio-fertilizers in agriculture and forestry. Bioremediation of problem soils, plant growth promoting rhizobacteria and their mode of action. Formation and composition of soil organic matter: fulvic acid and humic acid.

Unit 4: Environmental Microbiology and Basic Microbiological Techniques

Isolation and preservation of different types of microorganisms. Methods of sterilization and disinfection. Microscopy: Optical, phase contrast, fluorescent, dark field and electron. Microbial assay of vitamins, enzymes and antibiotics, Pollution of soil, water and air, Role of microorganisms in pollution, sources of pollution and their impact on environment, microbiology of sewage and industrial effluents and their safe disposal, management of solid and liquid organic wastes, composting, biogas, water purification, sewage treatment, water-borne diseases and effluent management.

Unit 5: Microbial Biotechnology

Industrial production of metabolites - organic acids, alcohols, antibiotics. Fermentor designs and types. Control of fermentation process - batch, feed batch and continuous. Downstream processing in fermentation industry. Production of single cell proteins and probiotics, hormones, biofertilizers, biopesticides. Phyto-remediation. Microbiology of raw and processed foods. Fermented food – vinegar, wine sauerkraut, pickles, cheese, yogurt. Food preservation, contamination and spoilage, food-borne illness and intoxication. Food as substrate for micro-organism, microflora of meat, fish, egg, fruits, vegetables, juices, flour, canned foods; bio- degrading microbes, single cell protein for use as food and feed, bioactive food / probiotics

04. HORTICULTURE

[4.1 Vegetable Science/Olericulture, 4.2 Fruit Science/Pomology, 4.3 Floriculture & Landscaping/Floriculture & Landscape Architecture, 4.4 Spices, Plantation, Medicinal & Aromatic Plants, 4.5 Horticulture, 4.6 Post Harvest Technology (Horticulture)]

4.1 VEGETABLE SCIENCE/OLERICULTURE

Unit 1. Production Technology of Cool Season Vegetable Crops

Introduction, climatic and soil requirement, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: potato, cole crops: cabbage, cauliflower, knol khol, sprouting broccoli, Brussels sprout, root crops: carrot, radish, turnip, and beetroot, bulb crops: onion and garlic, Peas and beans, leafy vegetables: palak, methi and coriander cool season vegetables.

Unit 2. Production Technology of Warm Season Vegetable Crops

Introduction, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures, economics of crop production and seed production of: Tomato, eggplant, hot and sweet pepper, Okra, cowpea and cluster bean, Cucurbitaceous crops, and sweet potato, amaranths.

Unit 3. Breeding of Vegetable Crops

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, biotechnology and their use in breeding in vegetable crops - molecular marker, genomics, marker assisted selection and QTLs. Potato and tomato, Eggplant, hot pepper, sweet pepper and okra, Peas and beans, lettuce, gourds, melons, pumpkins and squashes, cabbage, cauliflower, carrot and radish.

Unit 4. Growth and Development

Cellular structures and their functions; definition of growth and development, growth analysis and its importance in vegetable production; Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscisic acid; Application of synthetic hormones, plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production; Role of light, temperature and photoperiod on growth, development of underground parts, flowering and sex expression in vegetable crops; apical dominance; Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening; Plant growth regulators in relation to vegetable production; morphogenesis and tissue culture techniques in vegetable crops. sex expression in cucurbits and checking flower and fruit drops and improving fruit set in Solanaceous vegetables.

Unit 5. Seed Production

Introduction; modes of propagation in vegetables; Seed morphology and development in vegetable seeds; Floral biology of these plant species; classification of vegetable crops based on pollination and reproduction behavior; steps in quality seed production; identification of suitable areas/locations for seed production of these crops; Classification based on growth cycle and pollination behavior; methods of seed production; comparison between different methods e.g. pollination mechanisms; sex types, ratios and expression and modification of flowering pattern in cucurbits; nursery raising and transplanting stage; Seed production technology of vegetables viz. solanaceous, cucurbitaceous, leguminous, malvaceae, cole crops, leafy vegetables, root, tuber and bulb crops; harvesting/picking stage and seed extraction in fruit vegetables; clonal propagation and multiplication in tuber crops e.g. Potato and sweet potato, seed-plot technique in potato; hybrid seed production technology of vegetable

crops, TPS (true potato seed) and its production technique; hybrids in vegetables; maintenance of parental lines; use of male sterility and self-incompatibility in hybrid seed production, importance and present status of vegetable industry.

Unit 6. Systematics of Vegetable Crops

Principles of classification; different methods of classification; salient features of international code of nomenclature of vegetable crops; Origin, history, evolution and distribution of vegetable crops, botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Cytological level of various vegetable crops; descriptive keys for important vegetables; Importance of molecular markers in evolution of vegetable crops; molecular markers as an aid in characterization and taxonomy of vegetable crops.

Unit 7. Production Technology of Underexploited Vegetable Crops

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, planting time and method, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of: Asparagus and leek; Brussels sprout, Chinese cabbage, broccoli and kale; Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella and bathu (chenopods); lima bean, winged bean, vegetable pigeon pea and sword bean; Sweet gourd, spine gourd, pointed gourd, little gourd (kundru).

Unit 8. Post-Harvest Technology of Vegetable Crops

Importance and scope of post-harvest management of vegetables; Maturity indices and standards for different vegetables; methods of maturity determinations; biochemistry of maturity and ripening, enzymatic and textural changes, ethylene evolution and ethylene management, respiration, transpiration, regulation methods; Harvesting tools, harvesting practices for specific market requirements; post-harvest physiological and biochemical changes, disorders-chilling injury in vegetables, influence of pre-harvest practices and other factors affecting post-harvest losses, packaging house operations, commodity pretreatments- chemicals, wax coating, prepackaging and irradiation; packaging of vegetables, post-harvest, diseases and prevention from infestation, principles of transport; Methods and practices of storage-ventilated, refrigerated, MA, CA storage, hypobaric storage, pre-cooling and cold storage, zero energy cool chamber; storage disorders.

Unit 9: Organic Vegetable Production Technology

Importance, principles, prospective, concept and component of organic production of vegetable crops, managing soil fertility, pest, disease and weed problem in organic farming system, crop rotation in organic vegetable production. Method of enhancing soil fertility, mulching, raising green manure crops, indigenous methods of compost, panchgavya, biodynamics preparation, ITKs organic farming. Role of botanicals and bio-control agents. GAP and GMP, opportunity and challenges in organic production of vegetables.

Unit 10: Hi-tech Production Technology of Vegetable Crops

Importance and scope of protected cultivation of vegetable crops, principles used in protected cultivation and greenhouse technology, effect of temperature, carbon dioxide, humidity; energy management, low cost structures, training methods, engineering effects, Use of plastics, structures including low cost poly-house/green houses and other structures in vegetable production. Drip and sprinkler irrigation, fertigation, shading, hydroponics and other production technologies for enhancing productivity and off-season of high value vegetable crops like tomato, capsicum and cucumber.

4.2 FRUIT SCIENCE/POMOLOGY

Unit 1. Tropical and Dry Land Fruit Production

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bio-regulators, abiotic factors limiting

fruit production, physiology of flowering, pollination, fruit set and development, honeybees in cross pollination, physiological disorders – causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones (AEZ) and industrial supports.
Crops: Mango, banana, citrus, papaya, guava, sapota, jackfruit, pineapple, annonas, avocado, aonla, ber and minor fruits of tropics.

Unit 2. Subtropical and Temperate Fruit Production

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination, fruit set and development, honeybees in cross pollination, physiological disorders – causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones (AEZ) and industrial supports.
Crops: Apple, pear, quince, grapes, plums, peach, apricot, cherries, litchi, loquat, persimmon, kiwifruit, strawberry, walnut, almond, pistachio, hazelnut, mangosteen, carambola, bael, wood apple, fig, jamun, rambutan and pomegranate.

Unit 3. Biodiversity and Conservation

Biodiversity and conservation; issues and goals, centres of origin of cultivated fruits; primary and secondary centres of genetic diversity; present status of gene centres; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.* Germplasm conservation – problem of recalcitrancy – cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine; intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group; GIS and documentation of local biodiversity, geographical indication.
Crops: Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard apple, ber, aonla, Malus &*Prunus* sp., litchi and nuts.

Unit 4. Canopy Management in Fruit Crops

Canopy management – importance and advantages; factors affecting canopy development; Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies; Spacing and utilization of land area – canopy classification; Canopy management through rootstock and scion; Canopy management through plant growth inhibitors, training and pruning and management practices; Canopy development and management in relation to growth, flowering, fruiting and fruit quality in temperate fruits, grapes, mango, sapota, guava, citrus and ber.

Unit 5. Breeding of Fruit Crops

Origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement – introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.
Crops: Mango, banana, pineapple, citrus, grapes, guava, sapota, jackfruit, papaya, custard apple, aonla, avocado, ber, litchi, jamun, phalsa, mulberry, raspberry, apple, pear, plums, peach, apricot, cherries and strawberry.

Unit 6. Post-Harvest Technology

Maturity indices, harvesting practices and grading for specific market requirements, influence of pre-harvest practices, enzymatic and textural changes, respiration, transpiration; Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling; Treatment prior to shipment, viz., chlorination, waxing, chemicals, bio-control agents and natural plant products,

fungicides, hot water, vapour heat treatment, sulphur fumigation and irradiation. Methods of storage – ventilated, refrigerated, MAS, CA storage, physical injuries and disorders; Packing methods and transport, quality evaluation, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies; Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, food safety standards.

Unit 7. Growth and Development

Definition, parameters of growth and development, growth dynamics, morphogenesis; Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism, vernalisation, effect of temperature, heat units, thermoperiodism; Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscisic acid, ethylene, brassinosteroids, growth inhibitors, morphactins, role of plant growth promoters and inhibitors, developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development; Growth and developmental process during stress – manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Unit 8. Biotechnology of Fruit Crops

Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture; Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis; Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, *ex vitro*, establishment of tissue cultured plants; Physiology of hardening – hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion; Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering and transformation in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Unit 9. Protected Fruit Culture

Greenhouse – world scenario, Indian situation; present and future, different agro-climatic zones in India, environmental factors and their effects on plant growth; Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels – Design and development of low cost greenhouse structures; Interaction of light, temperature, humidity, CO_2, water on crop regulation – Greenhouse heating, cooling, ventilation and shading; Types of ventilation – Forced cooling techniques – Glazing materials – Micro irrigation and Fertigation; Automated greenhouses, microcontrollers, waste water recycling, management of pest and diseases - IPM.

Unit 10. Principles and Practices of Plant Propagation

Introduction, life cycle in plants, cellular basis for propagation. Sexual propagation – apomixis, polyembryony, chimeras. Factors influencing seed germination, hormonal regulation of germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing. Rooting of cuttings under mist and hot beds. Physiological, anatomical and biochemical aspects of root induction in cuttings. Selection of elite mother plants. Establishment of bud wood bank. Stock, scion and interstock relationship and incompatibility. Physiology of dwarfing rootstocks. Rejuvenation, progeny orchard and scion bank. Micropropagation ---- in vitro clonal propagation, direct organogenesis, embryogenesis, micrografting and meristem culture. Hardening, packing and transport of micro-propagules.

4.3 FLORICULTURE & LANDSCAPING/FLORICULTURE & LANDSCAPE ARCHITECTURE

Unit 1. Breeding

Principles – Evolution of varieties, origin, distribution, genetic resources, genetic divergence. Patents and Plant Variety Protection in India; Genetic inheritance of flower colour, doubleness, flower size, fragrance, post-harvest

life; Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants – introduction, selection, domestication, polyploidy and mutation breeding for varietal development, Role of heterosis, Production of hybrids, Male sterility, incompatibility problems, seed production of flower crops; Breeding constrains and achievements made in commercial flowers – rose, jasmine, chrysanthemum, marigold, tuberose, crossandra, carnation, dahlia, gerbera, gladioli, orchids, anthurium, aster, heliconia, liliums, Breeding constrains and achievements made in ornamental plants – petunia, hibiscus, bougainvillea, Flowering annuals (zinnia, cosmos, dianthus, snap dragon, pansy) and ornamental foliages – Introduction and selection of plants for waterscaping and xeriscaping.

Unit 2. Production Technology of Cut Flowers

Scope of cut flowers in global trade, Global Scenario of cut flower production, Varietal wealth and diversity, area under cut flowers and production problems in India – Patent rights, nursery management, media for nursery, special nursery practices; Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO_2 on growth and flowering; Flower production – water and nutrient management, fustigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes; Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation; Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Pre-cooling, pulsing, packing, Storage and transportation, marketing, export potential, institutional support, Agril. Export Zones; Crops: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, lilies, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromediads, dahlia, gypsophilla, limonium, statice, stock, cut foliage.

Unit 3. Production Technology for Loose Flowers

Scope of loose flower trade, Significance in the domestic market/export, Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shadenets, transplanting techniques; Soil and climate requirements, field preparation, systems of planting, precision farming techniques; Water and nutrient management, weed management, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM; Flower forcing and year round flowering production for special occasions through physiological interventions, chemical regulation; Harvest indices, harvesting techniques, post-harvest handling and grading, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, institutional support, Agril. Export Zones; Crops – Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabernaemontana, ixora, lotus, lilies, tecoma, pandanus).

Unit 4. Landscaping

Landscape designs, Styles of garden, formal, informal and free style gardens, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanas, Buddha garden; Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates; Garden plant components, arboretum, shrubbery, fernery, palmatum, arches and pergolas, edges and hedges, climbers and creepers, cacti and succulents, herbs, annuals, flower borders and beds, ground covers, carpet beds, bamboo groves; Production technology for selected ornamental plants; Lawns, Establishment and maintenance, special types of gardens, vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves; Bio-aesthetic planning, eco-tourism, theme parks, indoor gardening, therapeutic gardening, non-plant components, water scaping, xeriscaping, hardscaping.

Unit 5. Protected Floriculture

Prospects of protected floriculture in India; Types of protected structures – Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures – economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation; Environment control – management and manipulation of temperature, light, humidity, air and CO_2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled

greenhouses, light regulation; Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and IDM; Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.), Staking and netting, Photoperiod regulation; Harvest indices, harvesting techniques, post-harvest handling techniques, Pre-cooling, sorting, grading, packing, storage, quality standards.

Unit 6. Value Addition

Prospects of value addition, National and global scenario, production and exports, Women empowerment through value added products making, supply chain management; Types of value added products, value addition in loose flowers, garlands, veni, floats, floral decorations, value addition in cut flowers, flower arrangement, styles, ikebana, morebana, free style, bouquets, button-holes, flower baskets, corsages, floral wreaths, garlands, etc.; Selection of containers and accessories for floral products and decorations; Dry flowers – Identification and selection of flowers and plant parts; Raw material procurement, preservation and storage; Techniques in dry flower making – Drying, bleaching, dyeing, embedding, pressing; Accessories; Designing and arrangement – dry flower baskets, bouquets, pot-pourri, wall hangings, button holes, greeting cards, wreaths; Packing and storage; Concrete and essential oils; Selection of species and varieties (including non-conventional species), extraction methods, Packing and storage, Selection of species and varieties, Types of pigments, carotenoids, anthocyanin, chlorophyll, betalains; Significance of natural pigments, Extraction methods; Applications.

Unit 7. Turfing and Turf Management

Prospects of landscape industry, History of landscape gardening, site selection, basic requirements, site evaluation, concepts of physical, chemical and biological properties of soil pertaining to turf grass establishment; Turf grasses – Types, species, varieties, hybrids; Selection of grasses for different locations; Grouping according to climatic r3equirement – Adaptation; Turfing for roof gardens; Preparatory operations; Growing media used for turf grasses – Turf establishment methods, seeding, sprigging/dibbling, plugging, sodding/turfing, turf plastering, hydro-seeding, astro-turfing; Turf management – Irrigation, nutrition, special practices, aerating, rolling, soil top dressing, use of turf growth regulators (TGRs) and micronutrients, Turf mowing – mowing equipments, techniques to minimize wear and compaction, weed control, biotic and abiotic stress management in turfs; Establishment and maintenance of turfs for playgrounds, viz. golf, football, hockey, cricket, tennis, rugby, etc.

Unit 8. Computer Aided Designing (CAD) for Outdoor and Indoorscaping

Exposure to CAD (Computer Aided Designing) – Applications of CAD in landscape garden designing, 2D drawing by AUTOCAD, 3D drawing by ARCHICAD, Creating legends for plant and non-plant components, Basics of Photoshop software in garden designing; 2D drawing methods, AUTOCAD Basics, Coordinate systems in AUTOCAD LOT 2007, Point picking methods, Toolbars and Icons, File handling functions, Modifying tools, Modifying comments, Isometric drawings, Drafting objects; Using patterns in AUTOCAD drawing, Dimension concepts, Hyperlinking, Script making, Using productivity tools, e-transmit file, making sample drawing for outdoor and indoor garden by AUTOCAD 2D Drawing techniques, Drawing web format design, Making layout; 3D drawing methods, ARCHICAD file system, Tools and Infobox, modification tools, structural elements, GDL objects (Grid Dimensional Linking), Creation of garden components through ARCHICAD; ARCHICAD organization tools, Dimensioning and detailing of designs, Attribute settings of components, Visualization tools for landscape preview, data management, plotting and accessories for designing, inserting picture using Photoshop, Making sample drawing for outdoor and indoor gardens.

4.4 SPICES, PLANTATION, MEDICINAL & AROMATIC PLANTS

Unit 1. Production of Plantation Crops

Role of plantation crops in national economy, export potential, IPR issues, clean development mechanism, classification and varietal wealth. Plant multiplication including in vitro multiplication, systems of cultivation, multitier cropping, photosynthetic efficiencies of crops at different tiers, rainfall, humidity, temperature, light and soil pH on crop growth and productivity, high density planting, nutritional requirements, physiological disorders, role of growth regulators and macro and micro nutrients, water requirements, fertigation, moisture conservation, shade regulation, weed management, training and pruning, crop regulation, maturity indices, harvesting. Post-harvest processing practices. GAP and GMP in plantation crop production and processing. Cost benefit analysis, organic farming, management of drought, precision farming. Crops: Coffee and tea, Cashew and cocoa, Rubber,

palmyrah and oil palm, Coconut and arecanut, Wattle and betel vine. Role of commodity boards and developmental institutions in plantation crops.

Unit 2. Production Technology of Spice Crops

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management and processing practices, plant protection measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of: Black pepper, cardamom, Clove, cinnamon and nutmeg, allspice, Turmeric, ginger and garlic, Coriander, fenugreek, cumin, fennel, ajwain, dill, celery, Tamarind, garcinia and vanilla. Role of commodity boards in spices development.

Unit 3. Production Technology of Medicinal and Aromatic Crops

Herbal industry, WTO scenario, Export and import status, Indian system of medicine, Indigenous Traditional Knowledge, IPR issues, Classification of medicinal crops, Systems of cultivation, Organic production, Role of institutions and NGO's in production, GAP in medicinal crop production. Production technology, Post-harvest handling – Drying, Processing, Grading, Packing and Storage, processing and value addition; GMP and Quality standards in herbal products. Influence of biotic and abiotic factors on the production of secondary metabolites, Regulations for herbal raw materials, Phytochemical extraction techniques. Aromatic industry, WTO scenario, Export and import status, Indian perfumery industry, History, Advancements in perfume industry. Production technology, Post-harvest handling, Distillation methods, advanced methods, Solvent extraction process, TLC, HPLC, GC, steam distillation, Perfumes from non-traditional plants, Quality analysis, Value addition, Aroma chemicals, quality standards and regulations. Institutional support and international promotion of essential oil and perfumery products. Medicinal crops: Senna, Periwinkle, Coleus, Aswagandha, Glory lily, Sarpagandha, Dioscorea sp., Aloe vera, Phyllanthus amarus, Andrographis paniculata. Medicinal solanum Isabgol, Poppy, Safed musli, Stevia rebaudiana, Mucuna pruriens, Satavari, Mulhati, Asaphoetida, Nux vomica and Rosadle. Aromatic Crops: Palmarosa, lemongrass, citronella, vettiver, geranium, artemisia, Mentha, Ocimum, eucalyptus, rosemary, thyme, patchouli, lavender, marjoram, oreganum.

Unit 4. Breeding of Plantation, Spice, Medicinal and Aromatic Crops

Species and cultivars, cytogenetics, survey, collection, conservation and evaluation, blossom biology, breeding objectives, approaches for crop improvement, introduction, selection, hybridization, mutation breeding, polyploid breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, molecular aided breeding and biotechnological approaches, marker-assisted selection, bioinformatics, IPR issues, achievements and future thrusts. Crops: Coffee and tea, Cashew and cocoa, Rubber, palmyrah and oil palm, Coconut and arecanut, Black pepper and cardamom, Ginger and turmeric, Fenugreek, coriander, fennel, celery and ajwain, Nutmeg, cinnamon, clove and allspice. Role of commodity boards and developmental institutions in plantation crops.

Medicinal crops, viz. Cassia angustifolia, Catharanthus roseus, Gloriosa superba, Coleus forskohlii, Stevia, Withania somnifera, Papaver omniferum, Plantago ovata, Dioscorea sp, Chlorophytum sp, Rauvolfia serpentina, Aloe vera, Phyllanthus amarus, Medicinal Solanum

Aromatic crops: Geranium, vettiver, Lemon grass, Palmarosa, citronella, rosemary, Patchouli, Eucalyptus, Artemisia, Ocimum sp, and Mint.

Unit 5. Processing of Plantation Crops, Spices, Medicinal and Aromatic Plants

Commercial uses of spices and plantation crops. Processing of major spices - cardamom, black pepper, ginger, turmeric, chilli and paprika, vanilla, cinnamon, clove, nutmeg, allspice, coriander, fenugreek, curry leaf. Extraction of oleoresin and essential oils; Processing of produce from plantation crops, viz. coconut, arecanut, cashewnut, oil palm, palmyrah, date palm, cocoa, tea, coffee, rubber etc; Processing of medicinal plants– dioscorea, gloriosa, stevia, coleus, ashwagandha, tulsi, isabgol, safed musli, senna, aloe, catharanthus, etc. Different methods of drying and storage. Microbial contamination of stored product. Influence of temperature and time combination on active principles; Extraction and analysis of active principles using TLC/HPLC/GC. Distillation, solvent extraction from

aromatic plants– davana, mint, rosemary, rose, citronella, lavender, jasmine, etc. Study of aroma compounds and value addition. Nano-processing technology in medicinal and aromatic plants.

Unit 6. Organic Spice and Plantation Crop Production Technology

Importance, principles, perspective, concept and component of organic production of spice and plantation crops; organic production of spice crops and plantation crops, viz. Pepper, cardamom, turmeric, ginger, cumin, vanilla, coconut, coffee, cocoa, tea, arecanut; managing soil fertility, pests and diseases and weed problems in organic farming system; crop rotation in organic horticulture; processing and quality control for organic foods; methods for enhancing soil fertility, mulching, raising green manure crops. Indigenous methods of compost, panchagavya, biodynamics, preparation etc.; pest and disease management in organic farming; ITK's in organic farming. Role of botanicals and bio-control agents; GAP and GMP- certification of organic products; organic production and export - opportunity and challenges.

4.5 HORTICULTURE& 4.6 POST HARVEST TECHNOLOGY (HORTICULTURE)

Same as covered under 4.1 to 4.4 above

05. VETERINARY AND ANIMAL SCIENCES-I

(5.1 Animal Genetics & Breeding, 5.2 Animal Nutrition, 5.3Livestock Production Management, 5.4Livestock Products Technology, 5.5 Poultry Science, 5.6 Veterinary Physiology)

5.1 ANIMAL GENETICS & BREEDING

Unit 1 : Overview of Genetics

History and development of genetics. Classic researches and pioneer scientists in genetics. Mendalism and its deviations. Chromosomes and heredity. Sex in relation to chromosomes and genes. Linkage and crossing over. Artificial transmutation of genes. Penetrance and expressivity. Multiple factor inheritance. Gene modifiers. Non-chromosomal genes and their inheritance, Chromosomal aberrations. Mosaicism and chimerism.

Unit 2 : Advanced Genetics

Fine structure of chromosomes and chromosomal banding. Gene and mechanism of gene action. DNA replication. Central dogma. Protein synthesis. Genetic code and DNA cloning. Recombinant DNA technology. PCR. Gene banks. Split gene. Genetic control of hormone coordination, metabolism and metabolic diseases. Use of biotechnological tools in improving animal productivity. Application of immunogenetics. Biochemical polymorphism. Chromosomal studies in livestock improvement programmes. Development of clones in relation to animal productivity and maintaining biodiversity. Production of transgenic animals. Gene mixing for useful functions.

Unit 3 : Overview of Breeding

Brief history of domestication of livestock. Important breeds of livestock & poultry with special reference to economic characters. Evolution of genetic systems. Isolating mechanisms and origin of species / sub-species, their adaptation. Mating systems for different livestock and poultry. Genetic and phenotypic consequences and applications of inbreeding and out-breeding. Genetic basis of heterosis and its use. Diallele and polyallele crossing. Reciprocal and reciprocal-recurrent-selection. Combining ability. Developments in population and production of livestock and poultry in India. Status of Animal Genetic Resources in India.

Unit 4 : Genetic Properties of Population

Population Vs individual. Inheritance and continuity of population. Effective population size. Biodiversity. Description of animal population. Value and means; Average effect of gene and gene substitution. Components of total phenotypic variance of a population. Resemblances between relatives. Concept of heritability, repeatability; & phenotypic, genetic and environmental correlations. Methods of estimation, uses, possible biases and precision of estimates.

Unit 5 : Population Genetics

Gene and genotypic frequencies and factors affecting them. Hardy Weinberg Law and consequences of it. Prediction of selection response by different methods. Selection for threshold characters. Indirect selection and correlated response. Theoretical basis of change of population mean and variance on inbreeding and cross breeding. Genotype – environment interaction. Metric characters under natural selection. Quantitative trait loci and their applications. Marker-assisted selection.

Unit 6 : Genetic Strategies

Purpose-wise breeding strategies for livestock and poultry under different agro-climatic zones of India. Evaluation of past genetic improvement programmes for livestock and poultry in India. Bottlenecks in implementation of livestock breeding programmes in India. Evaluation and characterization of various indigenous breeds of livestock and poultry. *Ex-situ* and *In-situ* conservation of animal and poultry genetic resources. Development of new breeds / strains for better productivity in animals. Open nucleus breeding system in livestock improvement in India. Bio-technology and its role in improving animals and poultry production. Role of artificial insemination / frozen semen / embryo transfer / ONBS / MOET technology in animal breeding.

Formulation of breeding programmes : Purpose-wise, breed-wise, region-wise for different species of livestock and poultry. Programmes for genetic improvement of non-descript livestock population of different species. Evaluation and current recommendations of cross breeding programmes of cattle, sheep and goat in India.

Unit 7 : Selection & Selection Experiments

Basis and methods of selection. Construction of selection indices. Different methods of sire evaluation. Selection differential and intensity of selection. Prediction of response. Improvement of response. Effect of selection on variance. Realised heritability. Long-term and short-term objectives of selections. Selection experiments in livestock and poultry. Role of control population in selection experiments. Selection for disease resistance and development of general and specific disease resistant strains / breeds. Purpose based selection and breeding of domestic animals and poultry. Genetic-slippage. Estimation of genetic divergence and its implications in livestock improvement programmes. Selection for better feed conversion efficiency in meat animals and poultry.

Unit 8 : Genetic Laboratory Techniques

Culturing *Drosophila* stock. Study of *Drosophila* with markers. Gene sequencing. Blood group typing. Karyotyping and chromosomal mapping. Concept of recombinant DNA techniques cloning and gene mapping. Nucleic acid hybridization. Development of breed descriptors at molecular level for different livestock and poultry breeds. Biochemical polymorphism analyses – blood groups, transferrins, milk proteins. Collection and storage of samples for DNA fingerprinting; isolation and quantification of DNA from blood and semen; Restricted enzyme digestion of genome DNA, Analysis and transfer of DNA from agarose electrophoresis; Nucleic acid hybridization; Analysis of DNA fingerprinting, PCR-RFLP assay. Cryogenic preservation of animal germplasm.

Unit 9 : Research Techniques for Quantitative Animal Genetics

Use of computers in handling animal breeding data. Estimation of variances and covariances. Development of statistical models for analyses of breed data and to quantify environmental variance. Estimation of inbreeding and relationship. Estimation of inbreeding rate in a closed herd / flock. Estimation and interpretation of genetic and phenotypic parameters. Development of efficient selection programmes and procedures. Estimation of genetic gains. Designing and evaluation of breeding strategies like reciprocal recurrent selection, diallele and polyallele crossing. Designing field based progeny testing programmes. Development of efficient methods and traits for genetic evaluation of males under indigenous conditions. Data bank concept.

Unit 10 : Laboratory Animal Breeding

Laboratory animal species *viz* mice, rat, guinea pig, rabbit, dog and monkey – Their chromosome numbers – genome size – major genes. Physiological, nutritional, reproduction parameters, maintenance protocol – pedigree recording, planned mating. Selection and Mating methods /systems- monogamous, polygamous and others. Genetic control and monitoring-Record keeping-Ethics and legislation for management and use of laboratory animals. Nomenclature for different strains, inbred lines (SPF line, Knockout mice, etc.) – Animal model for human disease. Specific utility of different laboratory species for different requirements.

5.2 ANIMAL NUTRITION

Unit 1: Energy and Proteins

Nutritional significance of carbohydrates, lipids andproteins. Cell-wall fractionation. Available energy from organic nutrients. Partitioning of dietary energy. Basal metabolic rate. Energy retention. Factors affecting energy utilization. Direct and indirect calorimetry. Dietary lipids - their digestion, absorption and metabolism. Essential fatty acids. Effect of dietary fat on milk and body composition. Proteins - digestion, absorption and utilization. Comparative efficiency of amino acids as energy source. Essential and critical amino acids. Protein evaluation. Metabolizable protein concept. Protein energy inter-relationship. Energetic of protein utilization for maintenance and different productive functions.

Unit 2: Minerals, Vitamins and Feed Additives

Minerals: Classification of minerals,Physiological functions, Deficiency symptoms and toxicity - Inter-relationships - Synergism and antagonism - Requirements - Different sources and bio-availability - Role of chelated minerals. Vitamins: Physiological functions and co-enzyme role - Deficiency symptoms, hyper-vitaminosis. Requirements, Sources and vitamin analogues - Antivitamins – Feed Additives: Nutritional role. Prebiotics - Probiotics, phytochemicals other metabolic modifiers. Role of phyto-chemicals as growth promoters.

Unit 3: Rumen Eco-system and Functions

Rumen and its environment. Developmentof functional rumen. Digestion kinetics in reticulo-rumen. Role of rumen microbes, Significance of rumen fungi- Defaunation and transfaunation. Microbial fermentation in rumen. VFA production, inter-conversion and utilization. Dietary protein breakdown. Microbial protein synthesis. NPN compounds and their utilization. Ammonia toxicity - Role of slow release urea compounds. Manipulation of rumen fermentation. Bio-hydrogenation and utilization of dietary lipids. Methanogenesis and methane inhibitors.

Unit 4: Non-ruminant Nutrition

Comparative gastrointestinal physiology ofmonogastrics – digestion and metabolism of organic nutrients in poultry and swine. Significance of minerals and vitamins in mono-gastrics. Inter relationship in nutrient sparing activity. Feeding systems. Role of feed additives - Factors affecting nutritional quality and performance. Special nutritional needs of rabbits, horses and companion animals.

Unit 5: Nutrient Requirements

Energy protein requirements for maintenance andproductivity in ruminants and non-ruminants. Colostrum feeding of calf, mineral and vitamin requirements. Dry matter intake in relation to productivity. DM: water intake ratio. Palatability. Nutritional intake and energy density. Feeding standards - NRC, ARC, Kearl and Indian. Nutrient requirements under temperate and tropical environment. Feeding strategies during stress and natural calamities - Ration formulation - least cost rations.

Unit 6: Forage Conservation and Evaluation

Natural and cultivated forges-Theircomposition and nutritive values. Nutritive value Index. Forage quality evaluation in range animals -Role of indicator methods-Advances in silage and haymaking- Factors affecting quality of conserved forages- Quality criteria and grading of silage and hay under tropics-artificial drying of forages.

Unit 7: Feed Processing and Technology

Methods of feed processing - physical,chemical and biological effect of processing on nutritional quality and utilization. Pelleted and extruded feeds. Quality control of raw feedstuffs and finished feeds: Significance of BIS (standards). Handling and storage of raw and finished feeds. Methods to improve shelf life of fat rich feeds, By-products of newly introduced commercial crops including residues of genetically modified feeds. Alternative feed resources. Current approaches in enriching tropical feed resources - concept of total mixed ration and advances in complete diet formulation.

Unit 8: Anti-metabolites and Toxic Principles

Naturally occurring anti-nutritionalfactors and common toxins in feeds and forages. Methods of detoxification. Health hazards due to residual pesticides in feeds and forages - Environmental pollutants.

Unit 9: Elements of Research Methodology

Principles of animal experimentation -Experimental designs in nutritional research. Modern methods of feed evaluation – *Invitro*, gas production and nylon bag techniques, Rumen simulation techniques -Rusitec Tracer techniques in nutrition research - Role of NIR Spectroscopy - Feed microscopy in quality evaluation of feedstuffs.

Unit 10: Clinical Nutrition

Role of nutrition to control digestive and metabolic disorders (milk fever, ketosis, ruminal acidosis-laminitis, bloat), metabolic profile tests. Role of nutrition in immunity, nutrition and reproduction, nutrients as antioxidants. Role of nutrition in management of GI parasites

5.3 LIVESTOCK PRODUCTION MANAGEMENT

Unit 1: General

Present status and future prospects of livestock and poultry development in India. Animal production systems in different agro-climatic zones of the country. Sustainability issue in relation to environment. Livestock farming systems. Effect of mechanization of agriculture on livestock sector. Breeds of cattle, buffalo, sheep, goat, pigs, equine, camels, rabbits and poultry. Various livestock and poultry development programmes & their impact on productivity & health. Livestock behaviour vis-à-vis adaptation and production. Behaviour & welfare. Systems of behaviour. Sexual behaviour in various species of livestock and poultry. Social order in farm animals. Behavioural aberrations – causes and control. Adaptation of livestock and poultry in tropics, deserts cold and high altitudes. Biosecurity and environmental considerations. Emerging challenges for livestock production in relation to the climate change scenario. Biotechnology in animal improvement.

Unit 2: Breeding Management

Basic principles of inheritance. Concept of heritability, repeatability and selection. Important methods of selection and systems of breeding in farm animals and birds. Importance of maintaining breeding records and their scientific interpretation.

Unit 3: Feeding Management

Nutrients and their functions. Nutritional requirements and feeding managements of different categories of livestock and poultry. Feed additives including antibiotic and probiotic feeding in farm animals and birds. Formulation and compounding of rations for various categories of livestock and poultry. Least cost ration formulation. Systems of feeding livestock and birds. Feeding standards for livestock and poultry. Feed conversion efficiency of various categories of livestock and poultry. Processing and storage of conventional and non-conventional feed ingredients. Agro-industrial by-products in animal feeds.

