POST GRADUATE STUDIES REGULATIONS

and

COURSE DESCRIPTION

(SECTION- I & II)

M.Tech. and Ph.D.

Effective from 2016-17

COLLEGE OF TECHNOLOGY AND ENGINEERING
MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY
UDAIPUR (Rajasthan) 313001

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VISION & MISSION OF THE INSTITUTE

VISION

To create an institute of technical education of international standards and conducting research at the cutting edge of technology to meet the current and future challenges of technological developments.

MISSION

- Promise excellence, foster high standard and orient the educational program towards future needs and opportunities through strong Academia-Industry-Stakeholders linkages.
- Strengthen the curricula and add frontier engineering areas such as information and communication technology, environmental engineering, precision farming, energy conservation, dimensional stone technology, robotics, artificial intelligence, instrumentation and control.
- Provide opportunities for post doctoral research, continuing education, faculty upgradation and development of human resources in new and cutting edge technological areas especially through international collaboration.
- Strengthen non-formal training to promote entrepreneurial skills and commercialization of agriculture and promote client oriented on-farm research and technological assessment, refinement and transfer through participatory approaches by promoting the institute Village Linkage Program.

POST GRADUATE STUDIES REGULATIONS

(SECTION-I)

M. Tech. and Ph.D.

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MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY
UDAIPUR (Rajasthan) 313001

SECTION- I

ACADEMIC REGULATIONS
(POST GRADUATION COURSES)

UPDATED RULES AND REGULATIONS FOR POST GRADUATE STUDIES (2015)

The students admitted shall be governed by the relevant rules as indicated below and amendments made from time to time in future.

1.0 DEFINITIONS

1.1 "Academic Year" or "Academic Session" of the University shall ordinarily be between July to June and shall consist of two semesters.

1.2 "Semester" is an academic term of normally 110 days including examinations (with a minimum of 16 weeks of instructional days).

1.3 "Course" means a unit of instruction or a segment of a subject matter to be covered in a semester. Each course is assigned a specific number, title and credits.

1.4 "Credit Hour" also written as "Credits" imply that each credit hour will represent an hour of lecture or two to three hours of laboratory / field practical each week in a semester.

1.5 "Grade Point" is a numerical number which denotes student's performance in a course.

1.6 "Credit Point" is the product of credit hours and grade point obtained by the student in a course.

1.7 "SGPA" (Semester Grade Point Average) is the average of the credit points of a semester.

1.8 "OGPA" is the overall cumulative grade point average obtained by the student in the courses taken in all the semesters completed by him / her.

$$\text{OGPA} = \frac{\text{Sum of the products of grade point earned and credit hours of all the courses offered}}{\text{Sum of the credit hours of all the courses offered}}$$

1.8.1. For obtaining equivalent percentage of OGPA under 10 point scale, the OGPA will be multiplied by factor 10 (Ten). The division of Post Graduate students shall be determined by the OGPA at the end of successful completion of programme as follows-

OGPA	**Division**
6.50-6.99	II- Division
7.00-7.99	I- Division
8.00 and above	I- Division with distinction

Further, the OGPA, at the end of the programme will be calculated up to third decimal digit but will be awarded up to two decimal digits. However in case, third decimal digit is 5 or above, the OGPA will be rounded to next higher digit i.e. an OGPA of 6.995 and above will be considered as 7.00.

1.8.2 Conversion of OGPA into percentage or vice-versa:

A. Percent of marks obtained under traditional system be converted to OGPA under 10 point scale by dividing it by 10 (ten).

B. OGPA obtained under grading system (like 4 or 5 point scale etc.) be converted to OGPA in 10 point scale or the percentage using following formulae:

(i) OGPA under 10 point scale = 9G / N

(ii) Percentage of marks = 90G / N

Where G is the OGPA under grading system and N is the value of scale like 4 in 4 point scale, 5 in 5 point scale and likewise.

1.9 "Year" means an academic session consisting of two semesters. Say, first year means the first academic session of the prescribed course of a degree programme. Similarly, second year, third year, and fourth year mean second, third and fourth academic session, respectively.

1.10 The University awards medals to meritorious students of which details are as follows-

A. Chancellor's Gold Medal

This is the highest honour bestowed on one meritorious student in the field of academics every academic year starting from 2016-17. The Chancellor's Gold Medal will be given each year in any one faculty at Post-graduate level by rotation. The student obtaining highest OGPA in any faculty across the department will be awarded Chancellor's Gold Medal. The rotation of the faculty will be on the alphabetical order i.e. Agriculture, Engineering & Technology, Fisheries and Home Science. A student being awarded University Gold Medal, if found eligible will also be awarded Chancellor's Gold Medal.