Unit 4: Reproduction Management

Reproductive systems of farm animals and birds. Climate and nutrition affecting reproductive performance in farm animals. Importance of early pregnancy diagnosis. Methods of heat detection. Artificial insemination. Oestrous prediction and synchronization. Causes of disturbed fertility and its prevention in farm animals. Management factors affecting reproductive efficiency. Summer and winter management problems and their solutions.

Unit 5: Shelter Management

Housing systems, Selection of site and lay out of animal and poultry houses. Space requirement for livestock and poultry, Housing designs in different agro-climatic regions. Macro and micro- climatic changes affecting designs of animal and poultry houses. BIS (standards) for livestock and poultry housing. Construction of cheap animal and poultry housing utilizing local resources. Automation in livestock farming. Types & designs of Milking parlours suitable for different scales of production. Disposal of animal wastes under urban and rural conditions. Disposal of carcasses.

Unit 6: Health Management

General approach to livestock health programmes. Prevention of diseases. Hygiene and sanitation on animal farm. Symptoms of ill health, important infectious diseases of livestock and poultry and their control. Vaccination schedules in animals and poultry. Internal and external parasites and their control. Accidental health disorders and their control. Common disinfectants used on animal farms. Concept of first aid at farms. Segregation and quarantine management for large animals and birds. Quarantine Act, Zoonotic diseases, labour health programme.

Unit 7: Production and Management of Cattle and Buffalo

Cattle and buffalo production trends and factors affecting them. Prenatal and postnatal care and management of cattle and buffalo. Care of neonates and young calves. Management strategies for reducing mortality in calves, age at first calving, and calving intervals. Management to improve reproductive efficiency in cattle and buffalo. Management strategies against summer & winter stress. Feed conversion efficiency for growth and milk production. Application of body condition scoring & other scoring techniques to improve productivity & efficiency of dairy animals. Milking management: hand vs machine milking practices. Standard milking protocols for clean milk production. Management practices for high yielding cows & buffaloes. Standard norms for manpower deployment for dairy farms & measures for improving labour efficiency. Dairy farm management efficiency measures. Mechanization & automation of various dairy farm operations (milking, feeding, waste disposal, heat detection, identification & health monitoring).

Unit 8: Production and Management of Other Animals

Draft animals: Population dynamics of various categories of draft and work animalsin India. Characteristics of draft animals. Estimating draft capacity of different species. Harness for various types of draft animals. Training of work animals. Feeding, care and management of draft animals. Management of camel with special reference to rearing, feeding and watering. Behavioural studies of various draft animals. Economics of draft animals *vis-à-vis* machine power.
Sheep and goat: Selection of breeds and breeding systems for improving wool,mohair, meat and milk. Feeding practices for economic rearing. Scope of intensive milk and meat production from goat. Mutton and wool production from sheep. Low cost shelter management. Sheep and goat reproduction. Health management.
Poultry: Brooding of chicks. Management of growing, laying and breeding flocks.Shelter management. Cage layer management and well-being of birds. Light management. Hatchery business management. Management during stress. Chick sexing. Maintenance of farm records. Health and sanitation problems. Prevention and disease control. Poultry shows. Handling care of table eggs and processing of birds for meat.
Equine: Care and management of horses, feeding and breeding systems, sheltermanagement, shoeing, preparation and management of race horses.
Swine: Importance of pig as a meat animal. Selection of breeds and breeding systemsfor improving pig production. Feeding strategies for pigs. Care and Management of pregnant sows and unweaned piglets. Reproduction problems in pigs and remedial measures.
Rabbit: Economic importance. Important fur and meat type breeds. Housing,handling, feeding, watering, breeding, management, sanitation and health care of rabbits.

Unit 9: Wildlife Management

Status of wildlife in India and its conservation. Biological and ecological basis of management of wildlife. Breeding and feeding of wildlife in captivity. Principles & practices health management of wild animals.

Unit 10: Forage Production and Conservation

Classification of feeds and forages. Feed and fodder resources used for feeding of livestock and poultry. Nutritive value of feeds and fodders. Conservation and
preservation of feeds and fodders. Annual and perennial fodder crops. Strategies for round the year fodder production. Pasture development and management. Enrichment of poor quality roughages.

Unit 11: Economics and Marketing of Livestock and Poultry and their Products

Economic principles as applied to livestock production. Production functions. Farm size, resources and product combinations. Cost concepts. Criteria for use of resources in livestock production. Maintenance of evaluation of different production records. Insurance and financing of livestock enterprises. Project formulation for setting up livestock farms. Different approaches to marketing of livestock and its products. Present status of cattle fairs and methods of selling livestock. Market news and information. Estimation of cost of different livestock products (milk, meat, egg & wool). Determination of prices of livestock products.

5.4 LIVESTOCK PRODUCTS TECHNOLOGY

Unit 1: Basic and General Aspects of Livestock Products

Composition and physico-chemical properties of cow and buffalo milk. Milk proteins, lipids, carbohydrates, minerals, vitamins and other minor constituents of milk. Nutritive value of milk. Reception of milk - platform tests, filtration and clarification, chilling, separation, standardization, pasteurization and homogenization. Cleaning and sanitation of dairy equipments.

Present status and future prospects of meat and poultry industry. Structure, composition, physical biochemical and nutritive aspects, and functional properties of different kinds of meat, fish, poultry and eggs. Sensory evaluation and organoleptic properties of livestock products. Post-mortem aspects of muscle as meat. Ageing of meat and chemical changes. Meat in human health. Bacteria, yeasts, molds, parasites important in food microbiology. General principles of spoilage. Chemical and deteriorative changes caused by micro-organisms. Contamination and spoilage of meat, fish, poultry and eggs. Food poisoning and food-borne infections. Assessment of microbial condition and wholesomeness of different livestock products. National and International microbial standards.

Unit 2: Abattoir and Poultry Processing Plants

Origin and source of animal foods. Lay out, construction, design, organization, operation and maintenance of abattoirs and poultry processing plants. Pre-slaughter care and slaughtering techniques for different animals and birds. Ante-mortem and post-mortem inspection. Judging and grading of animals and birds on foot and on rail. Condemnation and disposal of unfit material. Disposal of slaughterhouse effluents. Sanitation, plant operation and maintenance. Sanitary standards for meat packing plants. Meat cutting and deboning. Adulteration and misrepresentation of meat. State, municipal and other regulations pertaining to meat trade. Meat food products order. Processing and utilization of various animal and poultry by-products, slaughterhouse and poultry plant offals. Methods of utilization of blood, fat, hides and skin, horns, hooves, wool, hair, feather, glands and other by-products. Importance and utilization of by-products in industry, Application of computer science in abattoir operation. Robot technology and its application in meat and poultry industry.

Unit 3: Processing and Preservation

Principles of processing of dairy products. Special milk: sterilized milk, flavoured milk, homogenized milk, soft curd milk, Vitaminized/irradiated milk, fermented milk, standardized milk, reconstituted/rehydrated milk, recombined milk, toned, double toned milk, skimmed milk, Humanized milk. Processing of dairy products: - butter, butter oil, ice-cream, fresh and ripened cheeses, cream, condensed milk, dried milk, dried milk products etc. Indigenous dairy products: ghee, khoa, dahi, misti dahi, makkhan, chhana, paneer, Khurchan, Lassi, kunda, milk cake, Organic milk.

Principles of preservation of livestock products. Equipment and technology of processing and preservation. Industrial food preservation, chilling, freezing, freeze drying, dehydration, canning irradiation, pasteurization, curing, smoking, use of chemical additives and antibiotics. Cooking methods including micro-wave cooking. Tenderisation and use of enzymes for processed foods. Production of value added products, process methods, process optimization and quality control. Development and preservation self-stable (canned and dehydrated) intermediate moisture, textured, cured, fermented fabricated meat and poultry products. Sanitation, regulation and inspection of processed meat foods. Effect of processing on nutritional, chemical, microbiological and organoleptic qualities of livestock products. Economics of pre-costing and product development. Application of biotechnology in processing and preservation of meat, poultry and fish products. Bioactive products and biogenic amines.

Unit 4: Wool, Mohair and Fur

Basic aspects of wool science. Shearing, physical and chemical characteristics, processing, grading, standardization, storage and marketing of wool, mohair and fur (National and International).

Unit 5: Packaging

Principles of packaging. Types of packaging materials. Characterization, methods and systems of packaging. Gas packing, Vacuum packing, modified atmosphere packing, shrink and stretch packing, industrial packaging. Aseptic and retort pouches. Standardization and quality control of packaging material. Product attributes and packaging requirements for different livestock products. Latest trends in packaging of meat, poultry, eggs, wool and fish

products: Active and smart packaging, antimicrobial packaging, edible films and coatings, nanocomposite materials for food packaging.

Unit 6: Quality Control

Grades and grading of livestock products. Stress factors effecting meat quality – PSE, DFD, Hot boning, Cold shortening and electrical stimulation. Regulatory and inspection methods – Municipal and State laws. Bureau of Indian Standards and International Standards of fresh meat and poultry including their products and by-products. Detection of antibiotics, chemical residues, heavy metals and toxins in meat. Techniques for detection of adulteration of meat. HACCP concept of quality control of meat, fish, poultry and eggs.

Unit 7: Marketing

Livestock production and supply characteristics. Meat consumption and related demands. Types of market and trends in marketing livestock products and by-products, wholesale, retail and future trends. Consumer aptitude, education and awareness, and popularization of new products. Corporate bodies in regulation of markets, marketing boards, Co-operative agencies, internal trade and development of international market for livestock products. Organization, operation and sanitation of meat, poultry, fish and egg retailing units. Fast food chains and super markets. Situation and outlook and methods for promotion and marketing of livestock products.

5.5 POULTRY SCIENCE

Unit 1: Poultry Genetics and Breeding

Phylogeny of poultry species, class, breed, variety and strains of chickens, ducks, geese, turkeys and other species of poultry. Mendelian traits in poultry. Inheritance of qualitative traits in poultry and their usefulness. Inheritance of comb, plumage and other qualitative traits. Sex-linked and sex influenced traits, their inheritance and usefulness. Economically important traits and their modes of inheritance. Gene action influencing the traits. Lethal and semi-lethal traits in poultry and their mode of inheritance. Quantitative traits. Inheritance of egg number, egg weight, growth rate, livability, fertility, hatchability, egg quality and other economic traits. Heritability and their estimates. Genetic correlations, their computation and application. Selection methods for genetic improvement-natural, artificial, directional, disruptive and stabilizing. Individual selection and family selection. Mass selection, combined selection and indirect selection. Construction of selection indices. Exploitation of additive and non-additive gene effects. Selection for specific characters. Recurrent and reciprocal recurrent selection. Part record versus complete record selection. Genotype and environment interaction. Relative merits and demerits of different methods of selection. Different mating systems-Diallel mating, pair mating, pen mating and block mating. Artificial insemination – collection and insemination techniques, dilution, diluents and cryopreservation of semen. Inbreeding and out-breeding. Pure-line breeding. Cross-breeding. Hybridization and hybrid vigour in improving economic traits, 3-way and 4-way crossing and development of hybrids. Modern trends in commercial poultry breeding. Major genes and their usefulness in poultry breeding in tropics. Dwarf gene and its usefulness in broiler breeding. Practical breeding programmes for developing broilers and layers. Selection for disease resistance. Immunogenetics. Blood group systems. Biochemical polymorphism and usefulness in poultry breeding. Development of transgenic chicken. Different molecular techniques for estimation of genetic diversity and similarity among breeds and lines of poultry. Scope of integrating quantitative and molecular approaches for genetic selection in poultry.

Unit 2: Poultry Nutrition

Various nutrients and their role in poultry. Nutrient requirements of different species of poultry as per Bureau of Indian Standards and National Research Council of the USA. Partition of energy. Estimation of M.E. and T.M.E. Essential and critical amino acids and their inter-relationships. Evaluation of protein quality. Essential fatty acids. Essential vitamins and minerals and their functions. Nutrients deficiency, toxicity, synergism and antagonism. Naturally occurring toxicants, their adverse effects on poultry and methods to overcome them. Fungal exotoxins of feed origin, their adverse effects on poultry, and methods to overcome them. Different systems of feeding wet mash, dry mash, crumble and pellet feeding. Restricted and phase feeding programme. Male separate feeding. Factors influencing the feed intake. Feed ingredients and sources of various nutrients. Quality control and BIS specifications for feed ingredients. Unconventional feed stuffs and their utilization for economic feed formulation. Feed formulation for different species and groups. Least cost feed formulation and linear programming. Non – nutrient feed additives. Antibiotics, probiotics – direct feed microbials, antimicrobials, anticoccidials,

performance-promoters, antioxidants, flavouring agents, colouring agents and other non-nutrient feed additives.

Unit 3: Avian Physiology

Homeostasis and its regulation; Characteristics features of endocrine glands; Regulation of feed and water intake; Feed Passage rate in G.I. tract in relation to digestion and absorption efficiency; Functional regulation of digestion, absorption and metabolism of nutrients; Endocrine control and variable factors influencing growth process; Mechanisms that determines the sex and allows the development of left ovary and oviduct only; Physiological control of age at sexual maturity, ovarian follicular hierarchy, atresia, ovulation, oviposition, pause, clutch size and secretion of egg components; Photoperiodism and its role in optimization of reproductive functions; physiology of avian testes, spermatogenesis, semen ejaculation and its characteristics. Fate of sperm in oviduct and fertilization; Respiratory system – mechanisms of gaseous exchange; Thermoregulatory and stress mechanisms; Physio-biochemical stress responses and remedial approaches; Factors influencing reproductive functioning.

Unit 4: Poultry Products Technology

Structure, chemical composition and nutritive value of egg. Various measures of egg quality. Shell, albumen and yolk quality assessment. Factors influencing egg quality traits. Mechanism of deterioration of egg quality. Weight and quality grades of egg as per BIS, Agmark and USDA standards. Egg processing and storage. Different methods of preservation of table eggs and their relative merits and demerits. Preparation of various egg products and their uses. Processing, packing, preservation and grading of poultry meat. Further processing and fast food preparation. Physical, chemicals, microbial and organoleptic evaluation of meat quality. Processing and utilization of egg and poultry processing waste.

Unit 5: Poultry Management

Poultry industry in India – past, present and future prospects. Statistics of egg and meat production in India. Major constraints facing the poultry industry. Selection, care and storage of hatching eggs. Principles and methods of incubation. Concept of modern hatcheries. Factors essential for incubation of eggs. Testing of eggs. High altitudes and hatchability of eggs. Embryonic communication. Photo acceleration and embryonic growth. Factors influencing hatchability and production of quality chicks. Analyzing hatchability problems. Hatchery hygiene. Fumigation procedure. Prevention of hatchery borne diseases. Utilization and disposal of hatchery waste. Prerequisite of good hatchery. Lay out of a modern hatchery. Equipments required in a modern hatchery. Single and multi-stage incubators. Hatchery business. Sexing, handling, packaging and transportation of chicks. Principles and methods of brooding. Space required for brooding, rearing, feeding and watering. Preparation of brooder house to receive young chicks. Forced feeding of turkey poults. Brooding of quails, ducklings and turkey poults. Managements during growing period. Overcrowding, culling. Management of replacement pullets for egg production and breeding stocks. Management of layers and breeders. Light management. Debeaking, dubbing and other farm routines. Littre management. Broodiness and forced moulting in layers. Management of turkey, ducks, quails and Guinea fowl. Summer and winter management.
Farm location and site selection. Ideal layout of poultry houses for different systems of rearing. Design of poultry houses like brooder, grower, broiler, layer and cage house, poultry processing unit, feed mill, etc. Environmentally controlled and open poultry houses. Types of construction materials used. Cross-ventilation and ridge ventilation. Effect of pollution on production performance of birds. Ammonia control in poultry houses. Type of brooders, feeders, waters, laying nests, cages, etc. Automation in poultry production.

Unit 6: Economics and Marketing

Economic principles as applied to poultry production. Production functions. Farm size-resources and product combinations, efficiency criteria in use of resources in poultry production. Cost concept. Maintenance and evaluation of different production records. Insurance and financing of poultry enterprises. Project formulation for setting up of poultry farms and hatcheries. Production and requirement of poultry products in India and for exports. Various marketing channels. Transportation of eggs and chicken. Marketing approaches. Horizontal and vertical integration in poultry industry and their importance. Price spread in marketing of poultry and poultry products. Role of cooperatives in poultry farming.

Unit 7: Poultry Health Management

Common diseases of poultry – bacterial, viral, fungal, protozoan, parasitic and other emerging diseases of poultry, their prevention, control and treatment. Metabolic and nutrient deficiency diseases and disorders. Vaccination programmes. Deworming programmes. Control of coccidiosis, worms, ectoparasites and flies. Medication procedures. Cleaning and disinfection of poultry houses. Drinking water sanitation. General farm sanitation and hygiene. Safe disposal of dead birds and farm waste. Stress control. Heat stroke. Cold shock. Vices of poultry and their control. Bio-security measures in poultry farms.

5.6 VETERINARY PHYSIOLOGY

Unit 1: Cellular Basis of Animal Physiology

Animal cell ultra-structure, composition and functions. Physio-chemical laws and membrane phenomena. Body fluid and its dynamics. Transport of through biological membranes.

Unit 2: Blood and Circulation

Composition of blood, structure & functioning of its constitutes. Blood coagulation and anticoagulants. Hemoglobin and its polymorphism. Anaemias. Reticulo-endothelial System. Body defense mechanism and immunogenesis.
Electrophysiology of heart. Electro-cardiography – Principles and interpretation. Hemodynamics and concerned biophysical principles. Capillary fluid exchange and lymphatic circulation. Neural and humoral control of heart and blood vessels. Cardiac Output and vascular reflexes. Autoregulation mechanism in the heart Regional circulation – coronary, pulmonary, cerebral, muscle, kidney and skin, blood brain barrier. Circulatory shock and hypertension and cardiac failure.

Unit 3: Respiration

Mechanics of respiration. Neural and chemical control of respiration. Gaseous transport and exchange. Hypoxia. Physiology of hypo-barrism and high altitude. Work and exercise physiology.

Unit 4: Excretion

Modern concepts of urine formation. Control of renal circulation. Secretion and absorption in renal tubules. Regulation of acid-base balance by blood buffers, lungs and kidneys. Hormonal and renal regulation of body fluids and electrolyte balance. Physiology of micturition. Uremia and other renal disorders.

Unit 5: Digestion

Control of motility and secretion of alimentary canal. Gastric hormones and reflexes in the control of digestive functions. Control of rumen motility. Digestion in ruminant and monogastric animals. Absorption from rumen and the digestive tract. Manipulation of rumen microflora to enhance fibre digestion and microbial protein synthesis. Nitrogen recycling and rumen bypass mechanisms. Post-ruminal digestion. Physiology of rumen disorders.

Unit 6: Muscle Physiology

Muscle types and their intra-cellular contractile mechanisms. Electrophysiology of muscles. Neuromuscular junction. Excitation contraction coupling, its biochemical and ionic mechanisms. Molecular basis of muscle contraction. Rigor mortis.

Unit 7: Nervous System
General organization of nervous system. Neurone structure and function. Excitability and transmission of impulse in neuron and muscle. Junctional transmission. Neuro-transmitters. Reflex action. Initiation of impulses from sense organ/receptors. Functions of spinal cord, brain stem and cerebellum. Limbic system and cerebral cortex. Hypothalamus and its autonomic functions in endocrine and visceral regulation. Ascending and descending tracts. Cerebral cortex, its role in motor and sensory functions. Physiology of learning and memory. Physiology of pain. Special senses (hearing, vision, taste, smell etc.).

Unit 8: Endocrinology

Hormones. Hormone receptors. Mechanism of hormone action at cellular and sub – cellular levels. Feedback control of hormone secretion. Hypothalamic – hypophyseal axis. It should include (i) Hypothalamic – hypophyseal axis controlling secretions from thyroid, parathyroid, adrenal and gonads, (ii) Endocrine control of general metalbolism. Releasing and inhibiting factors.

Pineal gland and its hormones. Hormones of hypophysis and all other endocrine glands. Mechanisms of different hormone actions. Endocrine disorders.

Unit 9: Reproduction

Gonadal hormones and their functions in male and female. Neuroendocrine-gonadal axis and feedback regulation. Male spermatogenesis. Accessory sex glands. Sexual behaviour erection, ejaculation etc. Semen evaluation. Factors affecting reproduction. Artificial insemination – collection, preservation and transport and semen diluents. Freezing of semen. Oogenesis. Follicular development. Ovulation. Corpus luteum. Reproductive cycles in animals. Factors affecting reproductive cycles. Female reproductive hormones. Oestrous synchronization, super-ovulation. Sperm capacitation and acrosomal reaction. Sperm and ovum transport in female genital tract. Fertilization. Implantation. Maternal recognition of pregnancy, Maintenance of pregnancy and its hormonal control. Physiology of placenta. Physiology of parturition and its hormonal control. Embryo transfer – collection, preservation, transport and transfer of embryos. Oocyte culture. *In vitro* fertilization. Mammary gland growth before puberty, during pregnancy and after parturition and its hormonal control. Lactation-Hormonal control of lactation and milk let-down. Maintenance and cessation of lactation. Mammary gland involution. Milk precursors and synthesis of milk constituents. Methods of studying mammary uptake of nutrients, Ultrastructure of lactating mammary gland. Milk composition in different animals.

Unit 10: Physiology of Growth

Concept and definition. Growth regulation and factors affection prenatal and post-natal growth. Role of growth in production. Growth curve and growth measurement, body conformation.

Unit 11: Climate Physiology

Physiology of climatic stress. Effects of stress on production and reproduction. Neuro-hormonal regulation of body temperature in homeotherms. Mechanism of adaptation. Photoperiodicity and biological rhythms. Design of shelters / animal houses for different class of livestock for different climate conditions.

06. VETERINARY AND ANIMAL SCIENCES-II

(6.1 Veterinary Parasitology, 6.2 Veterinary Public Health/Veterinary Public Health & Epidemiology, 6.3 Animal Biochemistry, 6.4 Animal Biotechnology, 6.5 Veterinary Microbiology, 6.6 Veterinary Pathology)

6.1 VETERINARY PARASITOLOGY

Veterinary Helminthology (Platyhelminthes, Nemanthelminthes), Veterinary Entomology (Insecta and Acarina), Veterinary Protozoology (Parasitic Protozoa), Clinical Parasitology, Parasitic Zoonoses, Diagnostic Parasitology, Management of Livestock Parasitism, Immunoparasitology, Antiparasite drug testing guidelines.

Unit 1: Veterinary Helminthology

Introduction to veterinary helminthology, general account of morphology, classification, life-cycle patterns, epizootiology, pathogenesis, symptoms, diagnosis; treatment and control of parasites belonging to the various families.

Unit 2: Veterinary Entomology

Introduction to veterinary entomology, classification, distributions, morphology, life-cycle, seasonal patterns and economic significance of insects and acarines belonging to the various families. Treatment, control and integrated arthropod pest management. Current advances in immunological interventions/ Control of arthropods.

Unit 3: Veterinary Protozoology

Introduction to veterinary protozoology, classification, morphology, life-cycle, clinical symptoms, pathogenesis, diagnosis, chemotherapy, prophylaxis and control of parasites belonging to the various families.

Unit 4: Clinical Parasitology

Clinical and parasitological signs of parasitic infections in domestic animals, Parasitic diseases of skin, eyes, alimentary, respiratory, urinary, genital, nervous, cardio-vascular and haematopoietic systems. Keys to identification and different diagnosis of helminthic eggs, nematode larvae, gravid proglottids of major tape worms, blood protozoans and apicomplexan group of parasites.

Unit 5: Parasitic Zoonoses

Introduction and importance of parasitic zoonoses, classification of parasitic zoonoses, geo-veterinary and epidemiological aspects including factors influencing prevalence, distribution and transmission of diseases. Role of reservoir hosts, natural habitat, wildlife and their public health significance, clinical features, pathology, diagnosis, treatment, control and prophylaxis of zoonotic parasitic infections.

Unit 6: Management of Livestock Parasitism

Factors affecting epidemiology, host environment, development and survival of infective stages, microhabitat, seasonal development (hypobiosis/diapause), dietary and host factors altering susceptibility, concurrent infections. Influence of genetic factors, general approaches to control of parasitic diseases – stock management practises, stock rates, rotational grazing, clean grazing. Parasite worm burden (EPG). Strategic and tactical control strategies involved in chemical control of helminth, protozoan and arthropod infestations. Broad and narrow-spectrum anthelmintics, antiprotozoal drugs, insecticides and acaricides. Newer drug delivery systems-slow and pulse release methods. Anthelmintic failure – drug resistance monitoring and management. Prospects of alternative methods of control, breeding for host resistance against parasites. Control of vectors and intermediate hosts and sustainable management. Estimation of economical losses due to parasitic diseases.

Unit 7: Immunoparasitology

General principles of parasitic immunity and immune responses to helminths, protozoa, arthropods – The adaptive immune responses, evasion of immunity, classical antiparasite responses – concomitant immunity, premunition, spring-rise, self-cure, VLM, CLM, parasitic granuloma, nodule formation, Parasitic antigens relevant to immunity and diagnosis, their identification and purification-general protocols, immunomodulators and their use in immunopotentiation. Demonstration and characterisation. Development of live, attenuated, killed and new generation vaccines.

Unit 8: Diagnostic Parasitology

Laboratory diagnostic procedures for parasite identification and detection, coprodetection techniques, floatation/concentration, methods, direct microscopy, parasitic staining and special techniques used in parasite identification. Culture and identification of nematode larvae, cercaria, identification of metacestodes and animal infestation, methods for parasite isolation. Diagnostic procedures for manage and bot infestations. General immunodiagnostic assays (ELISA, IFAT, Dot-ELISA, EITB). Principles of validation of diagnostic assays, and OIE recommendations for diagnosis and knowledge of referral laboratory of O.I.E. and molecular techniques used in parasite epidemiology and diagnosis.

6.2 VETERINARY PUBLIC HEALTH/VETERINARY PUBLIC HEALTH & EPIDEMIOLOGY

Unit 1: Veterinary Public Health

Definitions, concept of Public Health, Intersectoral approach to Human Health, Veterinary Medicine, Veterinary Public Health, Human health goals, veterinarians participation in public health and justifications, Veterinary Public Health Unit – its dimensions and functions, National and International organizations related with Public and Veterinary Public Health, Rural health, Role of Public Health Veterinarians in Public Health, Health Delivery System.

Unit 2: Milk Hygiene

Definitions, Dairy Industry and milk hygiene in India and other countries, Microbiology, of milk and milk products, microbial spoilage of milk and its products, Bacteriophage, Contamination of milk and its products, Public health aspects of residues: agricultural chemicals, antibiotics and drugs, toxic metals, plant toxins, mycotoxins and adulterants, Milk borne diseases, Milk hygiene, Hygienic aspects of production of milk and processing and manufacture of milk products, Clean milk production, Prevention of contamination by sanitation at dairy farm, collection centers, milk processing and manufacturing plants. Pasteurization, Sterilization, Standards. Quality control tests applied to milk and milk products.

Unit 3: Meat Hygiene

Definitions, Meat industry and meat hygiene in India and other countries. Raising meat food animals and birds, their trade and transport. Hygienic aspects of slaughter, bleeding, dressing and processing and manufacture of carcass meat and meat products. Rigor mortis, Emergency and causality slaughter. Abattoir/ Meat plant Sanitation, Microbiology of meat and their products. Sources of contamination, Disposal and reclamation of slaughterhouse wastes and by-products and associated public health problems. Spoilage of meat and meat products, Preservation of meat. Meat food safety, Ante mortem and post mortem examination, Inspection of poultry meat, eggs, fish and meat from game animals, Judgment, Indices of sanitary quality, National and International standards, Bacteriological, serological and biochemical tests for quality control, substitution and adulteration.

Section 4: Food-borne Infections and Intoxications

Definitions, Classifications of Food borne diseases, Meat-borne diseases, Milk-borne diseases, Infections and intoxications traced to consumption of fish/eggs, Fast/Street/Convenience foods, Epidemiological characteristics of food-borne infections and intoxications, Sources of pathogens and factors favouring for poisoning, bacterial, viral, protozoan, helminthic, mycotic and chemical food poisoning, Epidemiological investigation of food-borne infections and intoxications, Food specific attack rate. Odd ratio, Detection of foodborne pathogens and their

toxins. Management of food poisoning.

Unit 5: Zoonoses

Definitions, Concept and classification of Zoonoses, Ecological aspects of Zoonoses, Wild animals-, cold blooded animals - domestic animals -, and aquatic life, -associated Zoonoses, Vectors-, milk-, meat-, egg-, fish- and water-spread Zoonoses, Occupational zoonoses, Nosocomial zoonoses, xenozoonoses, Nationally and internationally emerging and re-emerging Zoonoses, Epidemiology of bacterial, rickettsial, viral, parasitic and mycotic Zoonoses, Principles of Zoonoses management: methods of prevention, control and eradication of Zoonoses.

Unit 6: Environmental Hygiene

Natural sources of water, water hygiene, Pure and wholesome water; microbial contamination and chemical pollution of water, Impurities in water, plankton, Purification and sanitization of water, Waterborne diseases, Microbiological examination of water, Potable water, Standards for drinking water. The atmosphere. Air Pollutants, Air-borne pathogens and diseases, Ventilation, Methods of air purification. Agricultural chemicals, industrial wastes, domestic and farm effluents polluting environment – and associated hazards and preventive measures. Antibiotic and pesticide residues and their effect on health. Waste-recycling, Methods of disposal of dead animals. Rodents and Vector control measures.

Unit 7: Epidemiology

Definitions, Epidemiology, Epizootiology, Causal association, concept of infection, Theory of natural nidality, Ecological basis of diseases, Disease transmission, Epidemic process, Distribution of diseases in space and time, Epidemiological hypothesis, Types of epidemiological studies, Epidemiological survey, surveillance, monitoring of diseases, experimental epidemiology, epidemiological measurements, Predictive epidemiology, Epidemiological models, Sero-epidemiology. Use of information technology and computer applications in disease monitoring, Epidemiological investigation and evaluation of intervention measures.

Unit 8: Experimental Animal Medicine

Occupational health and safety in the care and use of research animals. Breeding, care and management of experimental animals, Production of gnotobiotic, germfree, specific pathogen free, transgenic, syngenic animals and tailor-made animals in relation to public health, provisions of Animal welfare and Society for Prevention of Cruelty to Animals Act.

Unit 9: Health Education

Health education, communication techniques, Participatory programmes for awareness creation among agricultural workers, butchers, laboratory staff and those engaged in zoological gardens, laboratory animals rearing, processing of animal produce about occupational hazards and hazards to consumers.

Unit 10: Standard Guidelines and Legislation

Definitions, standards/guidelines of products and product ingredients. Hazards Analysis Critical Control Points (HACCP), Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP), Milk and Milk Product Order (MMPO), Meat Food Products Order (MFPO), Total Quality Management (TQM), Quality assurance and food safety management systems, Bureau of Indian Standards, International Organization for Standards, Codex Alimentarius, World Trade Order, Sanitary and Phyto-sanitary (SPS) measures, Technical Barriers to Trade (TBT), National and International Standards related to milk, meat, fish and their products and hygienic standards to ensure safety to domestic and foreign consumers of products of animal origin.

Unit 11: Microbiology in Public Health

Food microbiology, Characters of food bacteria, moulds, yeast and virus, Classifications of food microbes according to their requirements for growth – temperature, acidity, moisture, oxygen and salt concentration, resistance to microenvironment, Food processing and preservation methods. Pathogen- virulence factors, microbial enzymes, toxic metabolites and other molecules associated with pathogenic mechanisms. Resistance

mechanism of survival in environment in and outside the host, Antigens eliciting protective and diagnostic antibodies, Microbiological, Serological, Biological and Nucleotide based diagnostic methods. Issues on bioterrorism.

6.3 ANIMAL BIOCHEMISTRY

Unit 1

Scope of Biochemistry and molecular biology in animal sciences. Structural and functional organization of prokaryotic and eukaryotic cells, viruses and bacteriophages. Compartmentalization of metabolic processes within the cell and fractionation of subcellular components. Structure and functions of biomembranes with special reference to active transport of ions and metabolites. Extra and intracellular communication. General description of cell culture, hybridoma and animal cloning techniques.

Unit 2

Structure and properties of biologically important carbohydrates including storage and structural polysaccharides, mucopolysaccharides, blood group substances, peptidoglycans and bacterial polysaccharides. Structure and properties of fatty acids, acyl glycerol, glycerophospholipids, sphingolipids, glycolipids, sulfolipids, aminolipids, sterols, bile acids and prostaglandins. Basic principles of isolation, estimation and analysis of carbohydrates and lipids.

Unit 3

Aminoacids, structure and properties. Primary, secondary, tertiary and quaternary structure of proteins. Glycoproteins, lipoproteins, nucleoproteins, fibrous and globular proteins. Structure and functions of immunoglobulins, myoglobin and hemoglobin. Physical and chemical properties of proteins. Structure of different types of nucleic acids. Acid base properties, sedimentation behaviour, hyperchromic effect, base sequencing and restriction analysis of DNA. Computer applications in molecular biology, primer designing, sequence analysis and phylogenetic analysis.

Unit 4

Major classes of enzymes, general properties, kinetics and mechanism of their action. Activation energy and transition state. Coenzymes and cofactors. Regulation of enzyme activity and enzyme inhibition. Isoenzymes and enzymes of clinical significance. Applications and scope of enzymes in bioprocess technology and genetic engineering.

Unit 5

Bioenergetics, biological oxidation, respiratory chain and oxidative phosphorylation. Citric acid cycle and ATP generation. Glycolysis, pentose phosphate pathway and glycogenesis. Biosynthesis and oxidation of fatty acids. Volatile fatty acids as source of energy in ruminants. Ketogenesis and cause of ketosis in ruminants. Biosynthesis of sterols and phospholipids. Catabolism of amino acids, transamination and determination, urea cycle. Integration of carbohydrate, lipid and amino acid metabolism. Conversion of amino acids into other bioactive compounds. Biosynthesis of nutritionally non-essential amino acids. Metabolism of purines and pyrimidines. Disorders of lipid, carbohydrate, nucleic acid and amino acid metabolism. Inborn errors of metabolism and scope of gene therapy in combating genetic disorders.

Unit 6

Mechanism of storage, transmissions and expression of genetic information. DNA replication and control of gene expression in prokaryotes and eukaryotes. RNA synthesis and factors regulating transcription. Biosynthesis of proteins. Features of genetic code in prokaryotes and eukaryotes. Wobble hypothesis, post-translational modification, degeneracy and regulation of translation. Basic principles of recombinant DNA technology and its scope in animal health and production. Recombinant proteins and vaccines, safety, ethical issues and IPRs in molecular biology.

Unit 7

Structure and metabolic functions of water soluble and lipid soluble vitamins. Trace elements and their role in biological processes. Deficiencies and nutritional significance of vitamins and trace elements in domestic animals and poultry, nutraceuticals & probiotics. General description of nature of hormones, receptors and mechanisms of their action. Metabolic function of different hormones and associated disorders due to hypo or hyper secretions of major endocrine glands viz. pituitary, thyroid, adrenal, pancreas and gonads.

Unit 8

Blood composition and biochemical constituents of erythrocytes, leucocytes and platelets. Important plasma proteins and their functions. Haemoglobin in oxygen and carbon dioxide transport. Role of kidneys in acid base balance. Composition and metabolism of muscle, connective, tissue, cartilage, bone, nervous, tissue, adipose tissue and mammary tissue. Clinical significance of iron, iodine calcium and phosphorus metabolism in domestic animals and poultry. Biochemical tests for hepatic and renal functions. Urine composition and analysis.

Unit 9

Basic principles and use of latest photometric, chromatographic, electrophoretic and radioisotopic methods of biochemical analysis. Methods of isolation, purification and characterization of proteins, DNA and RNA. Basic principles of RIA, ELISA, PCR, RFLP and DNA fingerprinting NA probes, vectors, microarray, imaging, applications of nanotechnology, proteomics. Determination of enzymes, hormones, vitamins and other biochemical constituents with special reference to disease diagnosis in domestic animals.

Unit 10

Environmental pollution in relation to animal health and production. Biotechnology in pollution control. Biochemical basis of pollutant tolerance, host defence mechanisms including antigenic and non-antigenic interactions. Free radicals, carcinogenesis and role of liver and kidneys in detoxification. Oncogenes and mechanism of immunosuppression in cancer therapy and organ transplantation.

6.4 ANIMAL BIOTECHNOLOGY

Unit 1: Biomolecules and their Interaction Relevant to Biology

Structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Basics of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
Types of nucleic acids (helix A, B, Z DNA), (types of coding and noncoding RNA).
Stability of proteins and nucleic acids.
Metabolism of carbohydrates, lipids, amino acids and nucleotides.

Unit 2: Cell Biology

Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes).
Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).
Organization of genes and chromosomes in Bacteria and eukaryotes (Operon concept in bacteria, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, mobile genetic elements).
Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

Specialised cell and tissue culture in animal science: Sperm cell Oocyte. In-vitro fertilization. Transgenesis. Stem cell: Embryonic and somatic stem cell.
Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response)

Unit 3: Fundamental Cellular Processes

DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific and cre lox recombination).
RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).
Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).
Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing). Epigenetic regulation of gene expression.

Unit4: Cell Communication and Cell Signalling

Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.
Cellular communication Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.
Cancer Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth. Cellular and viral oncogenes.
Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation.

Unit 5: Molecular Biology and Recombinant DNA methods

Basics of DNA, RNA and Proteins: Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels.
Gene manipulation: Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequences. Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.
Sequencing: Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods, strategies for genome sequencing and Next Generation DNA sequencing principles.
Gene expression: Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques. DNA fingerprinting, RFLP, RAPD and AFLP techniques.
Recombinant vaccine and vaccine based on pathogen genome.

Unit 6: Animal Tissue Culture and Hybridoma Technology

Development of cell (tissue) and organ culture techniques. Nutrient requirements of mammalian cells. Media for culturing cells. Growth supplements. Primary cultures. Established cell lines. Stationary, Roller and Suspension culture techniques. Large-scale production of cells using bioreactors, microcarriers and perfusion techniques.

Characterisation and maintenance of cells, karyotyping, cryopreservation and revival. Detection of contaminants in cell cultures. Isolation and culture of lymphocytes. Application of cell and organ cultures.
Micromanipulation of cells. Cell cloning. Cell fusion and Somatic cell hybrids. Principles and methods of hybridoma technology. Production and characterization of monoclonal antibodies.

Unit 7: Embryo Transfer and Related Techniques

Induction of superovulation. Embryo collection and evaluation. Embryo splitting. Embryo sexing. Embryo transfer. Advantages of embryo transfer in farm animals.
In vitro fertilization. Embryo cloning. Nuclear transplantation. Production of transgenic animals and gene farming. Identification and transfer of gene influencing production and disease resistance.

6.5 VETERINARY MICROBIOLOGY

Unit 1: General Bacteriology

Milestones in the development of microbiology, Classification and nomenclature of bacteria. Structure, function and chemistry of bacterial nuclear apparatus. Cytoplasm, Intracellular granules, Cell wall, Cytoplasmic membrane, Mesosomes, Capsule, Flagella, fimbriae, Endospore, Protoplasts, Spheroplasts, L-forms, Involution forms. Bacterial stains, staining and microscopy. Growth and nutritional requirements of bacteria. Bacterial enzymes. Respiration in bacteria. Carbohydrate protein, fat and nucleic acid metabolism in bacteria. Reproduction and growth phase of bacteria. Effects of chemical and physical agents and antibiotics. Bacterial variations including transduction, transformation and conjugation. Bacterial vaccines and toxins.
The role of microbial toxins in the pathogenesis of diseases; Biochemical and biological characteristics of toxins produced by various bacteria. Toxin producing Gram-positive and Gram-negative bacteria. Properties and clinical conditions produced by different bacterial toxins.

Unit 2: Systematic Bacteriology

Systematic study of bacteria belonging to genera Borrelia, Leptospira, Campylobacter, Pseudomonas, Brucella, Bordetella, Escherichia, Citrobacter, Salmonella, Shigella, Klebsiella, Enterobacter, Proteus, Vibrio, Haemophilus, Staphylococus, Streptococcus, Bacillus, Clostridium, Listeria, Erysipelothrix, Corynebacterium, Nocardia, Rickettsia, Chlamydia, Mycoplasma, Acholeplasma, Spiroplasma, Anaeroplasma and Thermoplasma, Rhodococcus, Mycobacterium and Neisseria.

Unit 3: General Virology

Historical development of virology. Evolution, classification and nomenclature of viruses. Biophysical and biochemical characteristics of viruses. Cultivation of viruses and their growth pattern in cell culture, embryonated eggs and experimental animals. Purification and concentration of viruses. Qualitative and quantitative assay of viruses. Viral replication. Virus-host cell relationships. Replication strategies of animal viruses and molecular pathogenesis for selected viral system. Latent, persistent and chronic viral infections. Study of genetic variability of animal viruses through use of monoclonal antibodies, autoimmunity, immunosuppression and viral mutation in persistence infections. General principles of laboratory diagnosis of viral diseases. Epidemiology and pathology of viral infections. Immune mechanism in viral diseases. Interference and interferon. Viral vaccines, point of action of antiviral molecules during the replication cycle of a virus and search for new antiviral compounds, viruses and gene therapy. Chemotherapy of viral infections.

Unit 4: Systematic Virology

Systematic study of RNA and DNA viruses in livestock and poultry with reference to antigenicity, cultivation, pathogenesis, epidemiology, diagnosis and immunity, RNA viruses: Retroviruses and lymphotropic viruses, Visna and Maedi, Arboviruses, Rotaviruses. Birnaviruses. Picornaviruses. Bunyaviruses. Cornoaviruses. Togaviruses, Paramyxoviruses, Orthomyxoviruses, Rhabdoviruses. Picornaviruses. Bunyaviruses. Arenaviruses. Arterioviruses. Caliciviruses. Filoviruses, DNA viruses: Poxviruses. Hepadnaviruses. Iridoviruses, Adenoviruses, Papovaviruses. Parvoviruses. Circoviruses. Unclassified viruses. Slow viruses - Scrapie.

Unit 5: Mycology

General characteristics of fungi. Classification and study of pathogenic fungi-Epidermophyton, Microsporum, Trichophyton, Cryptococcus, Aspergillus, Blastomyces, Coccidioides, Histoplasma, Candida, Rhinosporidum, Contaminating fungi, Rhizopus, Mucor and Penicillium. Fungi causing mastitis, abortion and mycotoxicosis.

Unit 6: Immunology

Historical Perspectives. Host-parasite relationships. Antigens. Types of antigens. Properties and specificity of antigens. Factor determining antigenicity. Haptens and carriers. Heterophile antigens. Adjuvants. Mechanisms of action, classification and their uses. Immunoglobulins – their classes and sub-classes, structure and function. Allotypes. Idiotypes. Genes coding for Igs. Generation of diversity. Monoclonal antibodies. Purification of antibodies. Theories of antibody formation. Lymphoid organs: primary, secondary and circulation of lymphocytes, cells involved in the immune response – B lymphocytes, T lymphocytes, subsets and nature of receptors.
Macrophages, Dendritic reticular cells, Langerhan's cells. Cellular interactions Cell-mediated immune responses. Mechanism of interaction of antigen and antibody. The complement system. Classical and alternate pathways. Serological reactions: agglutination, precipitation, neutralization, CFT, FAT, ELISA, DIE, RIA, etc, Immunological methods as an aid to diagnosis, blotting techniques like Northern, Western blotting, Major, Histocompatibility complex: organization.
Nature of antigens and MHC restriction. Hypersensitivity – immediate and delayed types, and mechanism of hypersensitivity. Mechanism of immunity, autoimmunity and immunological tolerance.

Unit 7: Molecular Cell Biology (Vaccine & Diagnostic Technology)

Role of biotechnology in diagnostics and vaccines, RNA electropherotyping. Probes - preparation of cDNA. Use of DNA probe in animal diseases diagnosis. Monoclonal antibodies. Application on monoclonal antibodies for diagnosis of animal diseases. Preparation of monoclonal antibodies. Nucleic acid hybridization. Modern trends in vaccines. Recombinant DNA vaccines and their probable use in animal diseases. Bioinformatic tools in microbial research, Biosafety, Biosecurity, GMP and GLP.

6.6 VETERINARY PATHOLOGY

Unit 1: Introduction, History and Etiology

Introduction, history and scope of pathology. Definitions. Etiology of the disease. Predisposing factors, intrinsic and extrinsic factors responsible for the disease. Physical agents, mechanical injuries. Heat, cold and decreased atmospheric pressure, light (photosensitization) UV light, microwaves, electricity, chemical agents-exogenous chemicals (toxin, poisons, drugs and food substances), endogenous chemicals (metabolites, cytolytic or inhibitory immune complexes, free radicles, oxidants)

Unit 2: Haemodynamics Derangements, Degeneration and Necrosis

Disturbances of circulation/haemodynamic derangements hyperaemia, ischaemia, haemorrhage, sludged blood, thrombosis, embolism, infarction, oedema and shock. Disturbances of cell metabolism – protein, carbohydrate and lipid metabolism, pigment metabolism, pathological calcification / ossification. Apoptosis, necrosis, gangrene. Ultrastructural changes in cell organelles in haemodynamic derangements and cell metabolic disturbances.

Unit 3: Inflammation and Healing

Inflammation – definitions associated with inflammatory phenomenon, etiology of inflammation, cardinal signs, pathogenesis of inflammation, chemical mediators released from injured tissues and inflammatory cells. Cellular reponse in inflammation, structure and functions of cells associated with inflammation. Role of humoral and cell mediated defenses. Various classifications of inflammation. Healing, cellular regeneration capability of different body cells. Role of cells (macrophages, fibroblasts, myofibroblasts, endothelial cells), extracellular matrix components and growth factors in healing.

Unit 4: Immunopathology

Immunopathology – anibody and cells, immuno-competence of foetus and new-born. Immune mediated tissue injury, hypersensitivity reactions- anaphylaxis, Arthus reaction, cyototoxic antibody reaction, immune complex disease, delayed hypersensitivity to chemicals, immunodeficiency diseases, defective immuno-competence, autoimmune diseases.

Unit 5: Genetically Determined Diseases

Genetic abnormalities, aberrations of chromosomes, mosaicisi, chimerism, anomalies in sex chromosomes and it autosomal chromosomes. Pathological states determined by one or more genes, lethal genes.

Unit 6: Disturbances in Cell Growth and Oncology

Disturbance in cell growth – aplasia, hypoplasia, hyperplasia, atrophy, metaplasia, dysplasia. Neoplasms-growth, etiology, classification, morphology, and behaviour of the neoplasms, structure and biology of the tumor cell, tumor immunology, tissue response to tumors, spread of tumors, pathological features of various neoplasms.

Unit 7: Post-mortem Diagnosis and Histopathological Techniques

Post-mortem examination as a diagnostic tool. Post-mortem techniques for different species including poultry, post-mortem changes, lesions in various organs in different diseases, identification and interpretation of lesions, preparation of necropsy reports. Handling of necropsy in vetero-legal cases, collection, preservation and dispatch of materials for diagnosis. Fixation and processing of tissues for histopathology and histochemistry. Different staining techniques. Histochemistry and histoenzymology as diagnostic tools. Principles of electron microscopy, processing of tissue for scanning and transmission electron microscopy.

Unit 8: Clinical Pathology

Clinical laboratory examination of various biomaterials from different livestock species, complete blood counts, serum enzymology, bone marrow examination, erythrocytes, leucocytes and platelet disorders and their interpretations. Electrolyte and acid base analysis, altered electrolyte concentrations and their interpretations, fluid accumulation disorders, examination of effusions (chemistry and exfoliative cytology). Complete examination of urine, skin scrapings stools, CSF and milk for pathological constituents and interpretation of results.

Unit 9: Systemic Pathology

Pathology of cardiovascular, haemopoietic, respiratory, digestive, urinary, genital, nervous and musculoskeletal systems, endocrine glands, organ of special senses i.e, eye, ear, skin, appendages.

Unit 10: Pathology of Infectious Diseases

Pathology of bacterial, mycotic, viral, mycoplasmal, rickettsial, chlamydial and parasitic diseases. Diseases caused by prions.

Unit 11: Avian Pathology

Farm placements and building in relation to disease, management and nutrition in relation to disease. Biosecurity in the control of diseases. Stress and its effects. Omphalitis and yolk sac infection, Newcastle disease, infectious bronchitis, infectious laryngotracheitis, viral arthritis, infectious bursal disease, egg drop syndrome, inclusion body hepatitis and hydropericardium syndrome, infectious stunting syndrome, swollen head syndrome, Marek's disease, avian leucosis/sarcoma complex, salmonellosis, pasteurellosis, mycoplasmosis, chlamydiosis, colibacillosis, spirochaetosis, aspergillosis, thrush, mycotoxicosis, parasitic diseases – nematodes, cestodes and protozoa, nepherosis/nephritis syndrome, multi-etiology syndromes. Immunosuppression and conditions/diseases associated with it. Vaccinations against various diseases, their failures and remedies.

Unit 12: Nutritional and Production Pathology

Pathology of nutritional deficiency disease – protein, carbohydrate, mineral and vitamins. Concept of production diseases – pathology of milk fever, ketosis, magnesium tetany, rumen indigestion, nutritional haemoglobinuria.

Unit 13: Pathology of Toxicosis

Clinico-pathological features of toxicosis due to heavy meals, mycotoxins, insecticides, pesticides, toxic plants, chemicals and drugs.

Unit 14: Pathology of Diseases of Laboratory and Wild Animals

Etiopathology of common diseases of laboratory and wild animals.

07. VETERINARY AND ANIMAL SCIENCES-III

(7.1 Veterinary Medicine, 7.2 Veterinary Pharmacology& Toxicology, 7.3Vety. Gynaecology & Obstetrics/Animal Reproduction, Gynaecology & Obstetrics, 7.4 Veterinary Surgery & Radiology/Veterinary Surgery, 7.5 Veterinary Anatomy/Veterinary Anatomy & Histology)

7.1 VETERINARY MEDICINE

Unit 1: General Medicine

Epidemiology and its ingredients. Definitions of diseases known as – infectious, contagious, sporadic, epizootic, enzootic, panzootic, exotic, zoonotic, etc. Meaning and purpose of segregation, isolation, quarantine, etc., role of occurrence, prevalence, incidence, morbidity rate, mortality rate, case fatality rate, mode of transmission, vectors, spread, economics, etc. in terms of epidemiology of diseases. General systemic states like – bacteremia, septicemia, pyemia, toxemia, hyperthermia, hypoglycemia, allergy, anaphylaxis, shock, dehydration, stress, sudden death, anasarca, anaemia, pica, etc.

Unit 2: Diagnosis of Animal Diseases

History taking. General clinical examination. Special clinical examination – electrocardiography, paracentesis, rumen fluid examination, haematology, blood biochemistry, urinalysis, ophthalmoscopy, otoscopy, endoscopy, ultrasonography, biopsies, etc.

Unit 3: Gastroenterology

Specific conditions of organs of gastrointestinal system with special emphasis to – simple/acid/alkaline indigestion, GI ulcers, choke, tympany, colic, impaction, traumatic reticulitis / peritonitis, abomasal displacement, ascites, jaundice, hepatitis, enteritis, gastritis, etc.

Unit 4: Diseases of Cardiovascular and Pulmonary System

Principles of circulatory failure, Acute heart failure, Congestive heart failure, Perpheral circulatory failure. Myocardial and valvular diseases. Epistaxis. Pulmonary congestion and oedema. Emphysema. Pneumonia. Pleurisy, URI Aspiration pneumonia.

Unit 5: Diseases of Urinary, Nervous, Musculoskeletal and Integumentary Systems

Nephrosis, Nephritis. Pyelonephritis. Cystitis. Urolithiasis. Uremia. Cerebral anoxia. Encephalitis. Encephalomalacia. Meningitis. Encephalomyelitis. Paralysis. Urticaria. Dermatitis. Photosensitisation. Seborrhoea. Conjunctivitis. Otitis. Kerato-conjunctivitis. Corneal ulcers. Eczema. Impetigo. Alopecia.

Unit 6 : Production and Deficiency Diseases

Metabolic profile test, milk fever, Downer's cow syndrome, ketosis, hypomagnesaemia, diabetic ketoacidosis, hypomagnesaemia, post-parturient haemoglobinuria, azoturia. Fat cow syndrome, rickets, osteomalacia, osteodystrophia fibrosa. Trace mineral and vitamin deficiency.

Unit 7 : Common toxicities

Sources, pathogenesis, clinical manifestations, post-mortem findings, diagnosis and treatment of conditions occurring in the following classes of poisonings: Metal Corrosives/irritants. Plant poisonings. Water-borne toxicities. Pesticide poisonings. Insect bites and stings. Snake bite. Environmental pollution hazards. Radiation hazards and injuries.

Unit 8 : Infectious Diseases (Bacterial and Mycoplasmal)

Etiology, epidemiology, pathogenesis, clinical manifestations, post-mortem findings, diagnosis, treatment and control of the following diseases of livestock : Mastitis, Strangles. Caseous lymphadenitis in sheep and goats. Clostridial diseases. Ulcerative lymphangitis in horses & cattle. Listeriosis, Leptospirosis, Erysipelas, Collibacillosis, Salmonellosis, Pasteurellosis, Brucellosis, TB, JD, Actinomycosis, Actinobacillosis, Glanders and Mycoplasmal diseases.

Unit 9 : Infectious Diseases (Viral, Chlamydial, Rickettsial and Fungal)

Etiology, epidemiology, pathogenesis, clinical manifestations, postmortem findings, diagnosis, treatment and control of the following diseases of livestock: Hog cholera. African swine fever. Leucosis FMD, RP. PPR. BMC BSE. Bovine viral diarrhoea. Mucosal diseases. Bluetongue. Influenza. Maedi. Pulmonary adenomatosis. Rabies. Encephalomyelitis. Pseudorabies. Louping ill. Caprine arthritis, encephalitis, Scrapie, Visna, Contagious ecthyma. Pox, Papillomatosis, Distemper. Infectious canine hepatitis. Parvo virus enteritis. Feline panleucopenia. Anaplasmosis, Heart water diseases, Contagious opthalmia., Aspergillosis, Ring worm, Bursattee, Lymphangitis, Babesiosis, Theileriosis, Coccidiosis, Trypanosomosis, Toxoplasmosis.

Unit 10: Parasitic Diseases

Etiology, epidemiology, pathogenesis, clinical manifestations, post-mortem findings, diagnosis, treatment and control of the following diseases of livestock: Major conditions produced by nematode, cestode and trematode infestations. Major conditions produced by arthropod parasites.

Unit 11: Poultry Disease

Etiology, epidemiology, pathogenesis, clinical manifestations, post-mortem findings, diagnosis, treatment and control of the following diseases of poultry: Newcastle disease, IBD, ILT, mycoplasmosis, coccidiosis, salmonellosis, necrotic enteritis, malabsorption. leucosis. Marek' disease, mycotoxicosis, avian encephalomyelitis. hydropericardium syndrome. avian influenza, psittacosis-ornithosis, TB, histomonosis, spirochaetosis, trichomonosis, etc., parasitic diseases of poultry.

Unit 12: Veterinary Jurisprudence and Ethics

Judicial procedure. Duties of veterinarian particularly as an expert e*vide*nce. Vetero-legal aspects of wounds. Vetero-legal aspect of death in general, due to diseases, drowning, near drowning, electrocution, lightening, etc. Post-mortem examination of a vetero-legal, cases. Collection and dispatch of materials for forensic science examination. Common offense against animals. Common frauds in dealing with livestock and livestock products. Animal Insurance. Identification of animal species for vetero-legal purposes. Determination of time since death. Examination of blood and semen stains. Blood grouping in animals and its vetero-legal significance. Veterinary ethics: Code of conduct, professional ethics and etiquette for veterinarian. Laws: Role of veterinarian. Legal enactment in IPC related to animals and veterinarians. Prevention of Cruelty to Animal Act, Indian Veterinary Council Act. Wild life (protection) Act. Glanders and Farcy Act, Livestock Importation Act. Dangerous Drug Act and Prisoning Act. Legal provisions related to animals, animal diseases and drugs.

Unit 13: Special Therapeutic Approaches

Veterinary fluid therapy with fluid, electrolyte, plasma expanders, packed cell transfusions, etc. Clinical assessment of their requirement and doses. Blood transfusion with blood groups in animals-their therapeutic significance. Blood matching methods. Oxygen therapy.

Unit 14: Prevention and Control of Diseases

General principles of control of diseases. Role of OIE in disease control. Internationally recongnised control methods of designated diseases. Prevention and control methods for national, area and herd based control programmes of diseases like TB, JD, rabies, brucellosis, HS, anthrax, BQ, mastitis, FMD, bluetongue, etc.

Unit 15: Common Diseases of Zoo, Laboratory Animals and Wildlife

Clinical signs, diagnosis and treatment of diseases of wildlife and zoo animals: Shock, stress, diseases of cardiovascular system, capture myopathy, metabolic and nutritional diseases, toxicosis by chemicals and plants, tuberculosis, paratuberculosis, pasteurellosis, anthrax, rabies, FMD, RP, Kyasanur forest diseases (KFD), surra, helminthiasis. Clinical symptoms, diagnosis and treatment of diseases of laboratory animals: Tyzzer's diseases, salmonellosis, pasteurellosis, strepto and staphylococcosis, psedudomoniasis, corynibacteriosis, mycoplasmosis (MRM), herpesvirus infection, pox diseases, coccidiosis, toxoplasmosis, giardiasis, helminthic infection, dermatophytosis, scabies, dermatitis, metabolic and nutritional deficiencies. Management related diseases of mice, rat, guinen pig, hamster and rabbit.

7.2 VETERINARY PHARMACOLOGY& TOXICOLOGY

Unit 1: General Pharmacology

Development and Scope, branches of pharmacology,Terminology, Sources and nature of drugs. Pharmacopoeia and drug compendia. Drug Schedules. Factor modifying drug activity. Concepts of pharmacogenetics, pharmaco-genomics Gene based therapy, overview of indigenous medicinal plants its active principles in therapeutic use.
Pharmacodynamics: Drug structure activity relationship. Drug receptor interaction.Role of secondary messengers. Drug modulation via different types of channels. Characterisation of agonist, antagonists.
Pharamacokinetics:Principles, Drug absorption, distribution, metabolism and excretion. Factors modifying drug kinetics. Kinetic constants. Different models, determination of kinetic parameters and application in rational dosage regimen.
Pharmacometrics:Drug discovery and development process. Multidimensional screening methods, bioassays. Determination of median doses – LD50, ED50, therapeutic indices. Types of dose response relationship.

Unit 2: Drugs Acting on Central Nervous System

Role of neurotransmitters in CNS. Sedatives, Hypnotics, General anaesthetics, Hypotheses and clinical stages of anaesthesia. Pre-and post-anesthetics, Molecular mechanism of action of inhalant and parenteral anesthetics. Anticonvulsants. Tranquilizers. Narcotic and non-narcotic analgesics and antipyretics. Drugs affecting behaviour. Drug dependence and addiction and abuses. CNS stimulants. Muscle relaxants. Local anaesthetics.

Unit 3: Drugs Acting on Humoral and Autonomic Nervous Systems

Neurohumoral transmission. Adrenergic and antiadrenergic drugs including adrenergic neuron blockers. Cholinergic and anticholinergic drugs. Purinergic and Adenosine receptors. Dopaminergic and antidopaminergic agents. Nitric oxide mediators. Neuromuscular and ganglion stimulants and ganglion blockers.

Unit 4: Drugs Acting on Cardio-vascular and Respiratory Systems

Drugs acting on heart and blood vessles. Antihypotensive and anti-arrhythmic agents. Blood coagulants and anti-coagulants. Heamatinics. Haemorrhagic shock and its treatment. Expectorants, antitussives. Cough sedatives. Bronchodilators. Mucolytic agents. Analeptics.

Unit 5: Drugs Acting on Digestive System

Stomachics. Antacids. Carminatives and antizymotics. Emetics and antemetics. Cathartics. Antidiarrhoeal agents. Antispasmodics. Pharmacology of rumen and rumenotoric drugs. Drugs acting on hepatobiliary system.

Unit 6: Drug acting on Urogenital System

General principles of electrolyte therapy. Drugs altering fluid balance. Diuretics and antidiuretics. Drugs acting on uterus (oxytocics and tocolytics). Therapy of infertility and improving conception and synchronization of oestrus.

Unit 7: Endocrine Pharmacology

Mode of action and synthesis of pituitary hormones. Therapeutics of non-pituitary gonadotropin, adrenocorticoids, sex hormones, insulin, thyroid hormones, antithyroid agents, calcitonin, parathormone.

Unit 8: Autacoids

Pharmacological effects and therapeutics of histamine, antihistaminic agents, 5-HT its antagonists, prostaglandins and leukotrienes, peptides and kinins, rennin and angiotensins. Platelet activators. Anti-inflammatory drugs.

Unit 9: Chemotherapy

General principles. Classification of antibiotics based on chemistry, mechanism of action, etc., Drug allergy, hypersensitivity, mechanism of resistance development. Veterinary drug residues and its impacts. Extra label usage of antibiotics. Withdrawal period for antibiotics. Antiseptics and Disinfectants.

Antibiotics: beta lactams (Penicillin, cephalosporins, etc.) protein synthesis inhibitors (aminoglycosides, tetracyclines, chloramphenicol and macrolide/lincosamides, Quinolones, nitrofurans, polypeptide and other miscellaneous and emerging antibiotics. Sulphonamides, thrimethoprim and derivatives. Antifungal, antitubercular, antiviral and antineoplastic drugs.

Anthelminitic: Antinematodal, anticestodal, antitrematodal drugs. Antiprotozoans, Anticoccidials. Drugs used for ectoparasite control.

Unit 10: Toxicology

Terminology. Classification of poisons. Toxicity rating. Principles of selective toxicity. Toxicodynamics. Toxicokinetics. Diagnosis and treatment of poisoning (anti-dotal and non-antidotal). Mechanism of detoxification. Poisons causing respiratory insufficiency. Toxicology of common inorganic compounds. Toxicity of metals, non-metals and metalloids. Poisonous plant-cyanogenic, nitrate and oxalate producers. Mycotoxins : aflatoxin, rubratoxin, ergot. Toxic ferns. Venoms from snakes, scorpions, toads, etc. and treatment.

Unit 11: Ecotoxicology

Toxicity of pesticides, fungicides, weedicides, fertilizers on biosphere. Chemical warfare agents and radiation hazards. Toxicity from food additives, preservatives. Statutory regulation on agrochemical formulation and their uses. Recent advances in evaluation of cytotoxicity, immunotoxicity, teratogenicity, mutagenicity, embroyotoxicity.

Unit 12: Miscellaneous Topics

Drugs promoting growth and production. Agents used for doping and restraining of wild animals. Euthanising agents. Drug control and regulation.

7.3. VETY. GYNAECOLOGY & OBSTETRICS/ANIMAL REPRODUCTION, GYNAECOLOGY & OBSTETRICS

Unit 1: Veterinary Gynaecology

Biology of sex. Development of female genitalia. Functional anatomy of female reproductive system of farm animals. Growth, puberty and sexual maturity. Reproductive cycles (oestrous cycle) in female farm animals. Oogenesis and folliculogenesis. Follicular dynamics and ovulation. Transport and survival of gametes, fertilization, cleavage, implantation and maternal recognition of pregnancy. Sex determination and differentiation, Development of foetus and foetal membranes. Period of embryo and period of fetus, Teratology of fetus, Placenta-classification and functions. Gestation and pregnancy diagnosis in farm animals.

Unit 2 : Reproductive Endocrinology

Reproductive hormones, classification, synthesis, chemical composition and mechanism of action. Hypothalamus, pituitary, thyroid, gonadotropic, gonadal, placental and pineal gland hormones. Prostaglandins, pheromones, growth factors and hormone antagonists and their significance in animal reproduction. Hormonal assays. Hormonal regulation of male and female reproduction. Clinical uses of hormones.

Unit 3 : Accidents during Gestation

Pregnancy, Pseudocyesis, Ectopic pregnancy, Abnormalities of fertilization and foetal development, Superfecundation and superfetation. Abortion – bacterial, viral, mycotic, protozoal, physical, toxic and miscellaneous causes, diagnosis and prevention, Dropsy of foetal membrane and foetus, Maceration, mummification, Pyometra, Antepartum vagino-cervical prolapse, Uterine torsion and displacement of uterus. Retained fetal membranes.

Unit 4 : Veterinary Obstetrics

Pelvis and pelvimetry. Parturition – Signs approaching parturition, initiation and stages of parturition, induction of parturition and postpartum period. Presentation, position and posture. Causes and forms of dystocia and its treatment. Epidural anaestheia. Obstetrical maneuvers including fetotomy and Caesarean section. Post-partum complications in domestic animals, retention of placenta, uterine proplapse, endometritis, metritis, septic metritis. Post parturient metabolic disorders.

Unit 5 : Andrology

Comparative anatomy of male reproductive system. Thermoregulation of testis and blood testis barrier, Growth, puberty and sexual maturity. Spermatogenesis including cycle of somniferous epithelium and spermatogenic wave. Sperm morphology and ultra-structure of spermatozoa, sperm transport, maturation and storage in male genital tract, Secretions of male reproductive tract including accessory glands and their role in reproduction, Sexual/mating behaviour. Training of young bulls for semen collection, Semen and its composition, biochemistry of semen and sperm metabolism, sperm abnormalities and its classification, sperm separation and spermatozoa karyotyping. Breeding soundness evaluation of bulls, testicular cytogram, routine semen analysis, advances in semen analysis techniques including fluorescent dyes.

Unit 6 : Male Infertility

Fertility, infertility and sterility in male domestic animals. Causes and forms of male infertility. Testicular hypoplasia, cryptorchid, testicular degeneration, orchitis, affections of epididymis, vas deference, penis, prepuce and accessory glands & their management, tumors of the male reproductive tract, nutritional infertility, Vices in the males. Libido problem and its management, fertility markers.
Evaluation of male for breeding soundness, reproductive health status. Effect of parental drugs and vaccines on semen quality.

Unit 7 : Frozen Semen Technology and Artificial Insemination

History and development of artificial insemination. Advantages and disadvantages of AI and frozen semen, selection of bulls for AI purpose. Management of breeding bulls, methods of semen collection in different domestic animals, semen evaluation including latest techniques for evaluation of motility and fertilization.
Ideal extenders, extenders for liquid semen. Preservation of semen at various temperatures. Processing and preservation of liquid semen. Extenders for frozen semen, principles and techniques of semen freezing. Cold shock and ultra-low temperature shock. Cryoprotectants. Semen additives. Evaluation of frozen semen. Transport and storage semen. Handling of frozen semen, Liquid nitrogen and its containers. Insemination techniques. Estrus and estrus detection tools, Planning and organization of semen bank.

Unit 8 : Reproductive Technology

Synchronization of oestrous cycle in domestic animals, control of ovulation. Embryo transfer technology – History, advantages and disadvantages, superovulation, collection, evaluation, preservation and transfer of oocytes / embryos.
History of *in vitro* maturation and fertilization. Recovery of oocytes *in vitro* and *in vivo*, maturation, fertilization, culture, evaluation, preservation and transfer of oocytes / embryos. Micromanipulation of embryos. Embryo splitting and cloning. Stem cells and production of transgenic animals. Sex determination and gene insertion. Establishment of laboratory for ETT, IVM, IVF and IVC.
Use of Ultrasonography, laparoscopy and ovum-pick technology in farm animals.

Unit 9 : Infertility in Cows and Buffaloes

Fertility, infertility and sterility. Fertility indices, Evaluation of herd fertility. Incidence and economic role of infertility, forms of infertility, congenital and hereditary defects, infectious diseases. Pathological conditions of ovary, oviduct, uterus, cervix and vulva. Management causes of infertility. Hormonal causes of infertility, anestrus, repeat breeding, cystic ovarian degeneration, sexual health control and reproductive health programmes. Breeding soundness examination of cows and buffaloes.

Unit 10 : Reproduction and Infertility in Ovine/Caprine

Puberty, sexual maturity, breeding season, oestrous cycle, Breeding and conception, gestation, parturition, peri-parturient and obstetrical complications. Synchronization of oestrous cycle. Embryo transfer. Causes of infertility and their management.

Unit 11 : Reproduction and Infertility in Swine

Oestrous cycle, synchronization of oestrous cycle, Hormonal control of reproduction. Various forms of infertility in swine and their management. Various obstetrical problems and their management.

Unit 12 : Equine Reproduction

Physiology and pathology of equine reproduction. Research techniques and methodology for the study of equine reproduction. Equine andrology. Reproductive behaviour and management of stallion. Semen collection, examination and artificial insemination. Pregnant mare behaviour . Application of modern reproductive techniques in equine reproduction. Equine infertility.

Unit 13 : Canine and Feline Reproduction

Functional anatomy of dog and cat reproductive system, oestrous cycle and endocrinology of oestrous cycle and detection of optimum breeding time. Exfoliative vaginal cytology. Methods of pregnancy diagnosis, contraception. Medical termination of pregnancy. Infertility in bitches, disorders of oestrous cycle, pseudopregnancy, pyometra, cystic endometrial hyperplasia, tumors of reproductive tract. Difficult whelping – types and methods of handling dystocia. Caesarean section. Ovarian hysterectomy. Peri-parturient complications. Semen collection, evaluation, techniques of artificial insemination, infertility in male including testicular tumors – cryptorchid, affections of prostate.

7.4 VETERINARY SURGERY & RADIOLOGY/VETERINARY SURGERY

Unit 1: General Surgery

Current concepts of inflammation and its management. Asepsis and antisepsis in surgery. Disinfection and sterilization. Surgical bacteriology. Pre-, Peri and post-operative considerations. Physiopathology of burns, trauma, surgical stress and shock. Haemorrhage, haemostasis and administration of whole blood, blood extracts and plasma substitute. Acid – base and electrolytes imbalance. Rehydration and fluid therapy. Tissue repair including its biochemical aspects. Principles of tissue and organ transplantation. Tissue transplantation immunity. Sutures and suture materials. Operation theatre management. General surgical affections viz.. abscess, cyst, haematoma, tumour, gangrene, sinus, fistula and hernia. Neurological examination, paralysis and its treatment. Surgical instrumentations. Care of critically ill patients. Cosmetic surgery. Skin grafting techniques in animals.

Unit 2 : Anaesthesia

History and instrumentation. Pre-anaesthetic considerations of patient. Selection of various anaesthetic and pre-anaesthetic agents and their effects on different body organs. Inhalant and non-inhalant anaesthetic agents including dissociative, neurolept and balanced anaesthesia and their administration in small and large animals. Monitoring of patient during anaesthesia. Anaesthetic emergencies and their management. Muscle relaxants. Local anaesthetic agents. Local and regional anaesthetic procedures. Anaesthesia for special surgical procedures and special disease conditions. Electronarcosis. Hypothermia. Acupuncture analgesia. Anaethesia and methods of capture of zoo animals. Therapeutic usage of local anaesthetic agents and techniques. Methods of artificial

ventilation.

Unit 3 : Radiology

Production and quality of X-rays; exposure factors and formulation of technique chart. Basics of radiation physics. Interaction of particulate and non-particulate radiations with matter. Radiographic artifacts and their prevention. Radiographic quality and factors affecting it. Radiographic features of diseases of musculo-skeletal, digestive, urogenital, cardiovascular, respiratory and lymphatic system of small and large animals. Radiation hazards. Radiation biology including its mechanism of action and effects on various organ systems. Radiation protection. Radiological contrast agents and common contrast radiographic procedures. Principles of radiotherapy and physiotherapy. Invasive and non-invasive imaging modalities viz. echocardiography, computed tomography, scintigraphy, magnetic resonance imaging, ultrasonography and subtraction angiography.

Unit 4 : Orthopaedics and Lameness

Physiological and biochemical considerations of bone. Osteogenesis and mineralization of bone. Bone research techniques. Circulation of long bones. Biomechanics of fractures. Etiology, classification and healing of fracture; factors affecting fracture healing. Complications of fractures and their management. Methods of internal and external fixations of fracture and factors governing selection of fixation methods. Effect of various internal fixation methods on physiology and blood circulation of bone. Bone grafts. Metallic and non-metallic materials in bone surgery and their biological behaviour. Surgical affection of vertebral column. Etiology, pathophysiology, diagnosis and treatment of affections of bones and joints. Technique of arthroscopy. Lameness and allied surgical conditions of fore and hind limbs. Various foot diseases. Affections of tendons, ligaments and their management. Relationship between conformation of the limbs, foot and its axis to soundness. Soundness and examination of horse for soundness

Unit 5 : Surgery of Head and Neck Region

Etiology, diagnosis and surgical management of the affections of sinuses, horn, nasal and buccal cavity, teeth, tongue, salivary glands, larynx, pharynx, trachea and oesophagus. Surgical affections of eye lids, lacrimal apparatus, nictitating membrane, conjunctiva, cornea, sclera, chloroids, iris, retina, lens, optic nerve, aqueous and vitreous humours and other parts of eye and their management. Surgical affections and management of ear and guttural pouch.

Unit 6 : Thoracic Surgery

Various approaches for thoracic surgery in large and small animals. Physiological alterations following thoracotomy. Heart lung machine and its use in thoracic surgery. Different congenital and acquired surgical affections of thoracic wall and thoracic organs viz. lung, mediastinum, oesophagus, heart and diaphragm in large and small animals. Surgical diseases of the vascular and lymphatic systems.

Unit 7 : Abdominal and Pelvic Surgery

Different surgical approaches for abdomen. Hernia: etiology, pathophysiology and treatment. Various acquired and congenital surgical affections of abdominal organs viz. Traumatic reticulitis, abdomasal displacement, impaction of omasum, pyloric stenosis, gastric torsion, caecal dilation, intestinal obstruction, rectal and anal prolapse, and peritonitis. Colic in horse:- etiology, diagnosis and treatment. Affection of liver, spleen, kidney and urinary bladder their complications and surgical management. Urolithiasis, uraemia and their management. Surgery of male and female genital organs. Etiology, diagnosis and surgical management of the affections of udder, teat and tail.

7.5 VETERINARY ANATOMY/VETERINARY ANATOMY & HISTOLOGY

Unit 1: Comparative Osteology and Arthrology

Structure, chemical composition and classification of bones, Bones of appendicular and axial skeleton of ox as a type and their comparison with those of horse, dog, pig and poultry, classification and detailed study of different

joints of the body. Study of various indices for estimating race, sex and age of different animals. Basics of biomechanics of the locomotor system, Radiography of normal and developing bones.

Unit 2: Comparative Splanchnology

Descriptive anatomy of various organs of digestive system and associated glands, respiratory system and associated glands and urinary system and associated glands of ox and their comparison with those of horse, dog, pig and poultry. Study of formation of thoracic, abdominal and pelvic cavities and their reflection. Complete study of various organs and associated glands of male and female genital systems, surgical sites for various operations and clinically significant areas for performing auscultation, percussion and for carrying out surgical procedures such as laryngotomy, oesophagotomy, gastrotomy, rumenotomy, cystotomy, urethrotomy, caesarian section, exploratory laparotomy, mammectomy, thoracotomy, thoracocentesis, etc.

Unit 3: Myology, Angiology, Neurology and Aesthesiology of Ox

Classification of muscle fibres, origin, insertion and relations of muscles of different body parts. Topographic anatomy of the vascular system comprising of heart, arteries, veins and lymphatics. Study of various components of central nervous system, peripheral nervous system and autonomic nervous system. Complete study of the gross anatomy of various sense organs. Study of different nerve blocks, intravenous sites and enucleation of eyeball.

Unit 4: Histological and Histochemical Techniques

Preparation of tissues for light microscopy using different fixatives, different staining methods for routine light microscopy, frozen sectioning techniques and staining methods for enzymes, carbohydrates, lipids, proteins, pigments etc. Silver staining techniques for nervous tissue.

Unit 5: General and Systemic Histology and Ultrastructure

General: Light and ultra-structural details of animal cell, epithelial tissue, muscular tissue, connective tissue and nervous tissue.
Systemic: Light and ultrastructure of different organs of digestive system, respiratory, lymphoid and cardiovascular system, urogenital system, different sense organs and nervous system of ruminants with differential features among domestic animals.

Unit 6: Developmental Anatomy

Gametogenesis, fertilization, cleavage and gastrulation, development of foetal membranes and placenta in domestic animals, histogenesis of nervous system, sense organs, endocrine organs and cardiovascular system, embryonic development of digestive, respiratory, urogenital and musculoskeletal system.

Unit 7: Principles and Applications of Biomechanics

Biomechanics, its definition and scope with reference to anatomy and physiology of domestic animals and musculo-skeletal dynamics. Locomotion and clinical applications, biomechanics of cortical and trabecular bones, biomechanics of fracture fixation, instrumentation and techniques in locomotion and their application in lameness.

Unit 8: Avian Anatomy

Gross and microscopic features of different body systems of domestic fowl.

Unit 9: Neuroanatomy

Gross and microscopic anatomy of the brain and spinal cord, various cranial and spinal nerves along with their associated nuclei and ganglia, motor and sensory pathways, different ascending and descending tracts of brain and spinal cord and autonomic nervous system.

Unit 10: Endocrine Anatomy

Advanced gross and microscopic anatomy of the hypothalamus and pituitary gland, thyroid, parathyroid, thymus, adrenal glands, islets of Langerhans, pineal body and other tissues associated with endocrine secretions.

Unit 11: Theory and Applications of Electron Microscope

Introduction and principles of electron microscopy, methods for transmission electron microscopy and scanning electron microscopy.

Unit 12: Histoenzymology and Immunocytochemistry

Classification of enzymes – principles of enzymes, histochemistry methods; Substrates –combination–coupling azo-dye methods –capture reagents, localization of enzymes and controls in enzyme histochemistry. Fluorescence microscopy in enzyme histochemistry, immunohistochemistry- principles and techniques.

Unit 13: Applied Embryology and Teratology

Principles of experimental embryology and teratology, factors affecting the developmental mechanisms of embryo. Use of organizer implants, chemical and hormonal preparations in the developmental models and available literature on teratogenic experimentation.

Unit 14: Functional Veterinary Anatomy

The relationship of structure to form and function, the relationship of structure for adaptation and behaviour and in relation to clinical conditions/ applications.

Unit 15: Gross Anatomy of Laboratory Animals

Study of different organs of digestive system of different laboratory animals, detailed study of urinary, male and female reproductive systems of different laboratory animals, complete study of respiratory system of different laboratory animals, study of organs of circulation and nervous system of different laboratory animals. Descriptive anatomy of endocrine glands of different laboratory animals.

08. DAIRY SCIENCE, DAIRY TECHNOLOGY & FOOD TECHNOLOGY

(8.1. Dairy Chemistry, 8.2Food Technology, 8.3 Dairy Microbiology, 8.4Dairy Technology)

8.1. DAIRY CHEMISTRY

Unit 1

Milk constituents, their normal contents and physical and chemical nature. Specific compositional differences among milk from various species; Variations in milk composition due to breed, feed, season, stage of lactation and mastitis; Colostrum and abnormal milks, physical properties of milk; Acid base equilibria, oxidation-reduction potential, density, viscosity, interfacial tension, freezing point, electrical conductivity, thermal conductivity, refractive index, milk buffer capacity, physical equilibria among milk salts; Effect of various treatments on salt equilibria; Salt balance and its importance in processing of milk; Water activity, and its effect on shelf life; Colloids, properties and colloidal stability of milk; Emulsions, foams and gels formation, their stability and importance in dairy processing.
Lactose – structure, isomers, physical, chemical and biochemical properties. Browning mechanisms. Estimation and biosynthesis. Lactose intolerance. Significance of carbohydrates in milk and milk products. Distribution of trace elements in milk and their technological and nutritional importance; Water soluble vitamins – molecular structure and their levels in milk and milk products, biological significance, and factors affecting their levels.

Unit 2

Levels, distribution, isolation and genetic polymorphism of different milk proteins; Casein micelles – structure, size distribution, stability and physico-chemical properties; Casein models. Amino acid composition and physico-chemical properties of different fractions of caseins; Whey process, denaturation of milk proteins as influenced by temperature, pH and additives; Biosynthesis, structure, function and physico-chemical properties of α-lactalbumin and ß-lactoglobulin, immunoglobulins, lysozyme, lactoferrins, lipoproteins and fat-globule membrane proteins and their importance; Milk protein allergenicity; Role in immune response; Chemistry of milk enzymes and their significance with reference to milk processing and milk products. Kinetics of chemical reactions and enzyme kinetics; Casein hydrolysate, co-precipitates, and whey protein concentrates; bioactive peptides. Functional properties of milk proteins and their modifications using enzymatic and physical treatments.

Unit 3

Milk lipids – classification, composition, structure and general physical and chemical properties. Auto-oxidation – definition, theories, factors affecting, prevention and measurement. Antioxidants – mechanism of reaction and estimation. Lipolysis. Fatty acids – profile, properties and affecting factors. Unsaponifiable matter. Cholesterol – structure, forms, importance and level in milk. Chemistry of phospholipids and their role in milk and milk products. Fat – soluble vitamins – chemistry, physiological functions, levels in milk, cream, butter and ghee. Biosynthesis of milk fat. CLA biosynthesis and its nutritional and health benefits.

Unit 4

Milk adulteration and detection methods; Estimation methods for antibiotics, pesticides, heavy metals, lactose, lactate, protein, total solid, fat, salt, vitamin C, calcium, phosphorous, iron, citric acid in milk and milk products. Estimation of vitamin A, total phospholipids and free fatty acids in ghee. Estimation of starch in food. Measurement of BOD and COD in dairy waste.

Unit 5

Cream – Size distribution of fat globules, creaming phenomenon, composition and properties of cream and dry cream. Chemistry of neutralization and ripening. Butter. Mechanism of churning during butter preparation. Desi and creamery butter composition, properties, microstructure, grading, standards and defects. Ghee-Compositional differences in ghee prepared by different methods and variations in ghee and butter oil, Analytical constants and factors affecting them. Differences in cow and buffalo ghee. Hydrolytic and oxidative deterioration of ghee, their causes and prevention. Adulteration of ghee and methods of detection. Ghee grading, Antioxidants: natural and synthetic. Physico-chemical characteristics of buttermilk and ghee residue.

Unit 6

Heat stability of milk as affected by various milk constituents and additives. Role of protein-protein interaction and age gelation of UHT milk. Physical and chemical changes during preparation of concentrated milk and subsequent storage. Compositional differences between condensed and evaporated milk. Dried milk; Structure and physico-chemical properties. Physical properties of instant powder, Infant food. Spoilage of milk powder and its control. Khoa : composition and changes during manufacture. Composition and changes during preparation of chhana and paneer.

Unit 7

Cheese : Composition and varietal differences. Chemistry of rennin action. Influence of acidity, renneting and heat on the process of cheese manufacture. Changes during manufacture and ripening. Role and mechanism of action of stabilizers and emulsifiers, rheological properties and defects of cheese. Milk clotting enzymes from different sources – microbial, animal and plant. Theories and metabolic pathways of fermentation. Dahi, yoghurt and Acidophilus Milk : Composition and specific differences, chemical changes during fermentation, flavour development. Composition of Lassi and buttermilk. Nutritional and therapeutic significance of fermented milk products.

Unit 8

Ice-cream : Composition and physical structure, changes during ageing, freezing, hardening and defects. Role and mechanism of stabilizers and emulsifiers. Kulfi: composition and differences with ice-cream.

Unit 9

Definition of quality, quality control and assurance. Standards, statutory and voluntary organization. PFA act, sampling, labelling, PFA and AGMARK, BIS, ISO9000 standards for milk products. Total quality management, sensory evaluation of milk and milk products. Calibration of glasswares (lactometer, butyrometer, milk pipette, thermometer) used in Quality control laboratory, legal requirements of packaging material and product information, nutrition labeling.

Unit 10

Spectroscopy – UV – Vis spectrophotometry, IR. Separation techniques : TLC, GLC, HPLC, Ion exchange, size exclusion, affinity chromatography, analytical sedimentation, sedimentation equilibrium, isopycnic ultracentrifugation. Ultrafiltration. Precipitation by salting out agents. Electrophoresis – PAGE, SDS-PAGE, Radio-tracers technique. Flame photometry and potentiometry (principle, various electrodes, electrometric measurements of pH, buffers).

8.2. FOOD TECHNOLOGY

Unit 1: Introductory Food Technology

Introduction to food technology, Food processing industries/institutions/food scientists of importance in India, Food attributes *viz*. colour, texture, flavour, nutritive value and consumer preferences, Causes of food spoilage, sources of microbial contamination of foods, food borne illnesses, water activity and its relation to spoilage of foods, Spoilage of processed products and their detection, Principles and methods of food preservation. Food fortification, Composition and related quality factors for processing. Methods of food preservation such as heat processing, pasteurization, canning, dehydration, freezing, freeze drying, fermentation, microwave, irradiation and chemical additives. Refrigerated and modified atmosphere storage. Aseptic preservation, hurdle technology, hydrostatic pressure technology and microwave processing. Use of non-thermal technologies (microfiltration, bacteriofugation, ultra high voltage electric fields, pulse electric fields, high pressure processing, irradiation, thermosonication), alternate-thermal technologies (ohmic heating, dielectric heating, infrared and induction heating) and biological technologies (antibacterial enzymes, bacteriocins, proteins and peptides) in food processing.

Unit 2: Technology of Foods of Plant Origin

Fruits and Vegetable Processing:Post harvest handling and storage of fresh fruitsand vegetables. Preparation of fruits and vegetables for processing. Minimally processed products. Cold chain logistics. ZECC (Zero Energy Cool Chambers), CCSR (Charcoal cool storage Rooms) Thermal processing and process time evaluation for canned products, process optimization, aseptic canning, methods for canning of different fruits, and vegetables; Dehydration and associated quality changes during drying and storage of dehydrated products. Solar drying. Intermediate moisture foods. Preparation and utilization of fruits and vegetables juices in non-fermented/ fermented/ aerated beverages, health drinks. Membrane technology. Chemistry and manufacture of pectin, role in gel formation and products like jellies and marmalade.

Technology of preservatives, pickles, chutney's and sauces. Nature and control of spoilage in these products, Re-structured fruits and vegetables, By products utilization of fruits and vegetable processing industry, Processing methods of frozen fruits and vegetables, IQF products, packaging, storage and thawing, Role of Pectinases. Tomato products such as juice, puree, paste, soup, sauce and ketchup, Other convenience foods from fruits and vegetables. Beverages, tea, cocoa and coffee processing. Medicinal and aromatic plants: their therapeutic values. Spice processing viz. cleaning, grading, drying, grinding, packaging and storage. Oleoresins and essential oils.

Food grain Processing: Structure, composition of different grains like wheat, rice,Barley, oat, maize and millets, Anti-nutritional factors in food grains and oilseeds, Milling of grains. Wheat flour/semolina and its use in traditional/non-traditional foods like breads, biscuits, cakes, doughnuts, buns, pasta goods, extruded, confectionary products, breakfast and snack foods. Rheology of wheat and rice flour, Preparation of vital wheat gluten and its utilization, Instant ready mixtures, Enzymes (amylases and proteases) in milling and baking, Milling and parboiling of rice; by-products of rice milling and their utilization, Processed products from rice, Pearling, malting, brewing and preparation of malted milk feeds from barley, Significance of β-glucans, Milling of oats and its processing into flakes, porridge and oatmeal, Wet and dry milling of corn, manufacture of corn flakes, corn syrup, corn starch, corn steep liquor and germ oil, Structure and composition of pulses and their importance in Indian diet. Milling and processing of pulses viz. germination, cooking, roasting, frying, canning and fermentation. Use in traditional products, protein concentrates and isolates. Modified starches and proteins. Oilseeds: edible oilseeds, composition and importance in India. Oilseed processing. Oil extraction and its processing, by-products of oil refining. Production, packaging and storage of vanaspati, peanut butter, protein concentrates, isolates and their use in high protein foods. Export of oilseed cakes. International market and consumer preferences for quality in cakes for use in textured vegetable proteins. Millets: composition, nutritional significance, structure and processing. Dairy analogues based on plant milk.

Unit 3: Technology of Foods of Animal Origin

Technology of Milk and Milk Products: Milk and Milk production in India.Importance of milk processing plants in the country. Handling and maintenance of dairy plant equipment. Dairy plant operations viz. receiving, separation, clarification, pasteurization, standardization, homogenization, sterilization, storage, transport and distribution of milk. Problems of milk supply in India. UHT, toned, humanized, fortified, reconstituted and flavoured milks. Technology of fermented milks. Milk products processing viz. cream, butter, *ghee*, cheese, condensed milk, evaporated milk, whole and skimmed milk powder, ice-cream, butter oil, *khoa*, *channa, paneer* and similar products. Judging and grading of milk products. Cheese spreads by spray and roller drying techniques. EMC (Enzyme modified cheese), Enzymes in dairy processing. Sanitization *viz*. selection and use of dairy cleaner and sanitizer. In plant cleaning system. Scope and functioning of milk supply schemes and various national and international organizations. Specifications and standards in milk processing industry. Dairy plant sanitation and waste disposal.

Technology of Meat / Fish / Poultry Products: Scope of meat, fish and poultryProcessing industry in India, Chemistry and microscopic structure of meat tissue, Ante mortem inspection, Slaughter and dressing of various animals and poultry birds, Post mortem examination, Rigor mortis, Retails and wholesale cuts, Factors affecting meat quality. Curing, smoking, freezing, canning and dehydration of meat, poultry and their products. Sausage making. Microbial factors influencing keeping quality of meat. Processing and preservation of fish and its products. Handling, canning, smoking and freezing of fresh water fish and its products. Meat tenderization and role of enzymes in meat processing. Utilization of by-products. Zoonotic diseases. Structure and composition of egg and factors affecting quality. Quality measurement. Preservation of eggs using oil coating, refrigeration, thermo stabilization and antibiotics. Packing, storage and transportation of eggs. Technology of egg products viz. egg powder, albumen, flakes and calcium tablets. Industrial and food user physiological conditions and quality of fish products.

Unit 4: Food Quality Management

Objectives, importance and functions of quality control. Quality systems and tools used for quality assurance including control charts, acceptance and auditing inspections, critical control points, reliability, safety, recall and liability. The principles and practices of food plant sanitation. Food and hygiene regulations. Environment and waste management. Total quality management, good management practices, HACCP and codex in food. International and National food laws. US-FDA/ISO-9000 and FSSAI. Food adulteration, food safety. Sensory evaluation, panel screening, selection methods. Sensory and instrumental analysis quality control. Quality control of food at all stages and for packaging materials. Non-destructive food quality evaluation methods. Biosensors and their use in quality evaluation of food products. Aspects of food safety.

Unit 5: Food Engineering/Packaging and Labeling

Unit operations of food processing viz. grading, sorting, peeling and size reduction machineries for various unit operations, energy balance in food processing. Packaging materials *viz.* properties and testing procedures, packaging of fresh and processed foods. Shelf life studies. Recent trends in packaging, aseptic, modified atmosphere, vacuum and gas packaging, active and smart packaging, antimicrobial packaging, edible films and coatings, nanocomposite materials for food packaging. Nutritional labeling requirements of foods. Requirements and functions of containers. Principles of package design.

Unit 6: Food Microbiology & Biotechnology

Fermentation technology, fermented food products (animal and plant based), microbial spoilage of foods, bacterial growth curve, hurdle technology. Role of biotechnology in productivity of plants, livestock and microbes of improved nutrition and quality. Use of biotechnology in production of food additives viz. preservatives, colorants, flavours. Use of biotechnologically improved enzymes in food processing industry, biomass production using industrial wastes. Single cell proteins, Single cell oils, Food contaminants viz. aflatoxins. Food intoxication and infection. Consumer concerns about risks and values, Biotechnology and food safety.

Unit 7: Flavour Chemistry Technology

Flavour composition of foods/beverages (identification and quantitative analysis of the flavour precursors and their products, characterization of the staling reaction using stable isotopes). Flavour composition of foods/beverages in relation with maturation and microbial activity/or the processing conditions (e.g. fermented dairy products, beer, wine, honey, fruits). Analysis of odour-active compounds of food/beverages (Charm analysis). Synthesis of flavour by microorganisms and plant cells. Lipid derived flavours. Investigation of equilibrium of key flavour compounds that govern the flavour stability of beverages. Natural antioxidant constraints in spices. Role of microorganisms in flavour development. Flavor emulsions, flavour composites, essential oils and oleoresins.

Unit 8: Consumer Sciences/Food Product Development/Health Foods

Socio-cultural, psychological and economical consideration for food appearance, domestic and export marketing. Consumer trends and their impact on new product development. Product development viz. to conceive ideas, evaluation of ideas, developing ideas into products, test marketing and commercialization. Role of food in human nutrition. Nutritional disorders, natural contaminants and health hazards associated with foods. Diet therapy. Therapeutic / Engineered / Fabricated and Organic foods/ Nutraceutical and functional foods.

8.3 DAIRY MICROBIOLOGY

Unit 1

Microflora associated with milk and milk products and their importance. Morphological, natural, physiological, spoilage and pathogenic characteristics of commonly occurring microbes in milk and milk products; Newer approaches for classification of microorganisms; types of microbes in normal and mastitic milk and importance of somatic cell counts; Food poisoning, food infections, toxi-infections and other milk borne diseases; Emerging food borne pathogens associated with milk and milk products; Epidemiological studies using DNA fingerprinting

techniques like RAPD, RFLP, DGGE, TGGE, Rep-PCR, etc. Sources of microbial contamination of raw milk and their relative importance in influencing quality of milk during production, collection, transportation and storage. Microbial and chemical changes in raw milk during chilling and refrigeration.

Unit 2

Bacteriological aspects of processing techniques like bactofugation, thermisation, pasteurization, sterilization, boiling. UHT, pulsed field treatment and membrane filtration of milk. Types of spoilages in heat-treated milks. Enumeration of heat resistant microbes. Germination and sporulation of bacterial spores; Prevention of post-processing contamination in heated milk. Identification of sources of contamination in heat treated milks. D, F and Z values for various microbes. Heat induced damage and repair in bacterial cells. Role of resuscitation in recovery of heat injured microbial cells; Bacteriological grading of raw and heat-treated milk. Microbiological spoilage aspects of thermally processed milks; Role of psychrotrophic, thermoduric, thermophilic bacteria and their metabolites in milk spoilage, biofilms.

Unit 3

Naturally occurring preservative systems in milk like LP system, Immunoglobulins, Lysozyme, Lactoferrin, etc. Preservation of milk and milk products by physical (irradiation) and chemical agents; Food grade Biopreservatives (GRAS), Bacteriocins of lactic acid bacteria; Nisin and other antimicrobials produced by Lactic Acid Bacteria (LAB). Application of bacteriocins as food grade biopreservatives in enhancing shelf life of foods; Enhancing antimicrobial potentials of LAB by recombinant DNA technology and Genetic engineering; Residues of antibiotics, detergents, sanitizers, pesticides and aflatoxins in milk, mode of action on microbes and biological consequences – as well as their detection by newer approaches like Charm test, HPLC, ELISA and biosensor based techniques.

Unit 4

Microbiological quality of fat rich products (cream and butter); Frozen dairy products (ice-cream); Concentrated dairy products (evaporated and sweetened condensed milk) and Dried milks (roller and spray dried milks and infant foods); Factors influencing the microbiological quality of above products during their production, processing, handling, storage and distribution; Microbial defects associated with these products and their control; Microbiological safety in relation to potential pathogens and their public health significance; National and International microbiological standards for dairy products (BIS, ICMSF, Codex Alimentarius Standards).

Unit 5

Lactic Acid Bacteria (LAB) as starters: Types of starter cultures and their classification; Identification of LAB based on conventional and molecular techniques such as 16S rRNA sequencing. Ribotyping, PCR and DNA fingerprinting; Microbiology of starter cultures; Single and multiple strain cultures, and custom cultures; Associative growth of starter cultures; Concepts of starter growth and metabolism of lactose and citrate; Production of taste and aroma compounds by starters in fermented milks and milk products; Changes caused by starters in milk during growth; Modem trends in propagation, production and preservation of starter cultures; Production of starter concentrates; DVS starters: Judging of starter quality and activity; Starter defects; Starter failure; Intrinsic and extrinsic factors associated with starter failure; Bacteriophages of dairy starters and their impact on dairy industry; Prevention and control of starter failures.

Genetics and molecular biology of acid, flavour and therapeutic properties of LAB. Role of plasmids in their metabolism; Genetic manipulation of LAB for ameliorated performance; Food grade cloning and expression vectors; LAB as hosts for expression for heterologous proteins and development of food grade oral vaccines; LAB genome projects.

Unit 6

Dairy products as functional / health foods : LAB as probiotics in development of health foods; Selection criteria, colonization and functional properties; Antibacterial and therapeutic properties of probiotic cultures; Survival and stability of probiotics in health foods, gut and their tracking; Concept of probiotics and synbiotics; Genetic markers of probiotic functions and their application for mass screening; Genomics of probiotic Lactobacilli and Bifidobacteria; Cloning and sequencing of probiotic genes; Sequence analysis; Blast, Clustal W and Clustal X. Pair-wise and multiple alignment; Homology and Phylogenetic tree / dendrograms; LAB as nutraceutical ingredients –

a source of vitamin synthesis and exopolysaccharide production; Bioactive peptides and their role as nutraceuticals in dairy foods.

Unit 7

Role of starters in the preparation of yoghurt, koumiss, kefir, cultured buttermilk, and whey based beverages and other fermented products; Therapeutic properties of fermented foods; Microbial defects in these products, safety and their prevention and control; Microbiology of hard, semi-hard and soft varieties of cheese; Role of starter culture and non-starter lactic acid bacteria (NSLAB) during preparation and ripening of cheese; Accelerated ripening of cheese; Production and use of microbial rennet substitutes; Recombinant chymosin and its application; Defects in cheese, Microbiological safety and their prevention and control.

Unit 8

Microbiological quality of indigenous dairy products, viz., khoa and chhana based sweets: Burfi, peda, rasogulla, gulabjamun, kheer, kulfi, shrikhand, paneer, dahi, lassi, ghee, etc. Sources of microbial contamination, their role in spoilage of these products and their microbiological safety, Prevention and control: Role of personnel and environmental hygiene at the level of production and processing; Need for microbiological standards for assessing the quality and safety of indigenous products; Concept of TQM and HACCP implementation in improvement of quality and safety of indigenous products; Current role of modified packaging for extending the shelf stability of indigenous dairy products, Antimicrobial packaging, controlled and modified atmosphere (CAP / MAP) based technologies.

Unit 9

Preparation of byproducts from dairy effluents by microbial fermentation; Cleaning and sanitization of equipments, machineries and other contact surfaces used in production and processing of milk and milk products; Types of detergents and their mechanisms of soil removal from the surfaces; Efficacy of sanitizers including gaseous disinfectants and evaluation of sanitizing disinfectant properties; Factors affecting activity of detergents and sanitizers; Built detergents, commercial detergents and combined detergent-sanitizers; Biological consequences of dairy waste disposal; Disposal of dairy effluents after microbial treatment; BOD and COD analysis in dairy effluents; Microbiological quality of air and water used in Dairy Plants.

Unit 10

Microbiological aspects of quality control and quality assurance in production of milk and milk products; Good Manufacturing Practices (GMP) and the relevance and Sanitary Standard Operating Procedures (SSOP); Importance of Total Quality Management (TQM) in dairy industry; Application of HACCP programme in dairy industry; Safety concerns of bio-film formation on equipment surfaces and their control measures; Risk assessment approaches and role of productive microbiology in dairy foods; Conventional and current methods like impedance, ATP luminescence, pyruvate, etc. in detection of food pathogens; Application of immunological, PCR, Real time PCR, DNA probes, Microarrays (Biochips) and Biosensors, etc. for detection of food pathogens; Biosafety of Genetically Modified Organisms (GMOs) / foods.

8.4 DAIRY TECHNOLOGY

Unit 1 : Market Milk

Status of dairy industry in India. Recent policy changes related to dairy sector (MMPO & WTO). Principles and practices for production of high quality milk. Methods of milk procurement, payment, quality assessment, detection of adulterants, handling and transportation of milk. Methods of raw milk preservation. Physical properties and chemical composition of milk of cow, buffalo and other species of milch animals; their importance in milk processing. Centrifugal separation, clarification and bactofugation and factors affecting their efficiency. Homogenization process and its implications in dairy processing; efficiency of homogenization and factors affecting it. Thermal processing of milk. Principles and methods of pasteurization and sterilization. UHT processing and aseptic packaging. Special milks. Principles of production, processing and marketing of toned, double toned, reconstituted, recombined, flavoured and filled milks.

Unit 2 : Fat Rich Dairy Products

Basic principles and recent concepts in production and processing of different types of cream, butter, margarine, fat spreads, butter oil and *ghee*. Fractionation of fat and its application. Health aspects of milk fat. Cholesterol reduced and cholesterol-free dairy products.

Unit 3 : Frozen Milk Products

Trends in the frozen milk products industry in India. Definition, classification and composition of ice-cream and other frozen desserts. Role of milk constituents and other ingredients, processing steps, packaging and storage methods on quality of ice-cream. Technological aspects of manufacture of plain, fruit, soft-serve, low fat and dietic ice-creams and novelties. Indigenous frozen desserts, kulfi, malai-ka-baraf etc.; their production techniques and quality. Distribution of frozen desserts. Newer ingredients for use in the ice-cream industry.

Unit 4 : Cheese and Fermented Milk Products

Status and scope of cheese industry. Fermented milk products – their nutritional and therapeutic value. Definition and classification of cheese and fermented milks. Milk in relation to cheese making. Manufacture of Cheddar, Gouda, Mozzarella and Swiss cheeses. Role of starter cultures in cheese quality. Types of rennet for cheese manufacture. Physical and chemical changes during cheese ripening. Manufacture of processed cheese, cheese spread and cheese foods. Mechanization of cheese-making process. Modern concepts in accelerated cheese ripening. Storage and defects. Production and storage of *dahi,* yoghurt, *shrikhand, lassi* and *misti dohi*. Probiotic dairy products.

Unit 5 : Concentrated and Dried Milk Products

Milk in relation to processing and manufacture of concentrated and dry milks. Principles and methods of manufacture, storage and defects in sweetened condensed milk. Evaporated milk. UHT sterilized concentrated milk. Whole milk powder. Skim milk powder, high-fat powders, and ice-cream powder. Instantization of milk powder. Newer technologies and formulations for infant foods and weaning foods, malted milk and malted milk foods.

Unit 6 : Indigenous Milk Products

Safety aspects of milk with reference to Status and role of traditional dairy products in Indian dairy industry and economy. Characteristics of various traditional products, their prospects and constraints. Methods of production; physico-chemical changes during manufacture; quality attributes, shelf-life, preservation and packaging. Process innovations relating to *khoa,chhana, paneer, rabri, kheer, khoa* and *chhana*-based sweets.

Unit 7 : Utilization of Milk Byproducts

Status, availability and utilization of dairy byproducts. Associated economic and pollution problems. Manufacture of casein, sodium and calcium-caseinates, edible casein, hydrolysates, coprecipitates, whey protein concentrates, whey beverages, whey syrups and lactose. Use of buttermilk. Development / formulation of new products based on dairy byproducts.

Unit 8 : Packaging of Milk and Milk Products

Present status and scope. Role of packaging and package design considerations. Evaluation of packaging materials and package performance. Packaging materials and systems for liquid, concentrated, dried, frozen and fat-rich dairy products. Special packaging methods such as vacuum, shrink and aseptic packaging. Modified atmosphere packaging. Package standards, regulations and quality control.

Unit 9 : Cleaning and Sanitation

Properties of important dairy detergents and sanitizers. Choice of detergents and sanitizers guiding principles and limiting factors. Basic principles in formulating the cleaning and sanitizing procedures for dairy equipments. Automation in cleaning and sanitization processes including CIP. Quality of water in detergency.

Unit 10 : Advances in Dairy Technology

Radiation preservation of milk and milk products. Theory and application of microwave heating, ohmic heating and high pressure processing. Immobilization of enzymes and their use in dairy and food industry. Theory of ultrafiltration, reverse osmosis, nanofiltration and microfiltration techniques. Selection and types of membranes. Application of membrane technology in dairy and food industry. Fouling, cleaning and sanitization of membranes. Emulsions, foams and gels. Electrodialysis and ion exchange in dairy applications. Processing of cereals and legumes for incorporation in milk and milk products. Use of milk solids in bakery and confectionery products. Application of biotechnology in dairy industry.

Unit 11 : Legal and Quality Aspects for Milk and Milk Products

Safety aspects of milk with reference to mycotoxins, antibiotics, pesticides, weedicides and heavy metals. PFA, BIS and Agmark standards for milk and milk products. Quality systems such as HACCP, ISO certification, etc.

09. AGRICULTURAL ENGINEERING AND TECHNOLOGY

(9.1 Farm Machinery and Power Engineering, 9.2Soil and Water Conservation Engineering/Soil and Water Engineering, 9.3 Agricultural Processingand Food Engineering, 9.4Renewable Energy Engineering, 9.5 Irrigation Water Management Engineering/Irrigation & Drainage Engineering)

9.1 FARM MACHINERY AND POWER ENGINEEERING

Unit 1: Farm Mechanization and Equipment

Status and scope of farm mechanization in India. Power availability on the farm. Identification of need based priorities of mechanization for various cropping systems. Hand tools used for different kinds of farm work, design considerations and materials for construction. Functional requirements, principles of working, construction, design, operation and management of animal-and power-operated equipment for tillage, land development, sowing, planting, fertilizer application, inter-cultivation, mowing, chaff cutting and baling. Special equipment for crops such as sugarcane, cotton, groundnut, and potato.

Unit 2: Design of Farm Machinery Components

Design and selection of machinery elements: gear, pulleys, chains and sprockets, belts and simple clutches. Dynamic balancing and stability of farm machines. Force analysis on agricultural tools and implements. Pull, draft, unit draft and energy calculations for animal and power operated equipment. Machinery systems design.

Unit 3: Testing and Management of Farm Machinery

Calibration of seed drills, planters, sprayers and fertilizer applicators. Performance and losses in harvesting and threshing. Calculations of field capacity, efficiency and rate of seed, fertilizer and chemicals applicators, threshers, harvesters and chaff cutters. Methods of testing of tillage equipment, seed-drills, seeders, planters, sprayers, threshers, and combines. Farm machinery selection for different soils, crops and operations. Cost analysis of implements and operations. Estimation of power-energy requirements. Reliability of farm machinery.

Unit 4: Engines and Tractor Systems

Engineering thermodynamics. Various systems of spark and compression ignition engines. Operations, adjustment and trouble shooting on the working of the systems. Calculations on horse power, torque, speed, firing arrangement and intervals, heat load and power transmission from piston to the fly wheel. Tractor transmission, Types of clutch, gear trains, differential and final drives. Tractor chassis mechanics. Tractor power outlets. Mechanical and power steering systems. Hydraulics and hitching systems, ADDC. Tractor performance tests. Maintenance schedules of tractors and power tillers. Recent trends in tractor design.

Unit 5: Ergonomics and Safety

Anthropometry in equipment design, physiological cost and effect of work on physiological responses, fatigue and comfort; ergonomics in design of farm tools; safety aspects of agricultural machinery; effect of noise and vibration on work performance; chemical hazards and control measures; operator's protective gadgets; 125 design of tractor controls viz., hand and foot controls, visual range and limitations, seat design, etc.

Unit 6: Soil Dynamics in Tillage and Traction

Dynamic properties of soil and their measurements; stress-strain relationships; theories of soil failure, mechanics of tillage tools; design parameters and performance of tillage tools. Introduction to traction devices, tyre function and size, their selection, mechanics of traction devices, traction theories, slippage and sinkage of wheels, evaluation and prediction of traction performance; soil compaction - causes and methods for alleviating the effect on soil and crop responses.

Unit 7: Manufacturing Technology

Specification of materials, surface roughness, production drawing, computer aided drawing heat treatment, workshop practices applied in prototype production, common tools and press operations, metal cutting and machining, jigs, fixtures and gauges, casting and die-casting processes; basic joining processes, welding processes, testing of joints and metallurgy.

Unit 8: Instrumentation and Measurement Techniques

Mechanical measurements, sensors and transducers, application of electrical strain gauges, signal transmission and processing, dynamic measurements; measurement of temperature, pressure, strain, force, torque, power vibrations etc.; determination of calorific value, fluid flow rates etc; signal conditioning and monitoring, data acquisition and storage.

Unit 9: Energy in Agriculture

Conventional and renewable energy sources in agriculture; solar radiation and its measurement; characteristics of solar spectrum; solar energy collection, storage and applications; solar photovoltaic conversion and SPV powered systems. Types of wind mills and their applications; thermo-chemical conversion of biomass, direct combustion, Pyrolysis and gasification, chemical conversion processes, carbonization, briquetting, pelletization and densification of biomass; bioconversion into alcohols, methyl and ethyl esters, organic acids, solvents of amino acids; types of biogas plants, biogas properties, uses and distribution, alternate fuels for IC engines. Energy requirement in agricultural production systems, energy ratio and specific energy value, inflow and outflow of energy in unit agricultural operation, energy audit, accounting and analysis.

9.2 SOIL AND WATER CONSERVATION ENGINEERING/SOIL AND WATER ENGINEERING

Unit 1: Groundwater Development, Wells and Pumps

Water resources of India. Present status of development and utilization of water resources of India and scope for additional use. Irrigation potential and contribution of groundwater, scope of groundwater development. Application of groundwater models for groundwater development and management. Aquifer types and parameters. Principles of groundwater flow, interaction between surface and groundwater, natural and artificial groundwater recharge. Salt water intrusion in inland and coastal aquifers. Groundwater exploration techniques. Hydraulics of fully and partially penetrating wells. Design, construction and development of irrigation wells. Water lifts, pumps and prime movers, well and pumps characteristics, performance evaluation and selection of pumps. Energy requirement in groundwater pumping. Design of centrifugal pumps. Groundwater pollution. Conjunctive use of surface and groundwater.

Unit 2: Open Channel Hydraulics

Hydraulics of open channel flow, energy and momentum principles, specific energy, Hydraulic jump, classification and its use as energy dissipater. Design of different types of irrigation channels. Irrigation water measurement: using velocity area method, water meters, weirs, notches, flumes, orifices etc. Water conveyance and control. Conveyance losses and lining of irrigation channels. Irrigation water delivery and distribution.

Unit 3: Soil, Plant, Water and Atmosphere Relationship

Soil physical characteristics influencing irrigation. Soil moisture characteristics, field capacity, permanent wilting point, plant available water and extractable water. Soil irrigability classifications, factors affecting water storage profile. Determination of soil water content, computation of soil water depletion, soil water potential and its components, hydraulic head. Field water budget: water gains and water losses from soil, deep percolation beyond root zone, capillary rise. Evapotranspiration (ET) and irrigation requirement, critical stages of crop growth in relation to irrigation. Irrigation scheduling. Plant water relations, concept of plant water potential. Water movement through soil plant atmosphere system. Uptake and transport of water by roots. Management strategies to improve crop productivity under limited water supplies. Contingent crop plans and other strategies for aberrant weather conditions. Cropping patterns, alternate land use and crop diversification in rainfed regions.

Unit 4: Watershed Hydrology

Hydrologic cycle, precipitation, infiltration and surface runoff. Measurement and analysis of hydrologic data. Intensity duration frequency analysis**.** Hortonian and saturation overland flow theories, partial source area concept of surface runoff generation. Rainfall and run off relationships, stream gauging and runoff measurement. Different methods of surface runoff estimation, hydrographs, S-hydrograph, IUH, Synthetic hydrograph, unit hydrograph theory and its application. Concept of hydraulic flood routing: channel and reservoir routing.

Unit 5: Soil and Water Conservation

Soil erosion and types of erosion. Quantitative soil loss estimation, universal soil loss equation and its subsequent modifications. In-situ measurement of soil loss. Field practices in controlling erosion by water and wind. Soil and Water conservation structures and their design. Gully control: vegetative measures, temporary, semi-permanent and permanent structures for gully control and reclamation and their design. Design and construction of farm pond and reservoir. Seepage theory. Design of earthen dams and retaining walls, stability analysis on slopes. Application of RS and GIS in soil and water conservation.

Unit 6: Watershed Management

Watershed concept, Identification and characterization of watersheds. Surveying: topographic, reconnaissance. Soil types and depth properties. Soil maps and their scales. Meteorological observations, monitoring, reclamation and conservation of agricultural and forest watersheds, hill slopes and ravines. Hydrological and geomorphological characteristics of watersheds. Land capability and irrigability classification and soil maps. Principles of watershed management. Development of watershed management plans, its feasibility and economic evaluation. Land levelling and grading, Criteria for land levelling, design methods. Machineries and equipments for land levelling.

Unit 7: Irrigation Water Management

History of irrigation in India. Management of irrigation water. Major irrigation projects in India. Crop water requirements. Soil water depletion, plant indices and climatic parameters. Methods of irrigation, surface methods, overhead methods, Pressurized irrigation system such as drip and sprinkler irrigation. Merits and demerits of various methods. Hydraulics of furrow, check basin and border irrigation, Hydraulics and design of pressurized irrigation systems. Irrigation efficiency and economics of different irrigation systems. Agronomic considerations in the design and operation of irrigation projects, characteristics of irrigation and farming systems affecting irrigation management. Irrigation strategies under different situation of water availability, optimum crop plans and cropping patterns in canal command areas. Quality of irrigation water and irrigation with poor quality water. On farm water management, socio-economic aspects of on farm water management.

Unit 8: Management of Degraded, Waterlogged and Other Problematic Soils and Water

Problem soils and their distribution in India. Excess salt and salt tolerant crops. Hydrological imbalances and their corrective measures. Concept of critical water table depths for crop growth. Contribution of shallow water table to crop water requirements. Management strategies for flood prone areas and crop calendar for flood affected areas. Crop production and alternate use of problematic soils. Agricultural field drainage, drainage techniques and theory of flow in saturated soil. Flow net theory and its application. Drainage investigations. Drainage characteristics of various type of soils. Water table contour maps and isobaths maps. Drainage coefficient. Design and installation of surface and subsurface drainage system. Interceptor and relief drains and their design. Drain pipe and accessories. Drainage requirements of crops. Drainage in relation to salinity and water table control. Bio-drainage. Reclamation of ravine, waterlogged, swampy areas and polders. Salt-affected soils and their reclamation. Command area development organizational structures and activities. Irrigation water users association concept and responsibilities. Environmental considerations in land and water resources management.

9.3 AGRICULTURAL PROCESSINGAND FOOD ENGINEERING

Unit 1: Engineering Properties and Quality of Biomaterials

Uniqueness of bio-materials, Importance of engineering properties of biological materials; physical characteristics *viz*. shape, size, volume, density, porosity, surface areas, Frictional characteristics *viz*., rolling resistance, angle of repose. Properties of bulk particulate solids *viz*. specific surface area, mean diameter, flow rate. Aerodynamics characteristics *viz*. drag coefficient and terminal velocity. Pressure drop through packed beds. Thermal properties *viz*. specific heat, thermal conductivity, thermal diffusivity. Dielectric properties *viz*. dielectric and microwave radiation, dielectric constant, energy absorption, heating. Optical properties and transmittance and reflectance. Rheological properties and stress-strain-time relationship, rheological models, visco-elasticity, Hertz's theory of contact stresses. Food Quality and BIS specifications for quality of food materials, milling quality analysis, cooking and baking qualities. Organoleptic and sensory evaluation of product quality. Determination of protein, oil content, carbohydrates, colour, hardness, texture, nutritive value, bio- availability and microbial loads, non-destructive quality evaluation techniques. Measurement techniques and instruments for food quality determination, destructive and non-destructive quality evaluation, UV VIS NIR spectroscopy, X-ray, CT, NMR, machine vision. Maturity, ripening stages and indices of fruits and vegetables.

Unit 2: Heat and Mass Transfer

Basic laws of thermodynamics, thermodynamic properties and processes, energy equations, heat, work, heat engine, heat pump, refrigeration and steam tables. EMC, sorption and desorption isotherms, water activity and psychrometry. Modes of heat transfer, heat exchanger. Mass transfer and mass-heat-momentum transfer analogies. Fluid statics, fluid dynamics, continuity equation and Bernoulli's theorem. Dimensional analysis and simulation. Simulation models and mathematical modeling. Finite difference analysis, Finite element analysis.

Unit 3: Post Harvest Unit Operations

Grading, cleaning, washing, sorting, shelling, dehusking, decortication, milling, polishing, pearling, drying (evaporative, osmotic and freeze drying), pasteurization and sterilization of liquid foods, kinetics of microbial death, size reduction, cryogenic grinding, granulation, crystallization, membrane separation processes *viz.* micro filtration, ultra-filtration, nano-filtration, reverse osmosis; Evaporation, Distillation, Mixing, coagulation, mechanical separation processes, *viz.* sedimentation, clarification filtration, pressing, expelling, leaching, extraction, pelleting, extrusion and industrial fermentation and processing.

Unit 4: Process Technology and Machinery

Pre-milling/ conditioning treatments. Process technology and machinery for cereals, pulses, oil seeds, fruits, vegetables, flowers, spices, condiments, plantation crops, animal products, sea-foods, fiber crops, animal feed, natural resins and gums. Bioprocess engineering, enzyme reaction kinetics, Industrial fermentation and processing, down-stream processing, bio-separation. Minimal processing of fruits and vegetables, high pressure processing, ohmic heating, ultraviolet light, pulsed electric field, pulsed light field, micro and nanoencapsulation of food ingredients, Food nanotechnology. Seed processing and technology, Agricultural by-products/residue utilization, Waste disposal of food processing plants, different methods and equipment.

Unit 5: Design of Processing Machinery

Design of grain cleaners, graders, dryers, parboiling plants, size reduction machines, bioreactors, fermenters, centrifuges, cyclone separator, heat-exchanger, evaporators, filters, extrusion cookers. Computer aided design and analysis of machines and machine components. Materials, manufacturing processes, design of elements and selection of standard parts *viz.* pulley, chains, sprockets, bearings, belts, fasteners, hydraulic components, pipes, hoses.

Unit 6: Material Handling, Packaging and Transport

Bulk conveying equipments, *viz*. belt conveyors, screw/auger conveyors, bucket elevators and drag/chain conveyors. Estimation of energy requirement and capacity, damage to products during mechanical handling. Operation and maintenance of conveying equipment. Packaging material characteristics and selection. Packaging

techniques and equipment for liquid, powder and granular materials, and horticultural produce. Transportation of agro-produce by bullock-carts, trailers, trucks, rail wagons and containers. Cold chain design and operation. Safety standards in handling, packaging and transport of agricultural produce.

Unit 7: Storage Engineering

Storage environment and its interaction with stored product. Factors/parameters influencing the shelf life of the stored product, climatograph and deterioration index. Modeling of metabolic activities and predication of storage life, quality deterioration mechanisms and their control. Storage practices (including fumigation) for food grains. Design of bulk storage and aeration system. Analysis of heat, moisture and gas transfer in bulk storage structures. Bag storage structures, their design and management. Storage of perishables in ventilated, refrigerated, controlled and modified atmosphere storage systems and their design, smart storage system. Quality analysis of stored produce.

Unit 8: Process Plant Design

Plant design concepts and general design considerations, plant location, product and process design, process flow charts, equipment selection, plant layout. Design and selection of machinery for handling utilities like water, steam, fuel etc. and disposal of effluents and residues.

Unit 9: Instrumentation and Process Control

Static and dynamic characteristics of instruments, Transducers elements, intermediate elements, indicating and recording elements. Measurement of motion, force, torque, power, temperature, humidity, pressure and flow. Physical and chemical sensors, biosensors, Fuzzy logic, neural networks and control. Monitoring of plant parameters through Internet, Programmable logic controller, Data loggers, Data Acquisition Systems (DAS). Introduction to Direct Digital Control (DDC), Supervisory Control and Data Acquisition Systems (SCADA), and Virtual Instrumentation.

Unit 10 : Agri-Project Planning and Management

Project development. market survey and time motion analysis. Selection of equipment, technology option, techno - economic feasibility. processing in production catchment. Product and process design, PERT, CPM, transport model, simplex, linear and dynamic programming, operation log book. Material balance and efficiency analysis, performance testing, performance indices, energy requirement and consumption. Marketing of agricultural products, market positioning. BIS/ FSSAI/ ISO standards/ guidelines on best practices, equipment and their design and operation for handling, processing and storage of food/feed.

9.4 RENEWABLE ENERGY ENGINEERING

9.5 IRRIGATION WATER MANAGEMENT ENGINEERING/IRRIGATION & DRAINAGE ENGINEERING

For 9.4 and 9.5, the syllabus would be the same as covered under 9.1 to 9.3 above

10.HOME SCIENCE (Currently renamed as Community Science)

(10. 1 Family Resource Management, 10.2 Textile and Apparel Designing, 10.3 Human Development and Family Studies/Human Development, 10.4 Foods and Nutrition/Human Nutrition, 10.5 Home Science Extension and Communication Management)

10.1 Family Resource Management

Family Resource Management: Interdisciplinary nature of management and systems approach to family management. Philosophy and concepts of management, goal types and goal setting and value types. Sources of learning values and their importance to family Standards – type and relationship with values and goals. Process of management : planning, controlling, evaluating, organizing and their application to resources use and resources development. Decision making in use and development of resources. Decision types. Application of management process and energy for work simplification. Application of Mudells classes of change in household work and agricultural task.

Art Principles and Interior Enrichment : Importance of interior enrichment. Elements and principles of art and their application to interior decoration. Selection and making of accessories for homes, Flower arrangement. Importance of colour in home, colour theories and schemes. Importance of natural and artificial light in homes. Selection, care and maintenance of Home Furnishings: Floor coverings, wall and window treatments

Housing and Space Designing: Identifying family housing needs. Selection of site. Principles of house planning: orientation, space requirements for various activities and room layout. Building materials, their characteristics, selection and suitability for low cost rural and urban housing, Estimating costs of building a house. Advantages of owning and renting. Green building design evaluation system – GRIHA and LEED. Energy Conservation Building Codes (ECBC) launched by BEE.

Household Energy and Equipments : Household energy forms : sources, fuels, and their classification. Energy crisis, its causes and implications for energy management in homes. National efforts for energy and environmental conservation Equipments, tools and accessories for rural and urban houses, their selection, maintenance and care. Base materials, finishes, insulation materials and methods of forming utensils. Modular Kitchen. Low cost simple equipments – hay box, water filter, solar cookers etc.

Family Finance and Consumer Education : Family income – types, sources and contributors Financial planning guidelines for budgeting. Engel's law, expenditure, account keeping, investment; and savings. Credit sources, advantages, disadvantages, selection and repayments. Consumer problems - buying problems, adulteration and substandard goods, Public distribution system, Consumer rights and responsibilities and consumer protection measures, Consumer organization and their roles.

Entrepreneurship Management: Scope of enterprise. Sources of information for project proposals and type of information needed. Role of government and private organizations in financing.

Markets and Marketing: Types of markets, their functions and pricing. Marketing information systems, Sales management and product promotion.

Ergonomics: Significance and scope of ergonomics. Man, Machine and Environment System and interactions. Anthropometry and its application.

10.2 Textile and Apparel Designing

Clothing Construction and Pattern Making: Methods of developing patterns – flat, draping and drafting. Application of special sewing techniques in dress designing. Figure irregularities and special problems with reference to apparel designing. Evaluation of finished garments . Commercial processes in apparel industry. Factors influencing fashion movement. Fashion forecasting. Understanding consumer demands. Consumer decision processes. Socio-psychological aspects of clothing. Traditional costumes, textiles and embroideries of India and their influence on modern trends. Costumes of world.

Fibre Science: Textile chemistry – polymerization, bonding, reactive groups. Manufacture/ processing, structure and physical, chemical and biological properties of cotton, silk,wool and linen, rayon and synthetics, Bleaches – types and their commercial application. Special finishes applied to different fibres such as wash-n-wear, water-proof, water repellent, shrink proof, durable press, carbonizing for p/c blends. Quantitative estimation of blends and mixtures. Water, detergents – types and their influence on fabric performance. Textile auxiliaries.

Dyeing and Printing: Study of dyes and pigments – composition, properties, advantages and disadvantages. Advanced dyeing and printing methods.

Textile and Apparel Quality Analysis: Importance of quality testing in textiles and apparel. Role of textile testing standards and methods. Fibre, yarn and fabric testing equipment and methods. Quality standards, specifications and accepted quality levels for apparel production.
Woven and Knitted Structures: Analysis of textile designs, Application of art principles in textile and clothing. Role of elements of art in designing. Classification and characteristics of yarns. Methods of fabric construction. Woven – special twills leno, double cloth, dobby, jacquard, warp and weft figuring, terry pile weaving, warp and circular knitting. Cloth defects and faulty merchandizing. Textile designing centres and their function. Computer aided textile and apparel designing.
Textile and Apparel Industry: Role of textile industry in Indian economy. Status of textile industry in the last decade with reference to cotton, rayon, jute, silk, wool, garments and hosiery. Domestic and international consumption. Export and import policies of textiles and garments. Five Year Plans and their influence on textile and clothing related policies. Associations and research organizations related to textiles, garments, hosiery and consumer. Sales promotion techniques for textiles and garments. Consumer education and protection.

10.3 Human Development and Family Studies

Lifespan Development: Major factors influence human growth and development. Principles of human growth and development. Analysis of significant areas of development. Physical, social, intellectual and emotional development during late childhood and their characteristic. Physical, moral, social, emotional and intellectual development during adolescence. Adulthood and old age, psychological, economic and social problems and rehabilitation of the aged. National and community service for the aged. Death and bereavement.
Theories of Human Development: Meaning and significance of child development theories. Psychoanalytic theories of Freud, Alder, Jung and the Neo Freudians-Karen Horney, Sullivan, and Erech Fromm Erikson's stages of psycho-social development. Pieget's theory of cognitive development. Language development theory of Chomsky and learning theories of Paviov Skinner, Thorndike, Watson and Gestalt psychology. Theories of Heinz Werner and Kohlberg Personality theories of Allport, Murray and Lewin's Field theory.
Early Childhood Education: History of early childhood education. Modern education, Historical review of major philosophies of early thinkers like Locke, Owan, Rousseau, Pestallozzi, Froebel and Montessori, Gandhi's basic education and contributions of Giju Bhai and Tarabai Modak. importance of pre-school education. Administration of pre-schools. Planning infrastructure and programmes for pre-schools education. Maintenance, budget and keeping of records. Principles of curriculum planning, and indoor and outdoor activities of nursery school. Models of types of pre-school in India.
Children with Developmental Challenges: Definition and needs of exceptional children. Classification of exceptional children, visual impairment, deaf and hard of hearing speech and language defect, crippled child, socially and emotionally maladjusted and juvenile delinquents. Gitted and mentally retarded children. Psychological problems; necrosis, psychoneurosis, psychoses and schizophrenia. Remedial methods and rehabilitation. Policies and legislations.
Assessment and Counselling: Concept, need and principles of guidance. Aims and objectives of individual and group guidance. Sources of information and methods of group guidance. Use of psychological tests and criteria for testing and measurements. Guidance services: meaning, scope, principles counseling services, methods and techniques in counseling service of children, parents and youth.
Family Ecology: Family in social context. Approaches to study of family: developmental, social, psychological and educational. Modern trends in Indian, urban and rural families and changing family functions. Changing roles and relationships, influence of socio-economic status, culture, religion and the role of family in maintaining mental health. Problems of the family related to sexual misbehavior, aggression and hostility, drug addiction, AIDS etc. Services for family and children, crèches. Impact of consumerism, migration and multiculturism. Marriage and family therapy.
Parenting and Community Education: Meaning and need for community education. Child rearing practices of community, Objectives and principles of parent education. The disadvantaged family. Problems and needs of the disadvantaged family and child. Subject matter or areas of knowledge for parent education. Role of parents and teachers in children. Methods and procedures of parent and community education.

10.4 Foods and Nutrition

Food and Food Groups: Food production and consumption trends in India and their consequences on nutrition situation. Cereals, millets, pulses, oilseeds, vegetables, fruits, milk, eggs, meat and other animal foods. Nutritional value of these food groups and their contribution towards nutrients in Indian diets.

Storage of Food Grains: Grain storage practices in India. Quantitative and qualitative losses during post-harvest handling and storage of food grains. Improved and scientific methods of storage of food grains.
Cooking Methods and Food Processing: Food processing-physical and chemical changes in foods during processing including cooking and preservation with special reference to sensory characteristics and nutritional value. Traditional methods of processing such as parboiling, germination, malting and fermentation and their nutritional advantages. Food colours, flavours and enzymes, and their importance.
Food Safety: Food safety-natural toxicants, pesticide residues, common adulterants and mycotoxins, their harmful effects on health, and methods of eliminating their harmful effects. Food borne diseases and their prevention.
Macro and Micro Nutrients in Human Nutrition: Macro and micro-nutrients in human nutrition. Carbohydrates, lipids, proteins, vitamins, minerals and trace elements. Requirements, sources, functions and effects of deficiency. Energy-methods of assessing energy requirement and factors influencing requirement. Qualitative differences in food proteins and methods of assessing protein quality. Factors influencing availability of minerals. Nutrients inter-relationships. Importance of fibre in human nutrition. Water and electrolyte balance. Metabolism of carbohydrates, proteins and lipids. Roles of vitamins and hormones in metabolism.
Community Nutrition: Major nutrition problems in India – causes, magnitude and distribution. Nutritional problems of vulnerable segments – pregnant and lactating women, and pre-school children. Food nutrition programmes to combat malnutrition-strategies, targets and progress. Assessment of community nutritional status-anthropometry, diet survey, biochemical and clinical methods. Indicators/parameters and standards used for assessment by different methods. Growth norms for pre-school children and importance of growth monitoring.
Nutrition During Life Cycle: Nutritional requirements of pregnant and lactating women and pre-school children. Consequences of chronic nutritional deficiencies in these groups. Infant and child feeding practices in India and importance of promoting good feeding practices. Nutrition for elderly.
Clinical Therapeutic Nutrition: Relationships between clinical results and nutritional status. Drug nutrient interaction. Nutrition in disease, therapeutic modifications of normal diets, and their use in treatment of diseases of gastro-intestinal cardio-vascular renal, hepatic metabolic and febrile disorders.

10.5 Home Science Extension and Communication Management

Home Science extension education: concept, principles, philosophy, objectives and approaches. Genesis of rural development programmes in India. Community Development and Integrated Rural Development- concept, principles and objectives. Relationship between family and community development. Gender sensitivity in extension education programmes. Leadership-concept, types, identification, training and mobilizing local leaders for community participation. Problems of women leaders. Panchayati Raj-philosophy, concept, functioning and scope.
Extension methods and audio-visual aids. classification, selection, use and production. Modularized communication- concept, approach, need , process of designing instruction for transfer of communication. Concept, functions, key elements, theories and models of communication. Barriers to communication. Revolution in communication strategies. Advanced techniques in mass communication and soft-ware production. Participatory communication – theories and models, designing and developing participatory massage. Concept, need and constraint of community based learning.
Concept, steps, principles and theories of programme planning. Application of programme planning for Home Science Extension through PERT and CPM. Evaluation – concept, significance, methods and tools for monitoring and evaluation. Development programmes, *viz*. Integrated Rural Development Programme (IRDP), Development of Women and Children in Rural Areas (DWCRA), Training of Rural Youth for Self Employment (TRYSEM), Krishi Vigyan Kendras (KVKs). Role of Non-governmental Organizations (NGOs) in extension, SWOT analysis of development programmes. Programmes and agencies promoting women as entrepreneurs. Types and techniques of training for developing entrepreneurial activities in Home Science areas. Self Help Groups- concept, organization, mobilization and functioning of SHGs for sustainability. Human Resource Development- concept, need and strategies.

11. FISHERY SCIENCES

(11.1 Aquaculture, 11.2 Fisheries Resource Management, 11.3 Fish Process Technology, 11.4 Fish Nutrition& Feed Technology,)

11.1 AQUACULTURE

Unit-1. Aquaculture System

History and scope of Aquaculture; Aquaculture practices in different parts of the world; Global Aquaculture production, consumption scenario and emerging trends; Different systems of Aquaculture-traditional, extensive, intensive, semi- intensive, flow through and re-circulatory. Farming methods-ponds, lens, cages, raceway, raft rope, monoculture, polyculture, mixed culture; Capture based Aquaculture and culture based Aquaculture, integrated multi-trophic Aquaculture (IMTA). Recirculation Aquaculture Systems (RAS, Integration of Aquaculture with agriculture and animal husbandry; sewage-fed faming, organic Aquaculture.

Unit 2. Species Selection Criteria for Various Culture Practices

Criteria for candidate species selection, criteria for site selection for various culture practices; Aquaculture practices for freshwater fish (carps, catfishes, snake heads, feather backs, tilapia, murrels, mahsee; trouts, etc) freshwater prawn, brackishwater and marine shrimp and fish (seabass, milkfish, mullets, pearlspot, cobia, pompano, grouper, snappers, breams, other perches) lobsters, freshwater and marine ornamentals, exotics.

Unit 3 Broodstock Development and Management

Broodstock management and seed production technology-Natural seed collection, holding, packaging, transportation; Environmental, nutritional and endocrine control of reproduction, improvement of seed quality through stock up-gradation induced breeding, synthetic hormones and its analogues and their application, layout and design of hatcheries, PIT tagging, canulation, hormonal and volitional spawning, incubation of eggs, cryopreservation of gametes, larval rearing, live feeds, microalgae, rotifers, Artemia, copepods, seed production of : carps, snakeheads, mahseer, trout, tilapia, pearlspot, ornamentals, Cobia, Grouper, Pompano, Tilapia, Mullets, Milkfish, Snappers, Breams, Shrimps (*Penaeus monodon, P. indicus, P. semisulcatus,Litopenaeus vannamei*) sand lobster, spiny lobster, mud crab (*Scylla serrata*) blueswimmer crab (*Portunus pelagicus*), giant freshwater prawn (*Macrobrachiumrosenbergii)* mussel, edible oyster, pearl oyster. Larval transportation, bio-securityprinciples, Specific pathogen Free (SPF) broodstock development, seed certification, quarantine and hatchery protocols, Nursery rearing, pre-stocking, stocking and post stocking management, feeding and nutrition management, health management, biofilm and its uses, probiotics, bioremediation, biofloc based nutrition.

Unit 4. Farm Design, Construction and Operational Management

Design and construction of aqua-farms: site selection, nutrient and soil quality, micro-organisms and their roe, water supply and water circulation, soil and water quality management, liming, manuring and fertilization, bio-fertilization, poly houses, recirculatory system; construction of pens, cage design and construction, fixed cages, floating cages, semi-submerged and submerged cages, towing cages, flow through systems, race ways.
Feed and nutrition management-Natural and formulated feeds, weaning to artificial feeds, feeding strategies, rations and feeding methods, manual and automatic feed dispersers, demand feeders, feed rationing, feeding protocols: Carrying capacity of aquafarms, use of biofilters, aerators; protocols in grow out systems.
Harvest management- continuous stocking and harvesting, staggered harvest, managing differential growth, live fish marketing, Best Management Practices (BMP) in Aquaculture, Hazards of drugs and chemicals, Environmental Impact Assessment (EIA), Responsible Aquaculture, Sanitary and Phytosanitary (SPS) agreement, IPR in Aquaculture, Ecosystem approach to Aquaculture, CRZ implications, CAA and its role. Ecolabeling, Organic certification.

11.2 FISHERIES RESOURCE MANAGEMENT

Unit 1: Fisheries Resources

Major fisheries resources of the world, global trends in production; Target and non-target fisheries resources of the Indian subcontinent and the EEZ; Distribution, composition, trends and dynamics of major exploited fishery resources in hill streams, rivers, reservoirs, lakes, lagoons, estuaries, territorial waters, oceanic waters, deep sea oceanic islands; Straddling/shared stocks and non-conventional resources; Sports, game and ornamental fisheries; Major commercially exploited stocks, their potentials, status, bionomics, methods of capture and yields; Issues related to capture fisheries; Endangered and threatened species, *in-situ* and *ex-situ* conservation; Fisheries and Biodiversity Acts; Juvenile fishing, destructive gears, by-catch and discards; Status and impact of exotic species, accidental introductions; Guidelines and policies for exotics.

Unit 2: Fishery Biology

Life history of economically important fish species; Food and feeding habits, methods of studying food and feeding habits; Reproductive biology, maturity stages, fecundity, ova diameter studies and breeding cycles; Length- weight relationships; Condition Factor, Gonado-Somatic Index; Age and growth studies - methods for determination of age, study of growth rates, direct and indirect methods; Taxonomy of major fish groups; Recruitment, growth and mortality of fish in natural water bodies; Different analytical and Holistic models for fish stock assessment, their advantages and disadvantages; Catch per unit effort, Concept of Maximum Sustainable Yield and Maximum Economic Yield; Application of remote sensing and Geographical Information System (GIS) in resource mapping and forecasting; Mechanisms, methods and status of fish yield data acquisition, storage, retrieval and processing for national estimates; Ecosystem-based fisheries management tools; Monitoring, control and surveillance (MCS) systems for major fisheries; Computer softwares in stock assessment; Use of Virtual Population Analysis and Predictive models.

Unit 3: Aquatic Environment

Various aquatic habitats and fish faunal compositions, trophic relationships, distribution and abundance; Fisheries oceanography and marine fisheries; Limnological parameters; Influence of environmental parameters on fish abundance, distribution, resource resilience; Impact of fishing, aquaculture, other anthropogenic activities on the environment and fish stock. Disaster management in fisheries; Methods for increasing productivity of water bodies (Use of thermal energy and deep sea water through artificial upwelling, Use of ranching, Artificial reefs, FADs and their uses); Habitat degradation and its impact on fisheries; Pollution of water bodies and its impact; Bioindicators and Bioremediation; Protected areas (sanctuaries, marine parks, biosphere reserves and Ramsar sites); Potential fishing zones.

Unit 4: Fisheries Management

Concepts and principles of fisheries management; Fisheries Acts and Legislations, revisions and amendments; Fisheries policies, instruments and mechanisms for inland, coastal and open ocean fisheries management; Management of riverine, reservoir and lacustrine fisheries; Management of marine fisheries; Modes of fisheries management - Open access, regulated, advisory; participatory, user rights; International fishery regulations, treaties and instruments; Input control measures such as access control, size, type, number and power of boats, duration of fishing; Output control measures such as Total Allowable Catch, Catch Quotas, Licensing, Technical control measures such as size limitations, closed fishing areas, closed seasons, size of nets and mesh size regulations, limited entry; Impediments to fisheries governance; UNCLOS, FAO Code of Conduct for Responsible Fisheries; India's commitment to international treaties and resolutions.

Unit 5: Fishing Technology

Different types of craft and gear, their operation and their maintenance; Selectivity of fishing gears, by-catch reduction devices in trawls, turtle excluder devices; Use of modern techniques and equipment for fish finding and capturing.

Unit 6: Economics and Marketing

Supply, demand and price dynamics in the fisheries sector; domestic and export marketing of fish and fish products, trends, channels, mechanisms, regulations, trade and non-trade barriers, concerns and strategies; modern marketing methods and channels, cold chains, storage; value addition; domestic and international market demands; International regulations and practices affecting Indian fisheries trade; WTO and Indian fisheries scenario; Issues in branding and labelling; Quality concerns; Growth of domestic and exports markets; Market trends and diversification; Emerging consumer preferences and trade practices; Fisheries co-operatives; Institutional support for fisheries development.

Unit 7: Fisheries Livelihood

Relevance of capture fisheries in food, nutrition, employment, income and livelihood securities of fishers; Vulnerability of fishers to changes in resource availability, exploitation and utilization patterns; Marginalization of fishermen, small scale processors and traders due to changing scenarios of product diversification, markets and trade; Impact of dams, river linking, CRZ, Biodiversity Bill, protected/closed area, fishing bans, closed seasons, protected areas, mangroves, sanctuaries and parks on the fisher communities. Land and water body use issues in fisheries. Role of extension in fisheries, mechanisms and modes of extension and their impact on capture fisheries and fisher's livelihood, alternative livelihood options; Management of conflicts within sub-sectors in fisheries; Women in fisheries, status, role, impact, future; Vulnerability of fishers to natural disasters and coping mechanisms in disaster management.

11.3 FISH PROCESS TECHNOLOGY

Unit 1: Craft Technology

Fishing crafts of the world; Principles of design and construction; Corrosion protection; Craft materials - wood, marine plywood, fibreglass, reinforced plastic, aluminium, steel, ferro-cement; Bio-deterioration and preventive measures; FAO classification of fishing vessels; Different types of fishing vessels in India; General arrangements of fishing vessels; Basic principles of fishing vessel design; Stability of fishing vessels - factors affecting stability; Powering of fishing boats; Deck machinery for trawlers, seiners, gill netters and liner; Winches- net haulers, line haulers, power blocks, special purpose winches; Engine installation- types of engines for fishing vessels, four stroke cycle, two stroke cycle; Selection of engine for fishing vessels; Transmission systems - Reduction/reverse gear boxes; Modern navigation equipment, navigation and fishing lights; Life saving devices - life jacket, life buoy, life raft, SART, EPIRB.

Unit 2: Gear Technology

Gear Materials - Netting yarns, natural fibres and their classification, origin, properties & preservation; Synthetic fibres- Classification, manufacture, identification and comparative properties; Construction of netting twines; designation of netting yarns and twine twist-coefficient; direction, yarn numbering system; Specification and characteristics of netting; Fishing accessories- Floats, buoys and sinkers, connectors and swivels, ground gear sheer devices, hooks; Classification of fishing gear. Fishing gears used in India; Fish behaviour in relation to fishing techniques; Factors affecting fishing gear design; Fishing gear selectivity - Selectivity of trawls, gill nets and lines; Model testing of fishing gear - flume tank; Structure and operation of trawls; Otter boards - principles of operation, variation in design; Structure, design variation and operation of purse seines, gillnets and trammel nets, lines and traps. Electrical fishing; Harvesting machines; Selective fishing gear and practices: By catch and discards, By catch reduction devices (BRDs), Turtle excluder devices (TEDs); Fish aggregating devices.

Unit 3: Process Biochemistry

Major and minor constituents of fish, their distribution and function- moisture, proteins, lipids, carbohydrates, vitamins and minerals; Glycogen in fish and its functions; Structure, classification and constitution of proteins; Use of functional properties of proteins for developing fish products; Essential amino acids and limiting amino acids and their requirements; Post-mortem changes -rigor mortis, autolysis, auto-oxidation and their significance; antioxidant mechanisms; Biochemical and microbial spoilage of fish; Lipids in fish -their structure and classification; Enzymes in fish -their classification and mechanism of action; Vitamins in fish - vitamin deficiency diseases; Minerals and trace elements in fish; Toxins and toxic substances in fish, their bioaccumulation and biomagnification; Biogenic amines.

Unit 4: Fish Processing Technology

Factors affecting spoilage of fish; Principles of fish preservation; Preservation of fish by curing (drying, salting and smoking); Water content, water activity (aw) and storage stability; Onboard handling of fish; sanitary and phyto-sanitary requirements for maintenance of quality; grading of fish; Chilling and freezing of fish - principles of chilling and freezing, crystallisation, nucleation, crystal growth, methods of chilling, transportation and marketing of chilled fish, the application of freezing systems in fish processing; Changes in quality of chilled and frozen products during storage; Canning of fish and fish products- principles of canning, can materials, can shapes, process value calculation and spoilage of canned food; Modified atmosphere packaging (MAP) of fish and fish products; Accelerated freeze drying (AFD); Surimi and fish-mince products- the surimi process; Fish muscle proteins; Newtonian and non-Newtonian fluids; Irradiation- Radiation sources, units, dose levels, radappertization, radicidation, radurization; Effects of irradiation on protein, fat and vitamin; Packaging and transportation of fish and fishery products - temperature modeling and relationships in fish transportation; transportation containers; Safety and quality and spoilage of fish during transportation; Fishery products and by-products exported from India; Packaging- aim, purpose and objectives, packaging and transportation of fresh fish, cured fish, canned fish, frozen fish, freeze-dried fish, by-products and value-added products; Additives- classes of additives, preservatives, antimicrobial additives.

Unit 5: Microbiology, Quality Management and Certification

Roles of bacteria and moulds in fish preservation; Modification of intrinsic and extrinsic parameters for fish preservation; Spoilage of fresh fish, chilled fish and processed fish products; Micro-organisms in frozen, canned and dried products, and their control; Human pathogenic bacteria, virus, molds and parasites in fish and fishery products; Sources of contamination and control measures; Fish quality evaluation and different indices of quality; Quality management in seafood processing-Concepts of Total quality management, HACCP, practical aspects of planning and implementing HACCP systems; Hazards in sea foods; Risk assessment; National and international standards - ISO 9000 series, ISO 22000. Codex alimentarius, ICMSF; Food Safety and Standards Act of India 2006; Role of BIS and EIA; Traceability issues in international trade.

Unit 6: Fishery Engineering

Selection of site for fish processing plant, layout and design- Canning plant, fish meal plant, surimi plant, freezing plant; Ideal requirements for construction of cold storage; Different types of cold storage; Seafood waste management; Refrigeration engineering-fundamental principles of refrigeration, refrigeration cycle; Refrigerants definition, type of refrigerant and their properties; types of condensers, type of boilers, type of evaporators; Machinery for handling and processing fish- Deboner, filleting machine, freshness analysers.

Unit 7: Economics and Marketing

Fisheries enterprise management; Trends of domestic and export marketing of fish and fishery products, modern marketing methods and channels – supply chain management, cold chain facilities and infrastructure; Value-addition; Institutional support for fish harvest and post- harvest practices.

11.4 FISH NUTRITION& FEED TECHNOLOGY

Unit 1. Principles of Fish Nutrition

Nutrients, sources, structure, classification, bio-synthesis. Metabolism of proteins, lipids, carbohydrates, nucleic acids, vitamins and minerals. Essential aminoacids, functions and deficiency symptoms, Vitamins and minerals, their role in fish nutrition, deficiency symptoms, Vitamin and mineral requirements in herbivores, carnivores, major fresh water, marine and brackishwater cultured species. Metabolic pathways of proteins, lipids and carbohydrates, Sparing action, P:E ratio, Assessing nutritional requirements of larvae, fingerlings, young fish, growout, fattening, reproductive energy needs, basic fish bioenergetics, energy portioning, energy budget.

Unit 2. Nutritional Physiology

Morphology, anatomy and physiology of the digestive systems of various types of fish such as herbivores, planktivores, omnivores, carnivores, detritivores, mixed diet. Nutrient digestion and digestive processes. Control

and regulation of digestion. Factors affecting feed intake, digestion, absorption, assimilation. Microbial digestion; Digestibility and factors affecting. Digestive enzymes in fish; Gastric, pancreatic and intestinal secretions and role of microorganisms in digestion. Transport of nutrients in the body, storage, conversion and utilization. Role of liver and muscles in fat and glycogen storage and release. Digestive hormones, nutrient regulation of endocrine functions, role of nutrition in reproduction, transport and use of fat and protein for reproductive purposes.

Unit 3. Feed Formulation, Feed Technology and Feeding Management

Principles of feed formulation, feed ingredients, international coding of feed ingredients, evaluation of ingredient quality, conventional unconventional and novel ingredients, feed additives and feed binders, anti-nutritional factors and their prevention; Methods of feed formulation, feed processing units and processes, various feed types such as moist, semi-moist, dry, crumble, pellet, sinking, slow sinking, floating, microbound, microencapsulated, micro-coated, high energy. Fortification of micronutrients in larval and broodstock diet, exogenous enzymes in fish feed, Feed storage, packaging and prevention of spoilage.

Unit 4. Nutrition and Fish Health

Nutrients and their effects on fish health. Nutritional diseases, anti-nutritional factors, nutraceuticals for fish health, nutrients and immunity, nutrients and flesh quality, hyper and hypovitaminosis. Mycotoxins in fish feed, nutritional imbalances. Dietary lipid and stress tolerance in fish larvae. Mycotoxin in fish feed. Phytase and phytate in feed ingredients. Anti-nutritional factors in feed ingredients. Anti-nutrients and metabolism. Nutrient deficiency diseases.

Unit 5: Nutrigenomics

Nutritionally important genes, gene regulation by lipids and carbohydrates, metabolic control analysis, transcriptomics, proteomics and metabolomics, nutrient-gene interaction and expression, reverse transcription and CDNA synthesis, genetic control of metabolic pathways, functional food aids in prevention of human health disorders.

12.NATURAL RESOURCE MANAGEMENT-I

(12.1. Forestry/Agroforestry, 12.2Agricultural Meteorology, 12.3Environmental Sciences)

12.1FORESTRY/AGROFORESTRY

Unit 1

National Forest Policy 1894, 1952 and 1988; Indian Forest Act, 1927; Forest Conservation Act,1980 and Wildlife Protection Act, 1972; Amendments 1991, 2003 and 2006, Biological Diversity Act, 2002, The Scheduled Tribes and Other traditional forest dwellers (Recognition of Forest Rights) Act, 2006. Forests-extent, basis for classification and distribution in India; Geographical distribution and salient features of major world forest types; Phylogeographical regions and vegetation of India; Role of forests in national economy - productive, protective and ameliorative, tribal and rural livelihoods; Forest types of India: distribution and types; Succession, climax and retrogression; Concepts of biomass, productivity, energy flow and nutrient cycling in forest ecosystem; Migration and dispersal mechanism.

Unit 2

Concept and definition of agroforestry, social forestry, community forestry and farm forestry; Benefits and constraints of agroforestry; Historical development of agroforestry and overview of global agroforestry systems. Classification of agroforestry systems: structural, functional, socio-economic and ecological; Diagnosis and design of agroforestry system; Land capability classification and land use; Criteria of an ideal agroforestry design, productivity, sustainability and adoptability; Multipurpose tree species and their characteristics suitable for agroforestry.

Unit 3

Plant management practices in agroforestry; Tree-crop interactions: ecological and economic; Concept of complementarity, supplementarity and competition; Productivity, nutrient cycling and light, water and nutrient competition in agroforestry; Concept of allelopathy and its impact on agroforestry; Energy plantations - choice of species and management; Lopping of top-feed species such as frequency and intensity of lopping; Organic farming; Financial analysis and economic evaluation of agroforestry systems: cost benefit analysis and land equivalent ratio; Agroforestry practices and systems in different agro - ecological zones of India. Alley cropping, home gardens, shifting cultivation, shelterbelts and windbreaks, Principles and criteria of plant selection in agroforestry – Resource use efficiency in agroforestry.

Unit 4

Extent and causes of land denudation; Effects of deforestation on soil erosion, land degradation, environment and rural economy; Wastelands: their extent, characteristics and reclamation; Watershed management and its role in social, economic and ecological development; Biomass production for fuel wood, small timber, raw material for plant-based cottage industries, non-wood forest products such as fibres, flosses, dyes, gums, resins & tannins, medicinal plants, essential oils, edible fruits, spices, bamboo and canes; Wood quality, logging, wood seasoning and wood preservation techniques; Plywood and pulp industries.

Unit 5

Forest mensuration - definition, object and scope; Measurement of diameter, girth, height, stem form, bark thickness, crown width and crown length; Measurement methods and their principles. Measurement and computation of volume of logs and felled/standing trees; Construction and application of volume tables; Biomass measurement; Growth and increment; Measurement of crops; Forest inventory: kinds of enumeration, sampling methods, sample plots and aerial photo interpretation; Geographic information systems and remote sensing - concept and scope.

Unit 6

Definition, object and scope of silviculture; Site factors - climatic, edaphic, physiographic, biotic and their influence on forest vegetation; Forest regeneration: natural and artificial; Silvicultural systems - high forest and coppice systems; Silviculture of important tree species - Populus, Eucalyptus, Dalbergia, Acacia, Tectona, Shorea, Prosopis, Casurina, Pinus, Gmelina, Azadirachta, Diospyros, Pterocarpus, Anogeissus, Santalum, Quercus and Albizia bamboo, Meliadubia, Ailanthus excelsa , Simaroubaand Karanja.

Unit 7

Seed collection, processing, storage, viability and pre-treatment; Seed dormancy and methods for breaking dormancy; Seed testing and germination tests; Seed certification and ISTA Rules; Forest nursery - need, selection and preparation of site, layout and design of nursery beds; Types of containers; Root trainers; Growing media and sowing methods; Management of nursery-shading, watering, manuring, fertilizer application, weed control, insect pest and diseases control; Planting techniques: site selection, evaluation and protection; Soil working techniques for various edaphic and climatic conditions; Planting patterns; Plant spacing, manure and fertilizer application, irrigation/moisture conservation techniques; Choice of species. Afforestation on difficult sites: saline-alkaline soils, coastal sands, lateritic soils, wetlands, ravines and sand dunes, dry and rocky areas, cold desert; Tending operations - weeding, cleaning, climber cutting, thinning - mechanical, ordinary, crown and selection thinning, improvement felling, pruning and girdling; Forest fires: causes, types, impacts and control measures; Major forest pests and weeds.

Unit 8

Forest management: definition and scope; Concept of sustained yield and normal forest; Rotation; Estimation of growing stock, density and site quality; Management of even aged and uneven aged forest; Regulation of yield in regular and irregular forests by area, volume, increment and number of trees; land equivalent ratio; Working plan; Joint forest management; Conservation and management of natural resources including wildlife; Forest evaluation; Internal rate of return, present net worth and cost benefit analysis.

Unit 9

Tree improvement: nature and extent of variations in natural population; Natural selection; Concept of seed source/ provenance; Selection of superior trees; Seed production areas, exotic trees, land races; Collection, evaluation and maintenance of germplasm; Provenance testing. Genetic gains; Tree breeding: general principles, mode of pollination and floral structure; Basics of forest genetics - inheritance, Hardy weinberg Law, genetic drift; Aims and methods of tree breeding. Seed orchard: types, establishment, planning and management, progeny test and designs; Clonal forestry - merits and demerits; Techniques of vegetative propagation, tissue culture, mist chamber; Role of growth substances in vegetative propagation.

Unit 10

Forestry in bio-economic productivity of different agro-eco-systems and environmental management; Global overview and classification of agroforestry systems; Tree-crop interaction in agroforestry; Biomass production for fuel' wood, small timber, raw material for plants-based cottage industries, Principle and criteria of plant selection in agroforestry; Resource use-efficiency in agroforestry. Measurement of rangeland productivity, Ecosystem services, Population estimation in wildlife – census methods, Man-Animal conflicts and management strategies.

Unit 11

Measurement of trees and stand – diameter, girth, height, form and crown characteristics; Measurement methods and their principles; Volume/biomass estimation, volume tables; Measurement of rangeland productivity; Forest enumeration: sampling methods, sample plots, surveys and photo interpretation; Concept and application of GIS and remote sensing; Introduction to internal rate of return, present net worth, cost benefit analysis and land equivalent ratio; Agroforestry and environmental conservation; Role of green revolution in forest conservation in India. *In situ* and *ex situ* conservation of forest genetic resources – Sacred groves; Urban forestry – Choice of species, design, development and management, Eco-tourism.

Unit 12

Climate change: greenhouse effect, sources and sinks of greenhouse gases, major greenhouses gases; Global climate change – its history and future predictions; Impact of climate change on agriculture, forestry, wildlife, water resources, sea level; Livestock, fishery and coastal ecosystems; International conventions on climate change; Global warming: effect of enhanced CO2 on productivity; Ozone layer depletion; Disaster management, floods, droughts, earthquakes; Tsunami, cyclones and landslides; Agroforestry and carbon sequestration.

Unit 13

Statistics: definition, object and scope; Frequency distribution; Mean, median, mode and standard deviation, introduction to correlation and regression; Experimental designs: basic principles, completely randomized, randomized block, Latin square and split plot designs.

12.2 AGRICULTURAL METEOROLOGY

Unit 1 : General Meteorology

Laws of radiation: Planck's law, Stephan-Boatman law, Wein's displacement law; Kirchoff's law, Beer's law and Lambert's, Cosine law, Solar constant, length of day;
Atmospheric and astronomical factors affecting depiction of solar radiation; Ozone hole; Direct and diffuse radiation; Heat transfer, convection, conduction and radiation; Concepts of latent and sensible heat; Radiant flux and flux density; Atmospheric motion balanced forces; Gas laws, pressure gradient, isobars, hydraulic equation and its application; Carioles force, geotropic, gradient and cyclostrophic winds; Pressure systems; Cyclones and anticyclonic motions: trough, ridge and col; Thermal wind; Contour charts, Concepts of specific heat at constant volume and pressure; First and second laws of thermodynamics, vapor pressure, specific humidity, relative humidity, mixing ratio, absolute humidity and dew point temperature; Vapour pressure deficit; Psychometric equation, entropy, T-phi gram; Vertical stability of atmosphere, virtual temperature and potential temperature; Moist and dry adiabatic processes; Clouds their description and classification; Condensation process-artificial rain making; Bergeron-Findeison theory; Dew, frost, fog, mist, haze thunderstorm and hail; Air masses and fronts; Extra tropical cyclones; Land and sea breeze; Mountain and valley winds; Wind rose, Tropical cyclones and their structures; Weather variables and their measurements; Units for measurements of momentum, force work, power, surface tension, pressure, temperature; Thermal - conductivity and diffusivity, resistance, radiation light intensity and water vapour.

Unit 2 : General Climatology

Elements of weather and climate; Seasonal distribution of radiation, rainfall. temperature sunshine, wind pressure over India; Climatic classification - Koppen and Thornthwaite; Climatology principles of weather phenomena occurring in four main seasons of India; Mechanism of Indian monsoons; Climatic variability,recent trends, Mitigation and adaptation strategies, factor affecting rainfall distribution, cyclones and cyclonic tracks over the Indian region; North western disturbances and monsoon breaks; Drought climatology, rainfall and its variability, atmospheric and agricultural droughts intensity, duration, beginning and end of drought and wet spells; Moisture availability indices; Heat and cold waves; Contingents, maritime and monsoon climates, El-Niño, La Nino and their impact on Indian rainfall systems.

Unit 3 : Agricultural Climatology

Meaning and scope; Effect of thermal environment on growth and yield of crops; Cardinal temperatures; Thermoperiodism, photoperiodism; Vont Hoff's law, phenology of crops; Heat unit concept, thermal time and thermal use-efficiency and their applications; Length of growing period determination. contingency planning far different weather aberrations; Meteorological factors associated with incidence and development of crop pests and disease, potato blight, apple scan, groundnut red hairy caterpillar, locust etc.; Effect of climate on humans and animals, warm and cold season indices for comfort zones, role of weather in animal disease and protection against weather hazards.

Unit 4 : Micrometeorology

Concept of micro, meso and macro meteorology; Micrometeorological processes near bare ground and crop surfaces; Shearing stress, molecular and eddy diffusion, forced and tree convection; Boundary layer, frictional velocity, roughness length and zero plane displacement; Micrometeorology of crops, rice and wheat; Day and night radiation, humidity, temperature, wind and CO_2 profiles in crop canopies; Richardson number, Reynolds analogy, exchange coefficients, fluxes of momentum, water vapors, CO_2 and heat; Inversion and its effect on smoke plume distribution; Windbreaks and shelterbelts, different methods on modification of field microclimate; Frost protection, spectral properties of vegetation; Light interception by crop canopies as influenced by leaf area index, leaf arrangement and leaf transmissibility, extinction coefficient and radiation use–efficiency; Microclimate of field crops, forest and orchards etc.

Unit 5 : Evapotranspiration

Hydrological cycle and concept of water balance, concepts of evaporation. evapotranspiration, potential and actual evapotranspiration, consumptive use, different approaches of ET determination empirical methods, energy balance and Bowen's ratio methods, water balance single and multilayered soil methods, aerodynamic, eddy correlation and combination approaches, field lysimetric approaches and canopy temperature based methods; Advantages and limitations of different methods; Water use and water use-efficiency, dry matter production and crop yield functions; Irrigation scheduling based on ET; Advective energy determination and its effect on water use by crops; Physiological variation in relation to crop growth and development.

Unit 6 : Crop Weather Modeling

Concepts of mechanistic and deterministic models; General features of dynamical and statistical modeling techniques; Crop weather models and their use in crop yield assessments; Crop weather analysis models, empirical, statistical models, and crop growth simulation models for yield assessment; Use of SPA and CERES models, concepts for crop growth and yield; Advantages and limitations of modeling, climatic change, greenhouse effect, CO_2 increase, global warming and their impact on agriculture.

Unit 7 : Weather Forecasting for Agriculture

Crop weather calendars: Short, medium and long range weather forecasting; Monsoon onset and rainfall forecasts; Weather forecasting and agro-advisories; Use of satellite cloud imageries in weather forecasting; Synoptic charts and synoptic approach to weather forecasting, use of medium, long range and vegetative indices based agro meteorology forecasts for monitoring crop prospects and crop yield forecasts; Meteorological satellites for weather forecasts; Forecast of Indian monsoon rainfall; Early warning systems for agriculture operation forecasts.

12.3 ENVIRONMENTAL SCIENCES

Unit 1

Definition and scope of environment science and its interrelationship with other sciences and agriculture; Origin and evolution of the earth and its environs-atmosphere: hydrosphere, Lithosphere and biosphere; Biogeochemical cycles; Components of environment - biotic, abiotic and social; Weather and climate; History and evolution of human settlement; Effect of various developmental activities on environment.

Unit 2

Basic ecological concepts - habitat ecology, systems ecology, synecology, autecology; Ecosystem concept; Structure and functions of biotic and abiotic components; Energy in ecosystems and environment; Energy exchange and productivity-food chains and food webs-ecological pyramids, nutrient cycles and recycle pathways; Population - characteristics and measurement; Communities - habitats, niches, biomes, population dynamics, species and individual in the ecosystem; Recent trends in ecology; Types characteristic features, structure and function of forest, grassland, plantation, desert; Aquatic and agro-ecosystem; Ecological succession - types and causes.

Unit 3

Biodiversity concepts, levels and types, changes in tune and space, evolution, centres of origin of crops, species concept; Significance of biodiversity; Theories on biodiversity; Environment vs Transgenic crops and animals; Agro-biodiversity – Conceptual view and general benefits of Agricultural Development and its pros and cons on environment; Plant genetic resources, exploration and collection; Crop domestication, plant introductions; Migration and utilization; IUCN clauses and concept of threatened and endangered species; Biogeography; Principles of conservation of biological diversity *in-situ* and *ex-situ*. Causes of loss of biodiversity: introduction of exotics and invasive plants; Methods of conservation, role of national parks, wildlife sanctuaries, biosphere reserves; National and global conservation measures, institutions and conventions; Indian Biodiversity Act 2002; Biodiversity and economics with special reference to India; Biodiversity in relation to global environmental changes; Biodiversity hot spots in India and world; World heritage sites; Wetlands – Ramsar sites, Biodiversity and life security.

Unit 4

Composition of air; Criteria pollutants, Indoor and out-door air pollution, Air pollution: sources and classification of major air pollutants; Smoke, smog, photochemical smog and SPM; Methods of air pollution monitoring; Effects of air pollutants on crops, vegetation, animals and human health; mitigation measures for combating air pollution; Factors affecting plant response to air pollution; Acid rain, physiological and biochemical effects of SO2, HF, PAN and O3 on vegetation, toxicity symptoms on vegetation, defence mechanism against air pollutants in plants, sensitive and tolerant plant species to air pollutants. Mass transit and air pollution episodes in India and world, National and international laws and policies on air pollution; Permissible limits of air pollutants in the residential, commercial and industrial areas; Clean air program, Automobile pollution, Noise pollution-concept and effects, Light pollution; Fluoride pollution, Orbit pollution, Xenobiotics and their effect on agriculture.

Unit 5

Soil and water pollution: sources and types of soil and water pollutants; Effects of pollutants on soil health and productivity; Radioactive pollutants, their life time and disposal; Point and non-point sources of water pollution, major types of water pollutants, their impacts on environment and agro-ecosystems; Pollution in fresh water bodies, ponds, lakes, rivers and wells. Effects of soil and water pollutants on crop plants, animals, microorganism and human health; National and International laws and maximum permissible limits of soil and water pollutants; Biomagnification and its impact on loss of biodiversity; Physical, chemical and biological properties of wastes; Effluent treatment processes for major industries *viz.* distilleries; paper and pulp, sugar, sewage and other agro-industrial wastes; Resource, product recovery, recycling and value addition to wastes; Biodegradation and bioconversion of organic wastes, composting, landfills; Vermicomposting, biogas. animal feed. mushroom cultivation etc.; Use of sludge, flyash, effluents and other agro industrial wastes in agriculture; Microbial, chemical and phytoremediation processes; Microbiological and public health aspects of waste disposal; Heavy metal contamination of environments, source and sinks of heavy metals. Pesticide contamination in environment; Pesticide residues and its impact; Biomedical waste; Nano-remediation and ecotoxicology of nanoparticles in environment; Bio-remediation of organic and inorganic contaminations; GEM's and pollution abatement; E- waste and impacts on environment; Major river projects and its impact; Environmental Monitoring.

Unit 6

Climate change: Global warming and greenhouse effect, sources and sinks of greenhouse gases, major GHGs, analytical techniques of monitoring greenhouse gases in atmosphere; Global climate change - its history and future predictions. Impact of climate change on agriculture, forestry, water resources, sea level rise, livestock, fisheries, coastal ecosystem and dynamics and pests and diseases and overall ecological processes; Climate change and food security; Contribution of agriculture and forestry to climate change; International conventions on climate change; Stratospheric ozone layer depletion-effect of UV radiation on plants and human health; Adaptation and mitigation strategies of climate change, global dimming agrobiological effects of CO2 fertilization on crops; Carbon sequestration and clean development mechanism. Impact of climate change on crop productivity and soil fertility; Mathematical models and yield prediction and its role in predicting change and forecast; Assessing global shift in monsoon pattern; Carbon trading tax; Carbon credit; Vertical farming; Impact of troposphere trace gases on vegetation, field crops and soil properties.

Unit 7

Energy consumption pattern in urban and rural India; Types of renewable sources of energy; Solar energy: concepts of heat and mass transfer; design of solar thermal system and their applications in heating. cooling. distillation. drying. dehydration etc., design of solar photovoltaic systems, power generation for rural electrification-water pumping, solar ponds; Wind energy for mechanical and electrical power generation, types of wind mills; Geothermal and tidal energy; Offshore wind energy; Biomass conversion to energy; Biogas from animal and agricultural wastes, types of biogas plants, utilization of biogas for heating, cooking lighting and power generation; Characteristics of biogas slurry and its utilization; Energy from biogas; Liquid fuels from petro crops, energy plantation crops; Concepts of producer gas; characterization of materials for producer gas, types of gasifiers; Animals draft power and its utilization in rural sector; Briquetting of agro-wastes for fuel; Potential of renewable energy sources in India, Integrated rural energy programme; Causes of failure of biogas plants in rural India. Nuclear power – waste management; Use of green chemicals in industries; Earth hour.

Unit 8

Natural resources of India: land, soil, water and forest and their conservation and management including wildlife; Effects of deforestation on soil erosion; Land degradation; Environment and rural economy; Wasteland: their extent, characteristics and reclamation; Soil and water conservation, rain water harvesting and watershed management; Desertification and biological invasion; Rain water harvesting; Mineral resources: use and exploitation, environmental effects of extracting and using mineral resources; Disaster management: floods, droughts, earthquakes; Tsunami, cyclones and landslides; Nuclear hazards; Environmental impact assessment for physical, chemical, biological and socio-economic factors; Legislative implications of EIA, environmental impacts assessment and environmental auditing; Major global environmental issues; Human population and environment: population growth, variation among nations. Population explosion - Family welfare programme; World food resources; World food problems; Environment and human health; Environmental ethics: issues and possible solutions; Environmental policies and laws in India; Public environmental awareness; Human rights; Role of information technology in environmental and human health; Industrial pollutants; Sea weeds and their utilization in agar, alginic acid, carrageenan, agarose and agaropectin production; Impact of green revolution on the environments. Measuring environmental damage and valuation methodologies; ISO Certificates; CPCB and SPCB standards; MoEF; Environmental treaties; Role of NGO's in environmental protection; Corporate Social Responsibility (CSR) of industries in environmental protection; Advance tools for ecosystem analysis – Remote sensing (RS) and Geographic Information Systems (GIS).

Unit 9

Frequency distribution, mean, median, mode and standard deviation; Normal, binomial and poisson distribution; Correlations - partial and multiple; Regression coefficients and multiple regression. Tests of significance F and Chi-square (X2) tests; Experimental designs - basic principles, completely randomized, randomized block, Latin square and split plot designs.

13. NATURAL RESOURCE MANAGEMENT-II

(13.1 Agronomy, 13.2 Soil Sciences/Soil Science & Agricultural Chemistry)

13.1 AGRONOMY

Unit 1 : Crop Ecology and Geography

Principles of crop ecology; Ecosystem concept and determinants of productivity of ecosystem; Physiological limits of crop yield and variability in relation to ecological optima; Crop adaptation; Climate shift and its ecological implication; Greenhouse effect; Agro-ecological and agro climatic regions of lndia; Geographical distribution of cereals, legumes, oilseeds, vegetables, fodders and forages, commercial crops, condiments and spices, medicinal and aromatic plants; Adverse climatic factors and crop productivity; Photosynthesis, respiration, net assimilation, solar energy conversion efficiency and relative water content, light intensity, water and CO2 in relation to photosynthetic rates and efficiency; Physiological stress in crops; Remote sensing: Spectral indices and their application in agriculture, crop water stress indices and crop stress detection.

Unit 2 : Weed Management

Scope and principles of weed management; Weeds' classification, biology, ecology and allelopathy; Crop weed competition, weed threshold; Herbicides classification, formulations, mode of action, selectivity and resistance; Persistence of herbicides in soils and plants; Application methods and equipment; Cultural, physical, mechanical weed control, Biological weed control, bio-herbicides: Integrated weed management; Special weeds, parasitic and aquatic weeds and their management in cropped and non-cropped lands; weed control schedules in field crops, vegetables and plantation crops; Role of GM crops in weed management.

Unit 3 : Soil Fertility and Fertilizer Use

History of soil fertility and fertilizer use; Concept of essentiality of plant nutrients, their critical concentrations in plants, nutrient interactions, diagnostic techniques with special emphasis on emerging deficiencies of secondary and micro-nutrients; Soil fertility and productivity and their indicators; Fertilizer materials including liquid fertilizers, their composition, mineralization, availability and reaction products in soils; Water solubility of phosphate fertilizers; Slow release fertilizers, nitrification inhibitors and their use for crop production; Principles and methods of fertilizer application including fertigation; Integrated nutrient management and bio-fertilizers; Agronomic and physiological efficiency and recovery of applied plant nutrients; Criteria for determining fertilizer schedules for cropping systems direct, residual and cumulative effects; Fertilizer related environmental problems including ground water pollution; Site-specific nutrient management; Contamination of heavy metals in peri-urban soils and their remediation.

Unit 4 : Dryland Agronomy

Concept of dryland farming; dryland farming vs rainfed farming; History, development, significance and constraints of dryland agriculture in India; Climatic classification and delineation of dryland tracts; Characterization of agro-climatic environments of drylands; Rainfall analysis and length of growing season; Types of drought, drought syndrome, effect on plant growth, drought resistance, drought avoidance, drought management; Crop Planning including contingency, crop diversification, varieties, cropping systems, conservation cropping and mid-season corrections for aberrant weather conditions; Techniques of moisture conservation in-situ to reduce evapotranspiration, runoff and to increase infiltration; Rain water harvesting and recycling concept, techniques and practices; Timelines and precision key factors for timely sowing, precision in seeding, weed control; Fertilizer placement, top dressing and foliar application, aqua-fertigation; Concept and importance of watershed management in dryland areas.

Unit 5 : Crop Production in Problem Soils

Problem soils and their distribution in India, acid, saline, waterlogged and mined - soils; Response of crop to acidity, salinity, sodicity, excess water and nutrient imbalances; Reclamation of problem soils, role of amendments and drainage; Crop production techniques in problem soils - crops, varieties, cropping system and agronomic

practices; Effects of water table fluctuation on crop growth; Degraded lands and their rehabilitation.

Unit 6 : Crop Production

Crop production techniques for cereals, millets, legumes, oilseeds, fiber crops, sugarcane, tobacco, fodder and pasture crops including origin, history, distribution, adaptation, climate, soil, season, modern varieties, Seed rate, fertilizer requirements, crop geometry, intercultural operations, water requirement. weed control, harvest, quality components, industrial use, economics and post-harvest technology.

Unit 7 : Agricultural Statistics

Frequency distribution, standard error and deviation, correlation and regression analyses, co-efficient of variation; Tests of significance-t, F and chi-square (X2); Data transformation and missing plot techniques; Design of experiments and their basic principles, completely randomized, randomized block, split plot, strip-plot, factorial and simple confounding designs; Efficiency of designs; Methods of statistical analysis for cropping systems including intercropping; Pooled analysis.

Unit 8 : Sustainable Land Use Systems

Concept of sustainability; Sustainability parameters and indicators; Conservation agriculture; Alternate land use systems; Types, extent and causes of wasteland; Shifting cultivation; Agro forestry systems; Agricultural and agro-industrial residues and its recycling, safe disposal; Allelopathy and biomass production.

Unit 9 : Basics of Soil and Water

Soil and water as vital resources for agricultural production; Occurrence of groundwater, groundwater aquifers, exploration of groundwater; Hydrological cycle; Soil-plant water relationship; Fate of rain water received at the soil surface, runoff and infiltration reciprocity, factors affecting infiltration, means to enhance infilterability of soil, mechanical and biological means to reduce runoff and soil loss; Water harvesting for crop lifesaving irrigations; watershed management; Soil and water conservation; Contingent crop plans and other strategies for aberrant weather conditions; Cropping patterns, alternate land use and crop diversification in rainfed areas; Analysis of hydrologic data and their use.

Unit 10 : Soil Water Relationship

Soil water relations, water retention by soil, soil moisture characteristics, field capacity, permanent wilting point, plant available water and extractable water; Soil irrigability, classifications, factors affecting profile water storage; Determination of soil water content, computation of soil water depletion, soil water potential and its components, hydraulic head; Movement of soil water saturated and unsaturated water flow; Field water budget, water gains and water losses from soil, deep percolation beyond root zone, capillary rise; Evapotranspiration (ET), scope for economizing water, measures for reducing direct evaporation from soil and crop canopies; Soil physical properties in relation to plant growth and development; Erodability of soils and their prevention.

Unit 11 : Plant Water Relationship

Plant water relations: Concept of plant water potential, cell water relations, plant water potential and its components; Significance of osmotic adjustment, leaf diffusive resistance, canopy temperature, canopy temperature depression (CTD); Water movement through soil - plant atmosphere systems, uptake and transport of water by roots; Development of crop water deficit, crop adaptation to water deficit, morpho-physiological effect of water deficit; Drought tolerance, mechanisms of drought tolerance, potential drought tolerance traits and their measurements. management and breeding strategies to improve crop productivity under different patterns of drought situations of limited water supplies; Effect of excess water on plant growth and production; Types of droughts, drought indices.

Unit 12 : Irrigation Water Management

Management of irrigation water; History of irrigation in India; Major irrigation projects in India; Water resources development; Crop water requirements; Concepts of irrigation scheduling, Different approaches of irrigation scheduling; Soil water depletion plant indices and climatic parameters; Concept of critical stages of crop growth in relation to water supplies; Crop modeling, crop coefficients, water production functions; Methods of irrigation *viz.* surface methods, overhead methods, drip irrigation and air conditioning irrigation, merits and demerits of various methods, design and evaluation of irrigation methods; Measurement of irrigation water, application and distribution efficiencies; Management of water resources (rain, canal and ground water) for agricultural production; Agronomic considerations in tile-design and operation of irrigation projects, characteristics of irrigation and family systems affecting irrigation management; lrrigation legislation; Water quality, conjunctive use of water, irrigation strategies under different situation of water availability, optimum crop plans and cropping patterns in canal command areas; Socio-economic aspects of on-farm water management; Irrigation water distribution, Estimation of ET by direct and indirect methods, Irrigation efficiencies; Design of irrigation canals, design of irrigation structures; Interaction between irrigation and fertilizers.

Unit 13 : Management of Problematic Soils and Water

Problem soils and their distribution in India; Salt-affected, acidic, water logged soils; Ground water resources, water quality criteria and use of brackish waters in agriculture; Excess salt and salt tolerant crops; Hydrological imbalances and their corrective measures; Concept of critical water table depths for crop growth; Contribution of shallow water table to crop water requirements; Management strategies for flood prone areas crop and crop calendar for flood affected areas; Drainage for improving water logged soils for crop production; Crop production and alternate use of problematic soils and poor quality water for agricultural and fish production; Amelioration of salt affected soils.

13.2 SOIL SCIENCES/SOIL SCIENCE & AGRICULTURAL CHEMISTRY

Unit 1: Pedology

Concept of land, soil and soil science. Composition of earth crust and its relationship with soils; Rocks, minerals and other soil forming materials; Weathering of rocks and minerals; Factors of soil formation; Pedogenic processes and their relationships with soil properties; Soil development; Pedon, polypedon, soil profile, horizons and their nomenclature. Soil Taxonomy - epipedons, diagnostic subsurface horizons and other diagnostic characteristics, soil moisture and temperature regimes, categories of the system and their criteria; Interpretation of soil survey data for land capability and crop suitability classifications, Macro-morphological study of soils, Application and use of global positioning system for soil survey. Soil survey- types, techniques. Soil series-characterization and procedure for establishing soil series, benchmark soils and soil correlations. Study of base maps: cadastral maps, toposheets, aerial photographs and satellite imageries. Use of geographical information system for preparing thematic maps. Application of Remote Sensing in soil survey and mapping.

Unit 2: Soil Physics

Soil physical constraints affecting crop production. Soil texture – textural classes. Soil structure – classification, soil aggregation and significance, soil consistency, soil crusting, bulk density and particle density of soils and porosity, their significance and manipulation. Soil water- retention and potentials. Soil moisture constants. Movement of soil water - infiltration, percolation, permeability, drainage and methods of determination of soil moisture. Darcy's law. Thermal properties of soils, soil temperature, Soil air- composition, gaseous exchange, influence of soil temperature and air on plant growth. Soil erosion by water- types, effects, mechanics. Rain erosivity and soil erodibility. Runoff - methods of measurement, factors and management, runoff farming. Soil conservation measures.
Characterization and evaluation of soil and land quality indicators; Causes of land degradation; Management of soil physical properties for prevention/restoration of land degradation; Identification, monitoring and management of waste lands; Land use-land cover mapping and land use planning using conventional and remote sensing techniques; Concept of watershed – its characterization and management.

Unit 3: Soil Chemistry

Chemical composition of soil; Soil colloids - structure, composition, constitution of clay minerals, amorphous clays and other non-crystalline silicate minerals, oxide and hydroxide minerals; Charge development on clays and organic matter; pH-charge relations; Buffer capacity of soils.
Elements of equilibrium thermodynamics, chemical equilibria , electrochemistry and chemical kinetics. Inorganic and organic colloids- surface charge characteristics, diffuse double layer theories, zeta potential stability, coagulation/ flocculation, peptization, electrometric and sorption properties of soil colloid. Soil organic matter-fractionation, clay-organic interactions. Cation exchange- theories, adsorption isotherms, Donnan-membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement, thermodynamics, anion and ligand exchange- inner sphere and outer-sphere surface complex formation, fixation of oxyanions , hysteresis in sorption-desorption of oxy-anions and anions. Nitrogen, potassium, phosphate and ammonium fixation in soils and management aspects. Chemistry of acid, salt-affected and submerged soils and management aspects.

Unit 4: Soil Fertility

Essential elements in plant nutrition; Nutrient cycles in soil; Transformation and transport of nutrients (Macro and micro nutrients) in soil; Manures and fertilizers; Fate and reactions of fertilizers in soils; Chemistry of production of different fertilizers; Slow release fertilizers and nitrification retarders; Quality control of fertilizers.
Soil fertility evaluation – soil testing, plant and tissue tests and biological methods; Common soil test methods for fertilizer recommendation; Soil test-crop response correlations; Integrated nutrient management; Use of isotopic tracers in soil research; Nature, properties and development of acid, acid sulphate, saline and alkali and their management; Lime and gypsum requirements of soils; Irrigation water quality - EC, SAR, RSC and specifications. Fertility status of major soil groups of India. Application of Remote Sensing in Soil fertility mapping, Watershed management, Degraded land and soil erosion studies. Remote sensing and GIS in Carbon sequestration studies.
Pollution: types, causes, methods of measurement, standards and management. Heavy metal toxicity and soil pollution; Chemical and bio-remediation of contaminated soils; Soil factors in emission of greenhouse gases; Carbon sequestration in mitigating greenhouse effect; Radio-active contamination of soil.

Unit 5: Soil Microbiology

Soil biota, soil microbial ecology, types of organisms. Soil microbial biomass, microbial interactions, unculturable soil biota. Microbiology and biochemistry of root-soil interface. Phyllosphere. Soil enzymes, origin, activities and importance. Soil characteristics influencing growth and activity of microflora. Microbial transformations of N, P, K, S, Fe and Zn in soil. Biochemical composition and biodegradation of soil organic matter and crop residues. Humus formation. Cycles of important organic nutrients. Biodegradation of pesticides, organic wastes and their use for production of biogas and manures. Biofertilizers – definition, classification, specifications, method of production and role in crop production.
Methods of soil analysis - particle size distribution, bulk and particle density, moisture constants, Modern methods of soil, plant and fertilizer analysis; Flame photometry and inductively coupled plasma optical emission spectroscopy; Spectrophotometry - visible, ultra-violet and infrared; Atomic absorption spectrophotometry; Potentiometry and conductimetry; X-ray diffractometry; Mass spectrometry.

Unit 6: Statistics

Experimental designs for pot culture and field experiments; Statistical measures of central tendency and dispersion; Correlation and regression; Tests of significance - t and F tests; Computer use in soil research, Geostatistics.

14. AGRICULTURAL ECONOMICS & AGRI-BUSINESS MANAGEMENT

(14.1 Agricultural Economics, 14.2 Agribusiness Management)

14.1 AGRICULTURAL ECONOMICS

Unit 1: Economic Theory

Scope and methods of economics and agricultural economics, Characteristics of modern production, Problems of application of economic theory of agriculture. Production and consumption units and their peculiarities, Basic economics concepts - statistics. Comparative statics and dynamics equilibrium. Comparative economic systems, Development of economic theory and models. Themes of consumer behaviour -marginal utility, indifference curve (IC) and other models of utility maximization. Price and income consumption curves, Engel curves Elasticity of demand-substitution and income effects, Application of IC analysis -rationing, taxation and subsidy. Theory of production and cost optimizing behaviour of firm, output maximization, cost minimization and profit maximization. Elasticity of supply-substitution, output and profit maximization and profit maximization. Elasticity of supply-substitution, output and profit maximization effects. Optimally approach for joint products. Market classification-pure and perfect competition. Behaviour of the firm and industry. Supply-demand functions. Imperfect competition, monopolistic competition, monopoly, duopoly. Pricing and output decisions. Pricing and output decisions. Price discrimination. Product differentiation applications. Micro and macroeconomic analysis. Working of macro-economic systems. National income accounting. Theory of employment-classical. Keynesian and post Keynesian theories of income determination. Optimal saving and investments. Theory of income distribution and factor shares inflation, deflation, inflationary gap, monetary policy and banking systems.

Unit 2: Economic and Agricultural Development

Concept of economic and agricultural development, characteristics of developing countries, dualism and development, stages and theories of economic development, economic growth models, neo-classical growth models, role of technology in development and choice of techniques, human capital and development, inequality, poverty and migration in developing countries, trade and development, capital and growth, development challenges in developing countries, role of state, markets and civil society in development, institutions and economic development, international development institutions. Objective and processes for economic planning in India, economic and trade reforms in India.

Role of agriculture in economic development, theories of agricultural development, agricultural development challenges, planning and techniques for agricultural development, agricultural development, poverty and environment, application of institutional economics in agricultural development, institutional issues in natural resource management, agricultural policies (price, land, credit, R&D, trade, subsidy, etc.), role of innovations, investment and institutions in agricultural development, agricultural development programmes in India, issues of water, energy, environment, food and nutrition security, agro-eco -regional planning, assessment of ecosystem services, farm-non-farm linkages. Agricultural development in India, China, Latin America and East Asian countries.

Unit 3: Public Finance and International Economics

Public Finance: Public and private finance. General principles of public finance. Principle of maximum social advantage. Public revenue. Incidence of tax and financial policies. Public expenditure and economic development. Balanced and unbalanced budgets. Limitations of fiscal policies. Fiscal policy as an instrument of development. Structure of development taxation. Public debt policy and economic development, international Economics: Principle of comparative advantage. Factor endowment theory, Balance of payments. Problems of international monetary systems, Foreign trade and foreign capital. Export promotion and input substitution. Past experiences and future strategies.

Unit 4: Farm Management Economics

Definition of farm management and its relationship to technical and social sciences. Characteristics of modern farming. Role and functions of farm management under Indian condition. Measurement of management. Measures of farm efficiency. Cost concepts. Evaluation of farm assets and liabilities. Decision theory and decision making

models. Decision making under different knowledge situations. Tools and techniques in farm decision making. Farm planning and budgeting-sources of data and illustration. Linear programming. Problem formulation in farm planning. Farm records and accounts. Farm inventory with applications to farming enterprises. Farm cost accounting for managerial analysis. Management of farm resources-land, labour, capital and machinery. Review of farm management research, education and extension in relation to changing needs. Systems approach in agriculture. Farming systems, identification of farming system inputs and outputs, sub-systems and the circuitry connecting these systems. Systems analysis to find out needed changes in policies and programmes.

Unit 5: Agricultural Production Economics

Nature and scope of agricultural production economics vis-à-vis farm management. Relative importance of farm production economics and farm management in developed and developing countries. Economics of farm production- resource allocation and use under static and dynamic conditions. Resource — product relationships in agriculture. Types of production functions. General rules of their economics application. Technological change and production function analysis. Principles of choice and allocation of resources. Resource combination and cost minimization. Types of risk in agriculture, resource allocation and enterprise combination under risk and risk diffusion mechanisms. Nature of costs and family farm theory. Returns to scale and farm size. Derivation of cost and supply functions.

Unit 6: Agricultural Finance and Co-operation

Role of credit in agriculture and rural development. Estimates of agricultural credit requirements-investment, production, marketing and consumption. Role of public and private section banks and cooperatives in development financing. Classification of agricultural credit. Rural credit structure. Principles of agricultural finance and financial management. Agricultural finance as a part of public finance. Agricultural taxation and subsidies, capital in agriculture and sources of capital. Credit and saving -legal aspects of credit. Credit instruments. Farm planning as a basis for extension of agriculture credit. Nexus between commercial banks and cooperative credit institutions. Recent innovations in extension of credit to agriculture. Rural credit supply and credit gap. Multiagency approach and coordination of credit structure at different levels. Agriculture credit policy. Principles and practices of cooperation. Success and failure of cooperative sector in India. Credit and non-credit institutions. National federations of cooperative organizations. Review of reforms in cooperative structure. Single window approach in agricultural input supply and output marketing. Bureaucracy and cooperatives. Management of cooperative institutions. Professionalization and revitalization of cooperatives. Role of cooperatives under new economic policy.

Unit 7: Agricultural Marketing

Nature and scope of marketing in a developing economy. Classification of markets. Problems of marketing agricultural produce. Functions of marketing. Marketable surplus and marketed surplus. Channels of marketing agricultural produce and price spread. Marketing institutions, their role and functions. Regulated markets and other state interventions in agricultural marketing. Role of commission on agriculture cost and prices and parastatal organizations in agricultural marketing. Cooperative marketing. Marketing practices and cost-marketing of grains, pulses, commercial crops, fruits, vegetables, livestock and livestock products and inputs. Processing, transportation, storage and warehousing, equity aspects of marketing. Marketing efficiency. Marketing finance-methods and practices. Forward trading and speculation. Future markets. Market management. Agricultural price analysis. Seasonal and spatial variations in prices in agricultural price policy. Agricultural exports, problems and prospects.

Unit 8: Agricultural Project Analysis

Definition of project in agriculture. Need for project approach for agricultural development. Project cycle. Project identification and formulation. Project appraisal-ex-ante and ex-post. Projection worth measures-discounting techniques. Project monitoring and mid-course corrections. Project funding.

Unit 9: Research Methodology and Econometrics

Agricultural economics research, steps and themes, collection and analysis of economic data, scientific report writing. Optimization, econometric and statistical methods, differential and integral calculus; sampling methods, probability theory. Multiple regression analysis, ordinary and generalized least squares estimators, multicollinearity, heteroscedasticity, autocorrection, dummy variable. Simultaneous equation methods.

14.2 AGRIBUSINESS MANAGEMENT

Unit 1: Basics of Management, Organizational Behavior and Human Resource Management

The agribusiness system, management processes, planning, controlling, organizing motivating and leading; decision making; managerial skills; level of managers; organizational context of decisions; decision making models; management by objectives; organizational culture; management of organizational conflicts; managing change; leadership styles; group dynamics; motivation.

Human resource planning, job analysis and design; recruitment, selection, induction and placement; human resource training and development; management development; performance appraisal and job evaluation; wage and salary administration; promotion, transfer, separation, absenteeism and turnover, employee welfare and safety; morale; personnel supervision; styles; participative management; labour management relations; negotiation and negotiating skills; conflict management.

Unit 2: Managerial Accounting and Financial Management

Cost Accounting - Significance of Cost Accounting; Classification of Costs; Marginal Costing and cost volume profit Analysis- Its Significance, Uses and Limitations; Standard Costing - Its Meaning, Uses and Limitations; Determination of Standard cost, Variance Analysis-Material, Labour and Overhead; Accounting for Price Level Changes Concepts, CPP and CCA Methods. Budget and Budgetary Control- Its Meaning, Uses and Limitations. Budgeting and Profit Planning, Different Types of Budgets and their Preparations. Financial Statements- Ratios, Comparative and Common Size Statements, Cash Flow and Funds Flow Analysis.

Fundamentals of accounting and book-keeping; objectives and functions of financial management; analysis of financial statements- balance sheet, income statement, cash flow statement; capital structure theories; concepts of components of working capital, managing working capital - cash management, di*vide*nd decision; capital budgeting, appraisal criteria- Internal Rate of Return (IRR), Benefit Cost (B-C) ratio analysis. Importance of agricultural finance; rural credit structure-demand, supply, sources and forms; estimation of credit requirement; cost of credit/capital; credit appraisal- 3 Rs and 3 Cs of credit; reforms in agricultural credit policy; innovations in agricultural financing - microfinance, Kisan credit cards; role of institutions in agri-finance - public and private sector banks; cooperatives, micro- finance institutions (MF1s), SHGs; international financial institutions; principles of agricultural financial management; successes and failures of co-operative sector in India.

Unit 3: Marketing Management and International Marketing of Agri-products

Agricultural marketing system, government interventions including regulated markets, buffer stock operations, price stabilization measures and policies, etc.; Forward trading and futures market; Marketing of agricultural inputs; Rural marketing; role of private sector in input and output marketing; contract farming. Product management, pricing, communication, distribution and marketing information system.

International Marketing: Meaning, nature and importance; An overview of the International marketing management process and environment. International Marketing Segmentation, targeting and Positioning: Screening and selection of markets; International marketing entry strategies: Export- licensing, contract manufacturing, joint venture, setting up of wholly owned subsidiaries abroad.

International Product and Pricing Strategies: Product standardization vs. adaptation; International trade product life cycle, Factors affecting International price determination; Managing International Distribution and Distribution channel strategy. International promotion strategies: communications across countries, international promotion mix-advertising, personal selling, publicity and sales promotion; Standardization vs. adaptation issue. International marketing planning, organizing and control; ecological concerns and international marketing ethics. Key concepts in agri-export, procedures for export planning; analysis of export markets, tools and techniques; for optimizing the export functions.

Unit 4: Production, Operations and Quality Management

Operations management of an agro-industrial unit including operations system and processes; productivity of operations; work force productivity; facilities management; operations planning and control; material and supply chain management; quality management. Importance of quality in the globalized market place, significance of managing quality in manager's total field of concerns, An introduction to Agmark, BIS, ISI and FPO.
GMP/G (good manufacturing and hygienic practices), TQC/TQM (total quality control and total quality management), SQC (Statistical Quality Control), product quality monitoring, HACCP (hazard analysis and critical control points), Codex alimentarius (international quality standards), ISO-9000-standards and certification. Food standards, legislation and internal auditing.
Entrepreneurship for Small Scale Enterprises (SSE); Entrepreneurial Competencies; Institutional Interface. Establishing Small Scale Enterprises: Opportunities Scanning-Choice of Enterprise; Market Assessment for SSE; Choice of Technology and Selection of Site. Small Scale Enterprises-Getting organized: Financing the New/Small enterprises; preparation of the business plan; ownership structure and organizational framework. Financial management issues in SSE; Operations management issues in SSE; Marketing management issues in SSE; Organizational relations in SSE. Management Performance assessment and control; Strategies for stabilization and growth; Managing family enterprises.

Unit 5: Managerial Economics

Scope of managerial economics, objective of the firm and basic economic principles; Consumer theory. Demand analysis - meaning, types and determinants of demand; demand function; demand elasticity; demand forecasting-need and techniques. Production, cost and supply analysis- production function, least-cost input combination, factor productivities and returns to scale, cost concepts, cost-output relationship, Pricing-determinants of price-pricing under different market structures The national income; circular flow of income: consumption, investment and saving: money-functions, demand & supply; inflation; economic growth; business cycles and business policies; Recent developments in the national and international economic and agricultural scenarios.

Unit 6: Operations Research and Research Methods

Objectives, types, and process of research; Problem formulation; Scales of measurement; Sampling, Types of sampling - Probability and non-probability sampling techniques, sample size determination, sampling and non-sampling errors. Role and uses of quantitative techniques in business decision making, Use of introductory statistics, Report writing.
Linear Programming: Objective, Assumptions, Formulation of Linear Programming Problem, Graphic Method, Simplex method; Transportation and Assignment Problems; Inventory control Models, Costs Involved in Inventory Management, Types of Inventory; Waiting Line Models: Waiting Line Problem, Characteristics of a Waiting Line System; Decision making under Risk and uncertainties, Decision tree ; Game Theory- Two -Person Zero-Sum Game; Simulation; Network analysis -PERT & CPM, Markov Chains.

Unit 7: Agribusiness Environment and Policy

Role of agriculture in Indian economy; problems and policy changes relating to farm supplies, farm production, agro processing, agricultural marketing, agricultural finance etc. in the country.
Agribusiness - definition and nature, components of agribusiness management, changing dimensions of agricultural business. Structure of Agriculture - Linkages among sub-sectors of the Agribusiness sector; economic reforms and Indian agriculture; impact of liberalization, privatization and globalization on Agri-business sector. Emerging trends in production, processing, marketing and exports; policy controls and regulations relating to the industrial sector with specific reference to agro-industries. Agribusiness policies- concept and formulation; and new dimensions in Agri-business environment and policy. Agricultural price and marketing policies; public distribution system and other policies. International trade- basic concepts.

Unit 8: Strategic Management

Strategic management - meaning, concept and scope; framework for strategic management; industrial (external) and organizational (internal) environmental factors influencing strategy; scanning the external and internal environment; core competencies and resource strengths; SWOT analysis; strategy formulation and implementation; generic strategies; strategy and technology, strategy and leadership, total quality management,

the customer resource, creating competitive advantage, evaluation of strategy.

Unit 9: Project Management and Entrepreneurship Development

Concept, characteristics of projects, types of projects, project identification, and Project's life cycle; Project feasibility- market feasibility, technical feasibility, financial feasibility, and economic feasibility, social cost-benefit analysis, project risk analysis; Network Methods; Project scheduling and resource allocation; Financial appraisal/evaluation techniques; Project control and information system. Entrepreneurship, Significance of entrepreneurship in economic development qualities of entrepreneur, entrepreneurship development programs and role of various institutions in developing entrepreneurship, life cycles of new business, environmental factors affecting success of a new business, reasons for the failure and visible problems for business, Developing effective business plans, Procedural steps in setting up of an industry.

15. AGRICULTURAL EXTENSION

(15.1 Agricultural Extension/Extension Education/Communication)

15.1 AGRICULTURAL EXTENSION/EXTENSION EDUCATION/COMMUNICATION

Unit 1: Fundamentals of Extension and Communication

Concepts and scope of extension and communication particularly for primary and secondary agriculture. Historical and emerging perspectives of agricultural, veterinary and animal husbandry extension education in India and other countries. Community Development and Integrated Rural Development- concept, principles and objectives. Role of agricultural extension in different sectors of agriculture and rural development. Agricultural Extension in the context of enhancing productivity, Quality, Nutrition, post-harvest technology, product processing, Profitability, Income and Employment. Concepts of yield gaps. FLD and OFT in relation to TOT programmes. Farming System Research and Extension (FSR&E) and participatory development approaches. Concept and modules of communication, credibility, fidelity, empathy and feedback in communication. Similarities and dissimilarities among extension education, adult education and continuing/distance education. Andragogy and theories of adult learning. Human behavioural dimensions and gender sensitivity in extension education programmes. Meaning and characteristics of attitude, factors affecting attitude change; Understanding of basic rural institutions, social structure, culture and norms. Social and technological change processes, group dynamics, concepts and theories of rural leadership. Group and mass communication, Interpersonal and Intrapersonal Communication Skills, Key communicators and their role in agriculture and animal husbandry development. Acquiring communication skills for development of local leaders and key communicators for agriculture and livestock development. Organizational communication. Rapport building with clientele. Problems and barriers in communication; distortion and noise in communication. Importance of feedback in agriculture and veterinary extension, impact analysis of extension programmes.

Unit 2: Extension Methods & Farm Journalism

Concepts of teaching and learning processes–principles of learning as applied to agricultural extension. Individual, group and mass approaches in extension, audio-visual aids- classification, selection, use and production. Traditional media for communication in development programmes. Modularized communication- concept, approach, need, process of designing instruction for transfer of communication. Basics of agricultural journalism, types of publications – bulletins, folders, leaflets, booklets, newsletters, popular and scientific articles. Selection, planning and use of different extension teaching methods like demonstration, exhibition, farmers fairs, field days, tours, extension literature, etc. Preparation and presentation of different projected and non-projected audio-visual aids. Public speaking. Preparation of radio/*video* script. Principles of photography and its use in extension.

Unit 3: Information Communication Technologies (ICT)

Concept of ICT and its role in agriculture and rural development. ICT tools- print and electronic media, e-mail, Internet, use of multimedia, use of mobile phony, *video* and teleconferencing, computer-assisted instructions, touch screens, micro-computers, web technologies and information kiosks. Networking system of information and challenges in the use of ICT. E-learning, information resources, sharing and networking. Types of network – PAN, LAN, WAN, Internet, AGRINET, AKIS, Indian National Agricultural Research database. ICT programmes in agriculture and livestock development, Problems and prospects of ICTs in agriculture and livestock development, Digitization, Simulation models, Utilization of Internet for promoting advanced agriculture, veterinary and animal husbandry practices; communication with farmers and rural, semi-urban and urban livestock owners.

Unit 4: Training & Human Resource Development

Human resources and their importance in agricultural development. Concept of human resource management. Training and development of human resources. Identifying training needs and assessment of training impact. Training – principles, importance, methods and factors. Phases of training - pre training and post training. Developing training modules, training requirements, training methods. Lecture cum demonstration method, case method, group brain storming, syndicate method, business games, simulation exercises, in basket exercise, programmed instruction, experiential learning techniques such as sensitivity training, T-group, transactional

analysis and fish bowl exercise. Evaluation of training - types and techniques of training evaluation. Motivation, stress management and organizational behaviour as facilitators of human resource development. Capacity Building in relation to agriculture, Dairying, Poultry, Piggery, Goat and Sheep farming, cottage industries, Rabbit farming, Apiculture, Sericulture, Biofertilizer, Floriculture, and Biopesticides.

Unit 5: Research Methodology in Extension Education

Social research- concept, principles and approach. Selection and identification of research problems, methods of data collection- interview method and mailed questionnaires, variables -meaning and types, independent, dependent and intervening variables. Hypothesis – concept, characteristics, types and testing. MAXMINCON principle, Research design - concept and types, field studies, case studies and survey method. Measurement – meaning and levels. Methods of sampling and statistical tests. Reliability and validity of tests, normal distribution, tests of significance, ANOVA, correlation and regression, scaling techniques. Processing of data, coding - tabulation. Analysis and interpretation. Writing scientific reports, citing references. Participatory approaches, PRA, RRA, PLA and PTD.

Unit 6: Programme Planning, Evaluation & Diffusion and Adoption of Innovations

Concept, steps, principles and theories of programme planning. Steps in programme planning for agriculture and livestock development, organizing campaigns, mass vaccination programmes and variety of extension activities, evaluation of veterinary extension programmes, compilation and report writing. Evaluation of agriculture and animal husbandry development programmes and schemes. Monitoring and evaluation – concept, significance, types, methods and tools. Theoretical models of programme planning. Felt needs; need-based programmes. Social action. Five Year Plans – critical analysis with special reference to programmes for women, children and youth. SWOT/TOWS analysis of development programmes. Concept and elements of diffusion and adoption for social change. Diffusion process, adoption process, models of diffusion and adoption, adopter categories and their characteristics. Factors influencing adoption and attributes of innovations. Concept and stages of Innovation-decision process, consequences of innovations.

Unit 7: Extension Management

Concept and principles of administration and management, classical and modern theories, schools of management thought. Functions of management – planning, organizing, staffing, directing and leading, controlling, coordinating, reporting and budgeting. Types and methods of administrative communication. Decision-making in organization. Organizational effectiveness, organizational climate, organizational behaviour, organizational development, job satisfaction and morale. Time management. Performance appraisal. Coordination at different levels of extension management, methods of coordination. Management by Objective (MBO) and Total Quality Management (TQM). Project Evaluation and Review Technique (PERT). Logical Frame Working (LFW) and Project Management Techniques. Personal management, scope of Agribusiness Management and Institutions - National Institute of Agricultural Extension and Management (MANAGE). Indian Institute of Plantation Management (IIPM), NIRD, EEl and NAARM. Monitoring, evaluation and impact analysis of extension programmes. Critical analysis of organizational set up of extension administration at various levels. Agricultural Technology Information Centers (ATIC). Technology Parks. Management Information System. Management of Agricultural Knowledge System (MAKS) and use of Expert System. Traditional media for communication in development programmes. Problem Solving Techniques / Negotiation , Motivational Theories & Techniques, Work motivation Organizational climate; Resource management: concept and methods; Team building: process and strategies at organizational and village levels. Mobilization and empowerment skills: concept and strategies in mobilization, concretisation and empowerment of rural people.

Unit 8: Entrepreneurial Development

Concept, significance and scope. Programmes and agencies promoting entrepreneurship. Types and techniques of training for developing entrepreneurial activities in various areas. Self Help Groups – concepts, organization, mobilization, micro-finance and functioning of SHG for empowerment and sustainability. Agripreneurship-agriclinics and agribusiness centers. International cooperation in agriculture - SAIC, Commonwealth, FAO, USAID, DFID and CGIAR system. Critical analysis of extension systems of SAARC, BRICS and other selected countries (USA, UK, Japan, Philippines, Israel etc.).

Unit 9: Developmental Strategies and Issues in Extension

Extension policies. National Agricultural Extension System and Networking of State development Departments, NARS, NGOs, Farmers Organizations, producers companies, agricultural cooperatives, rural banks, insurance and private sectors. History of Agriculture and Veterinary extension programmes- NPCBB, PM assistance livestock development programmes and rural development programmes. Developmental strategies such as Watershed Development Programmes; Technology Mission, Horticulture Mission. Front Line Extension Programmes of ICAR/TAR-IVLP, NATP, NAIP, IRDP, ATMA, ITD, SREP, Research-Extension-Farmer-Interface. Identification, characterization, documentation and validation of ITKs. Privatization of extension, market led extension, production to consumption and end to end innovative approaches. Issues related to globalization and IPR. Rural, Agricultural, Animal Husbandry, Dairy and Women Developmental Programmes implemented by Govt. of India. Krishi Vigyan Kendras (KVKs).

Unit 10: Gender Sensitization and Empowerment

Gender and empowerment: meaning, gender related definitions and importance for empowering women; need and focus on gender sensitization, gender in community diversity and its implication for empowerment. Gender perspectives in development of women, social characteristics, roles, responsibilities, resources, constraints, legal issues and opportunities; economical, educational and other parameters. Gender tools and methodologies: Dimensions and methodologies for empowerment; gender budgeting; gender analysis framework- context, activities, resources and programme action profile; technologies and empowerment - gender specific technologies, household technology interface, socio-cultural interface and women as consumer of technologies. Gender issues and development: health and nutrition, violence, governance, education and media, Gender Audit.

16. AGRICULTURAL STATISTICS

(16.1 Agricultural Statistics)

16.1 AGRICULTURAL STATISTICS

Unit 1: Statistical Methods I

Descriptive statistics. Elements of probability theory, conditional probability, Bayes' theorem. Random variable-discrete and continuous. Mathematical expectation. Moment generating and characteristic functions. Laws of large numbers. Central limit theorem. Discrete probability distributions-binomial, Poisson, negative binomial and hypergeometric. Continuous probability distributions-normal, rectangular, Cauchy exponential, gamma and beta. Sampling distributions-chi-square, t, and F. Bivariate normal distribution-conditional and marginal.
Point estimation-unbiasedness, consistency, efficiency, sufficiency. Completeness Minimum variance unbiased estimator. Cramer-Rao Inequality. Rao-Blackwell theorem and Lehman-Scheffe theorem. Methods of point estimation like Maximum likelihood, Moments, Minimum chi-square. Confidence interval estimation. Testing of hypotheses -two types of errors, level of significance and power of a test. Neyman-Pearson Lemma. Uniformly most powerful tests and their construction. Unbiased test, Likelihood ratio test. Tests of significance based on Z, t, chi-square and F distributions.

Unit 2: Statistical Methods II

Correlation, rank correlation, correlation ratio, intra-class correlation. Simple and multiple regression analysis, partial and multiple correlation. Examination of residuals. Model-adequacy, Selecting best regression. Order statistics. Non-parametric tests-run, sign, rank, Wilcoxon, Kruskal-Wallis, Mann-Whitney, Cochran and Friedman's tests. Contingency tables. Log linear models. Sequential analysis sequential probability ratio test. Elements of stochastic processes. Multivariate normal distribution-estimation of mean vector and dispersion matrix. Wishart distribution, Hotelling T2, multivariate analysis of variance, principal component analysis, factor analysis, discriminant analysis, cluster analysis.

Unit 3: Statistical Genetics I

Statistical analysis of segregation, detection and estimation of linkage. Gene and genotypic frequencies. Random mating and equilibrium in large populations. Disequilibrium due to linkages for two pairs of genes and for sex linked genes. Selection, mutation and migration. Equilibrium between forces in large population. Polymorphism. Fisher's fundamental theorem of natural selection. Polygenic systems for quantitative characters, Concepts of breeding value, dominance, average effect of gene and epistatic interactions.

Unit 4: Statistical Genetics II

enetic variance and its partitioning. Correlation between relatives. Regular system of inbreeding, effects of inbreeding. Genotype and environment interaction, stability parameters. Estimation of heritability, repeatability and genetic correlation. Path coefficient analysis. Heterosis, concepts of general and specific combining abilities. Diallel crosses and line × tester analysis. Response due to selection. Prediction of response to individual, family and combined selections. Construction of selection index.

Unit 5: Design of Experiments I

Linear models-Random, fixed and mixed effects. Nested and crossed classifications. Gauss-Markoff theorem. Analysis of variance. Principles of design of experiments. Uniformity trials. Completely randomized design. Randomized complete block design. Latin square design. Factorial experiments-2n and 3n series and asymmetrical factorial experiments, confounding in 2n and 3n experiments, split and strip-plot designs, change over designs. Missing plot techniques. Analysis of covariance. Variance stabilizing transformations.

Unit 6: Design of Experiments II

Balanced incomplete block designs and their analysis with and without recovery of inter block information. Partially balanced incomplete block designs with two associate classes, lattice designs. Youden square design. Multiple comparison procedures. Fractional replication of symmetrical factorials, confounding in asymmetrical factorial experiments. Response surface designs, second order rotatable designs. Combined analysis of groups of experiments. Sampling in field experiments. Experiments on cultivators' fields.

Unit 7: Sample Surveys I

Sampling versus complete enumeration. Concept of probability sampling. Simple random sampling. Stratified sampling, allocation in stratified sampling, choice of strata, construction of strata boundaries and collapsing of strata. Use of auxiliary information in sample surveys, ratio and regression methods of estimation. Systematic sampling. Cluster and multi-stage sampling with equal probability.

Unit 8: Sample Surveys II

Sampling with unequal probabilities with and without replacement, sampling schemes with inclusion

probabilities proportional to size. Unbiased ratio type of estimators, Double sampling, sampling on successive occasions, inverse sampling. Non-sampling errors-sources and classification. Non-response in surveys interpenetrating sub-samples, randomized response techniques, imputation methods. Design and organization of pilot and large scale surveys. National sample surveys. Agricultural statistics system in the country-land use statistics, crop estimation surveys, livestock and fishery statistics.

Unit 9: Computer Applications

Computer Organization and Architecture- number system, input/output unit, memory, arithmetic logic unit and control unit. Computer algorithms. Programming in C-Building blocks, control structures, arrays, pointers, dynamic memory allocation, file management. Data Structures linked list, stack, queue, tree, graph, sorting and searching algorithms. Data Base Management System-definition and features, data models, relational database. Object oriented programming-encapsulation, inheritance, polymorphism with C++/JAVA. Networking-need, basic concepts, types of networks. Connecting computers-local area networks, wide area networks. Value added network services-E-mail, on-line services, Internet, etc. Hyper Text Markup Language (HTML), Building static and dynamic web pages.

Numerical analysis interpolation, numerical integration, solution of ordinary differential equations, solution of linear and non-linear system of equations. Modeling and simulation-random number generation and testing, discrete simulation models, simulation of stochastic events and processes, design of simulation experiments, analysis of data generated by simulation experiments, validation of simulation models. Linear Programming formulation and graphical solution, simplex method, duality, transportation and assignment problems.

NOTE 4: The syllabus mentioned above is illustrative only. Questions relating to recent/current developments taking place in agriculture and allied sciences in general and in the concerned subject areas in particular can also be included in the question papers as may be deemed appropriate by subject-paper experts.

ANNEXURE II

Employmentstatusofin-servicecandidates

Institutes/Agric.Universities/Other	Code Number
ICARInstitutesandICARInstitutebasedDeemed-to-be-Universities	01
StateAgriculturalUniversitiesincludingVeterinary/Horticulture/ FisheriesUniversities, CAUandCUshavingfacultyofagriculture	02
CentralGovernmentDepartmentsdealinginagricultureandalliedsectors	03
StateGovernmentDepartmentsdealinginagricultureandallied sectors	04
PublicSectorUndertakingdealinginagricultureandalliedsectors	05
Any other Govt. organization	06

Annexure-III

FORMAT OF THE CERTIFICATE FOR PHYSICALLY CHALLENGED (PC)/PERSONS WITH DISABILITY (PD)
NAME & ADDRESS OF THE INSTITUTE/HOSPITAL ISSUING THE CERTIFICATE

Certificate No. :

Date:

Affix Recent Passport size Attested Photograph here

CERTIFICATE FOR PERSONS WITH DISABILITIES

This is to certify that Shri/Smt/Kum*) _____ son/daughter* of Shri _____ Age_____ years, Registration No. _____ is a case of Locomotor disability/Cerebral Palsy/Blindness/Low vision/Hearing impairment/Other disability* and has been suffering from degree of disability not less than _____ % (_____). The details of his/her above mentioned disability is described below:
(IN CAPITAL LETTERS)

_____

_____

_____

Note:-

1. This condition is progressive/non-progressive/likely to improve/not likely to improve.*
2. Re-assessment is not recommended/is recommended after a period of _____ months/years.
3. The certificate is issued as per PWD Act, 1995.

* Strike out whichever is not applicable.

Sd/-	**Sd/-**	**Sd/-**
(DOCTOR)	**(DOCTOR)**	**(DOCTOR)**
Seal	**Seal**	**Seal**

Signature/Thumb impression of the person

Countersigned by the
Medical Superintendent/CMO/
Head of Hospital (With Seal)

ANNEXURE-IV

List of Accredited Universities along with the Contact Details of Registrars for Seeking Admission to Ph.D. Degree Programme

S. No.	Name & Address of University	Tel. No. of Registrar with STD Code	Fax No. of Registrar
A.	**STATE AGRICULTURAL/ VETERINARY UNIVERSITIES**		
1.	Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-500 030 (A.P.)	040-24015122	040-24018653
2.	Anand Agricultural University, Anand-388 110 (Gujarat)	02692-261310	02692-261310
3.	Assam Agricultural University, Jorhat-785013 (Assam)	0376-2340008	0376-2340001
4.	Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia-741 252 (West Bengal)	033-25878163	03473-222277
5.	Bihar Agricultural University, Sabour, Distt. Bhagalpur-813210 (Bihar)	0641-2452614	0641-2452614
6.	Birsa Agricultural University, Kanke, Ranchi-834006 (Jharkhand)	0651-2450832	0651-2450850
7.	C.S. Azad University of Agri. & Technology, Kanpur-208 002 (U.P.)	0512-2533704	0512-2533808
8.	Chhattisgarh Kamdhenu Vishwavidyalaya, Anjora, Durg-491001 (C.G.)	0771-4223613	0771-4223611
9.	Dr. Yashwant Singh Parmar Univ. of Horticulture & Forestry, Solan, Nauni-173 230 (H.P.)	01792-252219	01792-252009
10.	G.B. Pant University of Agri. & Technology, Pantnagar, Distt. Udham Singh Nagar-263 145 (Uttarakhand)	05944-233640	05944-233640
11.	Jawaharlal Nehru Krishi Viswavidyalaya, Adhartal, Jabalpur-482 004 (M.P.)	0761-2681778	0761-2681778
12.	Junagadh Agricultural University, Junagadh-362 001 (Gujarat)	0285-2672346	0285-2672482
13.	Kerala Agricultural University, Vellanikara, Thrissur-680 656 (Kerala)	0484-2348043, 2703782	0484-2700337
14.	Kerala Veterinary & Animal Sciences University, Pookot Wayanad -673576 (Kerala)	04936-209220, 21	04936-256650
15.	Lala Lajpat Rai University of Veterinary and Animal Science, Hisar (Haryana)	01662-270164, 289764	01662-270164
16.	Maharana Pratap University of Agriculture & Technology, Udaipur-313 001 (Rajasthan)	0294-2471302	0294-2471302
17.	Nanaji Deshmukh Pashu Chikitsa Vigyan Viswavidyalaya, Jabalpur-482001 (MP)	0761-2620545	0761-2620783
18.	Navsari Agricultural University, Eru Char Rasta, Vijalpore, Navsari-396 450 (Gujarat)	02637-282823	02637-283794
19.	Orissa University of Agriculture & Technology, Siripur, Bhubaneswar, Khurda, 751 003 (Odisha)	0674-2397424	0674-2397424
20.	Prof. Jayashankar Telangana State Agricultural University, Hyderabad-500030, Telangana	040-24013092, 24002314	040-24002324
21.	Punjab Agricultural University, Ludhiana-141 004 (Punjab)	0161-2400955	0161-2400955
22.	Rajasthan University of Veterinary and Animal Sciences, Bijay Bhawan Palace Complex, Bikaner-334006 (Rajasthan)	0151-2540028	0151-2540028
23.	Sardarkrushinagar-Dantiwada Agricultural University, Sardarkrushinagar, Distt. Banaskantha-385 506 (Gujarat)	02748-278226	02748-278234
24.	Sardar Vallabh Bhai Patel Univ. Of Agriculture &Technology, Modipuram, Meerut-250 110 (U.P.)	0121-2888502	0121-2888525

25.	Sher-e-Kashmir University of Agril. Sciences & Technology, Main Campus, Chatha, Jammu-180 009 (J&K)	0191-2262012	0191-2262012
26.	Sher-e-Kashmir Univ. of Agril. Sciences & Technology of Kashmir, Shalimar Campus, Srinagar-190 025 (J&K)	0194-2461271	0194-2461271
27.	Swami Keshwanand Rajasthan Agricultural University, Bikaner-334 006 (Rajasthan)	0151-2250292	0151-2250292
28.	Tamil Nadu Fisheries University, First Line Beach Road, Nagapattinam-611001 (Tamil Nadu)	04365-240088	04365-240087
29.	Tamil Nadu Veterinary & Animal Sciences University, Chennai-600 051 (Tamil Nadu)	044-25551584	044-25551585
30.	University of Agricultural Sciences, GKVK, Bengaluru-560 065(Karnataka)	080-23330984	080-23330277
31.	University of Agricultural and Horticultural Sciences, No. 126, Navile, Shivamogga -577204 (Karnataka)	08182-267001	08182-267011
32.	University of Agricultural Sciences Dharwad-580005, Karnataka	0836-2747958	0836-2745276
33.	University of Horticultural Sciences, Sector No. 60, Navanagar, Bagalkot-587102. Karnataka.	08354-230276	08354-230300
34.	UP Pandit Deen Dayal Upadhaya Pashu Chikitsa Vigyan Vishwa Vidyalaya Evam Go Anusandhan Sansthan, Mathura-281 001 (U.P.)	0565-2471178	0565-2470819
35.	West Bengal University of Animal & Fishery Sciences, 68 KB Sarani, Belgachia, Kolkata-700 037(West Bengal)	033-25563123	033-25563123
36.	Allahabad School of Agriculture, Allahabad, Sam Higginbottom University of Agriculture,Technology & Science, Allahabad (U.P.) - 211007	0532-2684781	0532-2684394
37.	Sri Venkateswara Veterinary University, Tirupati, (AP)-517502	08772-248894	08772-248881
38.	Faculty of Fisheries, Kerala University of Fisheries & Ocean Studies, Kochi Kerala-682506	0484-2703782	0484-2703782
B.	**CENTRAL AGRICULTURAL UNIVERSITY**		
39.	Central Agricultural University, P.O. Box 23, Imphal-795 004 (Manipur)	0385-2410644	0385–2415196
40.	Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur-848 125 (Bihar)	06274-240239	06274-240277
C.	**CENTRAL UNIVERSITIES WITH AGRICULTURE FACULTY**		
41.	Banaras Hindu University (Institute of Agricultural Sciences), Varanasi-221 005 (U.P.)	0542-2368556	0542-2369425
42.	Nagaland University (School of Agril. Sciences & Rural Development), Medziphema-797 106 (Nagaland)	0369-2268270	0369-2268223

ANNEXURE-V

Proforma of Caste Certificate for
Scheduled Caste/Tribe Candidate

1. This is to certify that Shri/Smt/Kumari ..... Date of Birth ..... Son/Daughter of.....of village/town ..... in District/Division of State/Union Territory ..... belongs to the ..... Caste/Tribe which is recognized as SC/ST under: The Constitution (Scheduled Castes) Order, 1950. The Constitution (Scheduled Tribes) Order, 1950.The Constitution (Scheduled Castes) (Union Territories) Order, 1951. The Constitution (Scheduled Tribes) (Union Territories) Order. 1951,
   [As amended by the SCs and STs Lists (Modification) Order. 1956; The Bombay Reorganization Act, 1960; The Punjab Reorganization Act, 1966; The State Of HP Act, 1970; The North Eastern Areas (Reorganization) Act, 1971; The SCs and STs Order (Amendment) Act, 1976 and The Scheduled Castes and Scheduled Tribes Orders (Amendment) Act, 2002].
   The Constitution (Jammu & Kashmir) SC Order, 1956. The Constitution (Andaman & Nicobar Islands) SC Order 1959 as amended by SCs and STs Order (Amendment) Act, 1976. The Constitution (Dadra And Nagar Haveli) SCs Order, 1962. The Constitution (Dadra And Nagar Haveli) STs Order, 1962. The Constitution (Pondicherry) SCs Order, 1964. The Constitution Scheduled Tribes (Uttar Pradesh) Order. 1967. The Constitution (Goa, Daman & Diu) SCs Order, 1968. The Constitution (Goa, Daman & Diu) STs Order, 1968. The Constitution (Nagaland) STs Order. 1970. The Constitution (Sikkim) SCs Order, 1968. The Constitution (Sikkim) STs Order, 1968. The Constitution (Jammu and Kashmir) Scheduled Tribes Order, 1989; The Constitution (Scheduled Castes) Order (Amendment) Act, 1990; The Constitution (Scheduled Tribes) Order (Amendment) Act, 1991; The Constitution (Scheduled Tribes) Order (Second Amendment) Act, 1991 or any such Govt. of India directive applicable at the time of declaration of result.

2. Shri/Smt/Kumari ..... and/or his/her family ordinarily reside(s) in Village/ Town ..... of District ..... of State/Union Territory of .....

3. Applicable in the case of SC/ST persons who have migrated from State/Union Territory Administration to another State/Union Territory.

   The certificate is issued on the basis of the SC/ST Certificate to Shri/Smt. ..... father/mother of Shri/Smt/Kumari ..... of Village/Town ..... in District/Division ..... of the State/Union Territory ..... who belongs to the ..... Scheduled Caste/Scheduled Tribe in the State/Union Territory issued by the ..... (Name of the prescribed authority) *vide* No ..... Dated .....

Signature
Designation (With Seal of Office)

Place ..... (State/Union Territory)
Date .....

*Please delete the words which are not applicable. Please quote specific Presidential Order.

Note: The term ordinarily reside(s) used here will have the same meaning as in section 20 of the Representation of the People Act, 1950.

List of Authorities Empowered to Issue SC/ST Certificates

1. District Magistrate/Additional District Magistrate/Collector/Deputy Commissioner/Additional Deputy Commissioner/Deputy Collector/1st Class Stipendiary Magistrate/City Magistrate/Sub-divisional Magistrate/Taluka Magistrate/Executive Magistrate/Extra Assistant Commissioner not below the rank of 1st class Stipendiary Magistrate.
2. Chief Presidency Magistrate/Additional Chief Presidency Magistrate/Presidency Magistrate
3. Revenue Officers not below the rank of Tehsildar
4. Sub-divisional Officer of the area where the candidate and/or his family normally resides
5. Administrator/Secretary to Administrator/Development Officer (Lakshadweep Islands)

Certificate issued by any other authority will be rejected.

ANNEXURE-VI

Proforma of Certificate to be Produced by Other Backward Classes-Non Creamy Layer [OBC (NCL)] Applying for Admission to Central Educational Institutions (CEIs), Under the Government of India

This is to certify that Shri/Smt./Kum..... Son/Daughter of Shri/Smt. ..... of Village/Town..... District/Division .....in the..... State belongs to the ..... Community which is recognized as a backward class under:

(i) Resolution No. 12011/68/93-BCC(C) dated 10/09/93 published in the Gazette of India Extraordinary Part I Section I No186 dated 13/09/93.
(ii) Resolution No. 12011/9/94-BCC dated 19/10/94 published in the Gazette of India Extraordinary Part I Section I No. 163 Dated 20/10/94.
(iii) Resolution No. 12011/7/95-BCC dated 24/05/95 published in the Gazette of India Extraordinary Part I Section I No. 88 Dated 25/05/95.
(iv) Resolution No. 12011/96/94-BCC dated 9/03/96.
(v) Resolution No. 12011/44/96-BCC dated 6/12/96 published in the Gazette of India Extraordinary Part I Section I No. 210 Dated 11/12/96.
(vi) Resolution No. 12011/13/97-BCC dated 03/12/97.
(vii) Resolution No. 12011/99/94-BCC dated 11/12/97.
(viii) Resolution No. 12011/68/98-BCC dated 27/10/99.
(ix) Resolution no. 12011/88/98-BCC dated 6/12/99 published in the Gazette of India Extraordinary Part I Section I No. 270 dated 06/12/99.
(x) Resolution no. 12011/36/99-BCC dated 04/04/2000 published in the Gazette of India Extraordinary Part I Section I No. 71 dated 04/04/2000.
(xi) Resolution no. 12011/44/99-BCC Dated 21/09/2000 published in the Gazette of India Extraordinary Part I Section I No. 210 dated 21/09/2000.
(xii) Resolution no. 12015/9/2000-BCC dated 06/09/2001.
(xiii) Resolution no. 12011/1/2001-BCC dated 19/06/2003.
(xiv) Resolution no. 12011/4/2002-BCC dated 13/01/2004.
(xv) Resolution no. 12011/9/2004-BCC dated 16/01/2006 published in the Gazette of India Extraordinary Part I Section I No. 210 dated 16/01/2006.
(xvi) Resolution no. 12011/14/2004-BCC dated the 12th March, 2007, published in the Gazette of India-Extraordinary-Part I, Section 0-I, No.67 dated 12th January, 2007.
(xvii) Resolution No. 12015/2/2007-BCC dated 18/08/2010.
(xviii) Resolution No. 12015/13/2010-BCC dated 08/12/2011.
(xix) Resolution No. 12012/05/2011-BCC dated 17/02/2014
(xx) Resolution No. 20012/129/2009-BC-II dated 04/03/2014

Shri/Smt./Kum .....and/or his family ordinarily reside(s) in the .....District/Division of.....State. This is also to certify that **he/she does not belong to the persons/sections (Creamy Layer)** mentioned in Column 3 of the Schedule to the Government of India, Department of Personnel & Training O.M. No. 36012/22/93-Estt.(SCT) Dated 08/09/93 which is modified vide OM No. 36033/1/2013 Estt.(Res.) dated 27/05/2013.

Dated:……..……..

District Magistrate/
Deputy commissioner, etc.
Seal

Note:

(a) The term 'Ordinarily' used here will have the same meaning as in Section 20 of the Representation of the People Act, 1950.
(b) The authorities competent to issue Caste Certificate are indicated below:
    (i) District Magistrate/Additional Magistrate/Collector/Deputy Commissioner/Additional Deputy Commissioner/Deputy Collector/Ist Class Stipendiary Magistrate/Sub-Divisional Magistrate/Taluka Magistrate/Executive Magistrate/Extra Assistant Commissioner (Not Below The Rank of I Class Stipendiary Magistrate).
    (ii) Chief Presidency Magistrate/Additional Chief Presidency Magistrate/Presidency Magistrate.
    (iii) Revenue Officer not below the rank of Tehsildar and
    (iv) Sub-Divisional Officer of the area where the candidate and/or his family resides.

Declaration/undertaking - for OBC (NCL) candidates only

I, ...son/daughter of Shri ..... resident of Village/Town/City.....District .....State hereby declare that I belong to the.....Community which is recognized as a Backward Class by the Government of India for the purpose of reservation in services as per orders contained in Department of Personnel and Training Office Memorandum No.36012/22/93- Estt.(SCT), dated 8/9/1993. It is also declared that I do not belong to persons/Sections (Creamy Layer) mentioned in Column 3 of The Schedule to the above referred Office Memorandum, Dated 8/9/1993, which is Modified vide Department of Personnel and Training Office Memorandum No. 36033/1/2013 Estt.(Res.) dated 27/05/2013.

Signature of the Candidate

Place: .....

Date: .....

- **Declaration/undertaking not signed by candidate will be rejected.**
- **False declaration will render the applicant liable for termination of registration at any time.**

Creamy Layer Definition
OBC (NCL) Creamy layer is defined comprehensively at http://ncbc.nic.in/html/creamylayer.html

All candidates for the OBC (NCL) reserved seats should make sure that they do not satisfy any of the creamy layer criteria as listed in the website. Some general exclusion for quick reference (no way comprehensive) are as follows.

1. Any of the parents holds a constitutional position in Govt. of India
2. Any one of the parents is a Class I officer.
3. Both the parents are Class II officers.
4. Any one of the parents is employed in an equivalent rank to Class I officer or both parents equivalent to Class II officer in a public sector, insurance companies, banks, universities or in other organizations
5. Land holdings on irrigated land is 85% or more of the statutory ceiling area.
6. Parents income is more than Rs.6 lakhs per year or Government of India directives applicable at the time of last date of receipt of application.

ANNEXURE-VII

SPONSORSHIPCERTIFICATE

DECLARATIONBYTHEEMPLOYEROFTHECANDIDATE
(FORIN-SERVICECANDIDATES)

[Inthecaseofemployed(in-service)candidate,admissionshallonlybegrantedoncompletingthis declaration in full by the Employer/Head of the Institution. It should be produced at the time of admission]

(i) CertifiedthattheparticularsfilledbyMr./Shri/Kumari .....son/daughterof.....inthea pplicationformhavebeen verifiedandfoundcorrect.

(ii) Thecandidatewillbegranteddeputationleave/studyleave/extraordinaryleaveorhe/shewillbegiven ascholarshiporstipendofthevalueofRs.....permonth.Oncompletionofthetraining,he/shewill berequiredtoservethisdepartment/institute/universityforaperiodof.....years.

(iii) Ifselectedforadmission,thecandidatewillberelievedtojointhecourseonthedateofstartofsession intheuniversitywhenadmitted.

(iv) Ifselectedfortheawardoforotherfellowship,therewillbenoobjectionforhis/herreceivingthescholarship andcontingencyamountsattachedtheretosubjecttothefollowingconditions:

(a) .....
(b) .....
(c) .....

(v) CertifiedthatIamcompetenttotakethedecisiontosponsorhim/heronthetermsandconditions mentionedabove/thedecisiontosponsorhim/herontheabovetermsandconditionshasbeentakenby andisbeingcommunicatedunderthedirectionofwhoisthecompetentauthority.

(vi) Thisuniversity/organization/departmentundertakestopayduesoutstandingagainstthecandidateifnot paidby him.

(vii) Any other relevant information:

SIGNATURE.....

DESIGNATION.....

ADDRESS .....

.....

(WITHOFFICIALSEAL)

Annexure VIII

Domicile State Codes for AICE-JRF/SRF (PGS)-2018*

State/UnionTerritory	Code No.
Andaman&Nicobarislands(UT)	01
AndhraPradesh	02
ArunachalPradesh	03
Assam	04
Bihar	05
Chandigarh(UT)	06
Chhatisgarh	07
Dadra&NagarHaveli,(UT)	08
Daman&Diu(UT)	09
Delhi	10
Goa	11
Gujarat	12
Haryana	13
HimachalPradesh	14
Jammu&Kashmir	15
Jharkhand	16
Karnataka	17
Kerala	18
Lakshadweep(UT)	19
MadhyaPradesh	20
Maharashtra	21
Manipur	22
Meghalaya	23
Mizoram	24
Nagaland	25
Odisha	26
Puducherry(UT)	27
Punjab	28
Rajasthan	29
Sikkim	30
TamilNadu	31
Tripura	32
UttarPradesh	33
Uttarakhand	34
WestBengal	35
Telangana	36

*** Required to be filled in Online application**

Annexure-IX

List of SAUs/DUs/CAU/CUs from where graduated/post graduated*

Sl. No.	State Agricultural Universities	Code Name	Code
1.	AssamAgriculturalUniversity,Jorhat-785013	AAU	01
2.	AcharyaNGRangaAgriculturalUniversity,Hyderabad-500030	ANG	02
3.	SriVenkateswaraVeterinaryUniversity,Tirupati-517502	SVV	03
4.	Dr. YSR Horticultural University,Venkataramannagudem, WestGodavari-534101(A.P.)	AHU	04
5.	Dr. Rajendra Prasad Central AgriculturalUniversity,Pusa-848125	DRU	05
6.	IndiraGandhiKrishiVishwavidyalaya,Raipur-492012	IGK	06
7.	AnandAgriculturalUniversity,Anand-388110	AND	07
8.	JunagarhAgriculturalUniversity,Junagarh	JAU	08
9.	NavsariAgriculturalUniversity,Navsari-396450	NAU	09
10.	SardarKrushinagarDantiwadaAgriculturalUniversity,Dantiwada-385 506	SDA	10
11.	ChaudharyCharanSinghHaryanaAgriculturalUniversity,Hisar-125004	HAU	11
12.	Ch.SarwanKumar HP KrishiViswaVidyalaya,Palampur-176062	HPK	12
13.	Dr.YashwantSinghParmarUniversityofHorticulture&Forestry, Solan-173230	YSP	13
14.	Sher-e-KashmirUniversityofAgriculturalSciences&Technology,Jammu-180012	SKJ	14
15.	Sher-e-KashmirUniversityofAgriculturalSciences&Technology,Srinagar-191121	SKS	15
16.	BirsaAgriculturalUniversity,Ranchi-834006	BAU	16
17.	UniversityofAgriculturalSciences,Bangalore-560065	UAB	17
18.	UniversityofAgriculturalSciences,Dharwad-580005	UAD	18
19.	KarnatakaVeterinary,AnimalandFisheriesSciencesUniversity,Bidar-585401	KVA	19
20.	KeralaAgriculturalUniversity,Thrissur-680656	KAU	20
21.	JawaharlalNehruKrishiVishwavidyalaya,Jabalpur-482004	JNK	21
22.	RajmataVijayarajeScindiaKrishiVishwavidyalaya,Gwalior-474002,M.P.	RVG	22
23.	DrBalasahebSawantKonkanKrishiVidyapeeth,Dapoli-415712	KKV	23
24.	MaharashtraAnimal&FisheriesSciencesUniversity,Nagpur-440006	MAS	24
25.	Vasantrao Naik MarathwadaKrishi Vidyapeeth,Parbhani-431402	MAU	25
26.	MahatmaPhuleKrishiVidyapeeth,Rahuri-413722	MPK	26
27.	DrPanjabraoDeshmukhKrishiVishwavidyalaya,Akola-444104	PDK	27
28.	OrissaUniversityofAgriculture&Technology,Bhubaneshwar-751003	OUA	28
29.	PunjabAgriculturalUniversity,Ludhiana-141004	PAU	29
30.	GuruAngadDevVeterinaryandAnimalSciencesUniversity, Ludhiana-141004	GAD	30
31.	MaharanaPratapUniversityofAgriculture&Technology,Udaipur-313001	MPU	31
32.	SwamiKeshwanandRajasthanAgriculturalUniversity,Bikaner-334016	RAB	32
33.	TamilNaduAgriculturalUniversity,Coimbatore-641003	TNA	33
34.	TamilNaduVeterinary and AnimalSciencesUniversity,Chennai-600051	TNV	34
35.	Chandra Shekhar Azad University of Agriculture & Technology, 36 Kanpur-208 002	CSA	35
36.	UP Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwa Vidyalaya, Evam Go Anusandhan Sansthan, Mathura-281 001	UPP	36
37.	Narendra DevaUniversityofAgriculture&Technology,Faizabad-224229	NDU	37
38.	SardarVallabhBhaiPatelUniversityof Agriculture&Technology,Modipuram, Meerut-250110	SVB	38
39.	GovindBallabhPantUniversityofAgriculture&Technology, Pantnagar-263145	GBP	39
40.	BidhanChandraKrishiViswavidyalaya,Mohanpur-741252	BCK	40
41.	UttarBangaKrishiVishwavidyalaya,Coochbehar-736165	UBK	41
42.	WestBengalUniversityofAnimal&FisherySciences,Kolkata-700037	WBU	42

43.	KeralaUniversityofFisheriesandOceanStudies,Panangad,Kochi-682506	KUF	43
44.	KeralaVeterinaryandAnimalSciencesUnive rsity,Pookot,Wayanad-673576	KVS	44
45.	LalaLajpatRaiUniversityofVeterinary& AnimalSciences,Hisar,(Haryana)	LLR	45
46.	RajasthanUniversityofVeterinary&AnimalSciences,BijayBhawan PalaceComplex,NearPt.DeendayalCircle,Bikaner-334006(Rajasthan)	RVB	46
47.	Bihar AgriculturalUniversity,Sabour–813210, Bhagalpur	BAS	47
48.	Nanaji DeshmukhPashuChikitsaVigyanVishwavidyalaya,Jabalpur-482004	NDV	48
49.	UniversityofHorticulturalSciences,Sector #60,Navanagar,Bagalkot-587102	UHB	49
50.	University of Agricultural Sciences, Raichur-584102	UAR	50
51.	Banda University of Agriculture & Technology, Banda-210001(U.P)	BUA	51
52.	Uttarakhand University of Horticulture & Forestry, Bharsar, Pauri Garhwal (Uttarakhand)	UUH	52
53.	Chhattisgarh Kamdhenu Vishwavidhyalaya, Raipur-492012	CKV	53
54.	Tamil Nadu Fisheries University ,Nagapattinam, Camp Office Madras Veterinary College Veperi , Chennai-600007(Tamil Nadu)	TNF	54
55.	University of Agricultural and Horticultural Science , No. 126, Navile, Shimoga-577204(Karnataka)	UAH	55
56.	Shri Karan Narendra Agriculture University, Jobner-303329(Rajasthan)	SKN	56
57.	Agricultural University, Jodhpur-342304 (Rajasthan)	AUJ	57
58.	Agricultural University, Kota Borkhera, Baran Road, P.B. No. 20, Kota-324001 (Rajashtan)	AUK	58
59.	Prof. Jayashankar Telangana State Agricultural University, Hyderabad-500030, Telangana	PJT	59
60.	Sri P.V. Narsimha Rao Telangana State University for Veterinary, Animal and Fisheries Sciences, Administrative Office Rajendranagar, Hyderabad-500030	SPV	60
61.	Sri Konda Laxman Telangana State Horticultural University Rajendranagar, Hyderabad (Telangana)	SKL	61
62.	Kamdhenu University, Karmayogibhavan, Block-1, Wing-B1, 4th Floor, Sector-10-A, Gandhinagar-382010 (Gujarat)	KUG	62
	ICARDeemed-to-beUniversities		
63.	IndianAgriculturalResearchInstitute,NewDelhi-110012	IAR	63
64.	IndianVeterinaryResearchInstitute,Izatnagar-243 122, Bareilly	IVR	64
65.	NationalDairyResearchInstitute,Karnal-132001	NDR	65
66.	CentralInstituteofFisheriesEducation,Mumbai-400061	CIF	66
	Deemed-to-beUniversities		
67.	SamHigginbottomInstituteofAgricultureTechnology&Sciences,Naini, Allahabad-211007	SHT	67
	CentralUniversitieshavingfacultyofAgriculture		
68.	AligarhMuslimUniversity,Aligarh	AMU	68
69.	BanarasHinduUniversity,Varanasi	BHU	69
70.	VisvaBharati(PalliSikshaBhavana),P.O.Sriniketan–731 236, Birbhum	VIB	70
71.	NagalandUniversity(SchoolofAgriculturalSciencesandRuralDevelopment) Medziphema-797106	NAG	71
	Central Agricultural University		
72.	CentralAgriculturalUniversity,Imphal,Manipur-795004	CAU	72
73.	Rani Lakshmibai Central Agricultural University, Jhansi	RLB	73
74.	Others	OTH	99

*** Required to be filled in Online application**

Note: In case any degree from a particular college/university is not considered for admission by an Agricultural University or any particular college/university has been derecognized by VCI/UGC, ICAR will not be responsible for admitting students of that college/university in the Universities not willing to admit such candidates.

Annexure-X A

Stream in Post Graduate Degree*

(Only the candidates with 4/5(BVSc&AH)/6 years'(10+6, BSc. Ag) UG degree and 2 years' PG degree with thesis work are eligible for admission to doctoral degree programme)

StreaminPostgraduatedegree	**Code No.**
Plant Biotechnology	01
Plant Science	02
Physical Science	03

Entomology and Nematology	04
Agronomy	05
Social Science	06
Statistical Science	07
Horticulture	08
Forestry/Agroforestry and Silviculture	09
Agricultural Engineering and Technology	10
Water Science and Technology	11
Home Science	12
Animal Biotechnology	13
Veterinary Science	14
Animal Science	15
Fisheries Science	16
Dairy Science	17
Dairy Technology	18
Food Science Technology	19
Agri-Business Management	20
Basic Science	21
Anyother(specify)	22

Annexure-X B

College of Postgraduation*

Collegefromwhichpost-graduationwascompleted	**Code**
CollegeofAgriculture	01
CollegeofHorticulture	02
CollegeofVeterinaryandAnimalSciences	03
CollegeofAgriculturalEngineeringandTechnology	04
CollegeofForestry	05
CollegeofFisheries	06
CollegeofHomeScience	07
CollegeofBasicSciencesandHumanities	08
Others	09

*** Required to be filled in Online application**

ANNEXURE-XI

TENTATIVESCHEDULEFORONLINE COUNSELINGOFQUALIFIEDCANDIDATESFOR ADMISSION TO DOCTORAL DEGREE COURSES IN AGRICULTURE & ALLIED SCIENCES INCLUDING VETERINARYSCIENCE THROUGH AICE-JRF/SRF(PGS)-2018 FOR THE ACADEMIC SESSION 2018-19

The time schedule for online counseling along with related instructions will be known after the declaration of result. Qualified candidates are advised to remain in regular touch with ICAR website www.icar.org.inor www.aieea.netin this regard.

1. For online counseling, candidates will be charged one time Registration fee of ₹2,000/- by the ICAR which will be non-refundable to the candidates. For those candidates who will finally take admission in the Universities, the concerned university shall send a list of admitted candidates with a request to ICAR to transfer this money to the University for the adjustment against the admission fee to be paid by the admitted candidates. The balance amount of fee as prescribed by the university would have to be deposited by the candidate to the University on the date of admission. Failure to deposit the requisite admission fee and certificates to the allocated University will forfeit his/her claim for admission.
2. Reserved category candidates must produce the required caste certificates in original and in the prescribed format at the time of admission.
3. Any temporary or permanent withdrawal of original certificates will be governed as per the concerned University rules. ICAR has no objection if certificates are returned to the candidate after verification.
4. In case of OBC candidates availing the benefits of reservation in Central Educational Institutions/Universities, the candidate will also be required to produce a Central OBC certificate **(Annexure-VI)** issued by the competent authority and satisfy following criteria:
   - Sub-caste must tally with the Central list of OBC.
   - Candidate should not belong to creamy layer.

   The proof of non-creamy layer shall be verified by the University authority before their admission (Original certificate has to be produced). Therefore, candidates while going for admission in the allotted university need to carry with them all the required documents (please also see 11.1iii) in original as well as photocopies thereof along with prescribed fee, etc.
5. No claim or compensation for problems (if any) encountered or cost incurred in counseling/admission will be entertained by the ICAR/Universities. Before registering for online counseling, candidate must ensure that all the eligibility conditions laid down in the Information Bulletin are fulfilled including the age limit, possession of Degree/PDC/final result in hand (including thesis submission and viva-voce), relevant certificates, etc. ICAR/ University will not be held responsible for denial of admission to non-eligible candidates.
6. The candidate should note that 4/5(BVSc & AH)/6 (10+6, BSc. Ag.) years' UG degree and 2 years' PG degree with thesis work are the essential requirements for admission to doctoral degree programmes in the AUs. The candidates having passed with 3 years' UG degree programme are not eligible for Ph.D. admission through AICE-JRF/SRF(PGS).
7. Candidates are advised to remain in touch with ICAR website for any change in schedule/notices/circulars etc. In case the SMS are issued and not received by the candidates due to technical reason in time, ICAR shall not be held responsible for it.

NOTE

The candidates are advised to remain in constant touch with the ICAR website (www.icar.org.in& www.aieea.net) for any change in counseling schedule/notices/circulars etc., related to this examination.

E-ADMIT CARD INSTRUCTIONS

1. This e-Admit Card allows admission of candidate in the examination hall subject to the condition that if ineligibility is detected at any stage, the candidature will be cancelled.
2. Entry to the Examination Hall without e-Admit Card and Aadhaar Card or 28 digit Aadhaar Enrolment ID or passport number or ration card number or driving license number or any other valid Govt. identity card number,is not permitted.
3. Particulars in the e-Admit Card must be checked carefully. Errors, if any, must be reported immediately at the Helpline Nos.
4. Candidates are advised to reach the venue at least 2½ hours before the examination so as to complete the frisking and registration formalities well before the time. Registration desk will be closed 05 minutes prior to the examination.
5. A candidate claiming relaxation under PC category must carry with him/her a copy of PC certificate.
6. No paper other than e-Admit Card and Aadhaar Card or 28 digit Aadhaar Enrolment ID or passport number or ration card number or driving license number or any other valid Govt. identity card number, as applicable, should be brought inside the examination hall. Any textual printed or written material, Calculator, Docu Pen, Slide Rule, Log Tables, Electronic watch with facilities of calculator, bits of papers, mobile phone, tablet, pager or any other device is strictly prohibited in the Examination hall.
7. No candidate, under any circumstances, will be allowed to enter the Examination Centre after the commencement of examination.
8. Bring a clear colour self-attested photograph (same as uploaded at the time of filling-in of online Application) to be handed over to the invigilator in case it is demanded. ICAR reserves all rights to verify the identity and genuineness of each candidate by any means that is considered appropriate.
9. During the examination time, the invigilator will check e-Admit Card and applicable Identity proof (Matching the candidate's face with colour photo on the attendance sheet) of the candidate to satisfy himself/herself about the identity of each candidate.
10. The Ball Pens will be supplied to the candidates in the examination hall, so they should not bring any type of Pen/Ball pens with them.
11. There is only one correct response for each question out of four responses given. Question with no response indicated will not be awarded any mark and there will be no negative marking for that question. The candidates are advised not to attempt such questions, for which they are not sure of the correct answer.
12. Do not attempt to give/obtain assistance of any kind. Any improper conduct of the candidate in the examination hall will entail forfeiture of candidature besides other legal action desirable.
13. Impersonation or attempt to impersonate would invite forfeiture of the candidature.
14. e-Admit Card and hardcopy of computer generated online application must be preserved for bringing at the time of admission or any further identity verification by the admitting University.
15. Failure to comply with these instructions will entail expulsion/cancellation of candidature and may invite further legal action.
16. The city of examination as filled by the candidate in the Online application shall not be changed. ICAR may change/shift the examination city center opted by the candidate to another nearby centre, if number of candidates are more at any city center.