B. University Gold Medal

Ph.D. Degree Programme- One Gold Medal for Ph.D. degree programme in the faculty of Engineering & Technology. For Rules and Guidelines for award of Gold Medal refer *Appendix XXIV.*

Master's Programme- For awarding Gold Medal at least three candidates should have completed the degree and that the candidate, who has been selected for award of Gold Medal, should possess a minimum OGPA of 7.5. The Gold Medals should be awarded on the basis of academic performance in each discipline.

C. Jain Irrigation Medal

'Jain Irrigation Medals' sponsored by M/S Jain Irrigation Systems Ltd., Jalgaon (Maharashtra) are provided to the meritorious students of the University in the faculty of Engineering & Technology, as specified-

i) B. Tech. (Ag.)- 1 Medal
ii) M. Tech. (Ag.) Soil & Water Conservation Engineering- 1 Medal
iii) M. Tech. (Ag.) Irrigation and Water Management- 1 Medal
iv) Ph.D. (Ag.) Irrigation Water Management- 1 Medal

2.0. MAJOR FIELD OF STUDY

The following shall be the Degrees and Major Fields of Studies there-in to be awarded in Faculty of Technology & Engineering:

2.1 Master's Degree (M.Tech.)

Major fields of study:-

i. Farm Machinery & Power Engineering
ii. Soil & Water Conservation Engineering
iii. Irrigation Water Management Engineering
iv. Renewable Energy Engineering
v. Processing & Food Engineering
vi. Mining Engineering (Mine Planning)
vii. Mechanical Engineering (CAD/CAM)
viii. Electrical Engineering (Power Electronics)
ix. Electronics & Communication Engineering (Communication Engineering)
x. Computer Science& Engineering
xi. Civil Engineering (Structural Engineering)

2.2 Ph.D. Degree by course work

Major fields of study:-

i. Farm Machinery & Power Engineering
ii. Soil & Water Conservation Engineering
iii. Irrigation Water Management Engineering
iv. Renewable Energy Engineering
v. Processing & Food Engineering
vi. Electrical Engineering
vii. Computer Science & Engineering
viii. Electronics & Communication Engineering
ix. Mechanical Engineering
x. Mining Engineering

3.0 GENERAL ADMISSION RULES

3.1 Mode of admission:

i). Master’s programme – On the basis of valid GATE Score w.e.f. academic session 2017-18. In case of non-availability of GATE candidates,seats shall be filled on the basis ofMerit cum Interview, as per the criterion fixed by the University.

ii). Ph.D. programme – Through Written Entrance Test w.e.f. academic session 2017-18& subsequently on the basis of Merit cum Interview, as per the criterion fixed by the University.

3.2 For Master's programme, a candidate must possess a Bachelor's degree (B.E./B.Tech.),with minimum 60% or equivalent marks in respective/ related subject (as

approved by Academic Council) for General and 55% for SC/ST/OBC/SBC (Non Creamy Layer).

3.3 For Ph.D. by course work programme, a candidate must possess a Master's degree in the respective/related subject and faculty from MPUAT, Udaipur or a degree declared equivalent thereto from a recognized University or Institute with 6.50/10.00 or equivalent OGPA for General and 5% relaxation for SC/ST/OBC/SBC (Non Creamy Layer) candidates in Technology & Engineering.

3.4 Admission shall be open in the first semester of the academic year for Master's degree and Ph.D. degree.

3.5 No student shall be entitled to join more than one programme of studies concurrently anywhere.

3.6 Admission to any University programme can not be claimed by a candidate as a matter of right.

3.7 Admission committee may refuse admission to any candidate on valid ground(s) to be recorded. However, in case a person obtaining qualifying marks in pre-entry examination is refused admission by the admission committee, it would be after the candidate has been given a hearing by the admission committee. The candidate may file appeal to the Vice-Chancellor. Decision of the Vice-Chancellor shall be final.

3.8 An applicant suppressing or giving wrong information or facts or forging signature of parents or attaching false certificates shall forfeit admission in addition to any other punishment that may be awarded to him / her.

3.9 Candidate who applies under a reserved quota shall be considered as per existing State Government rules and amended from time to time, hereafter.

3.10 Following candidates shall not be given admission in the University or its constituent Colleges, even if they are qualified for it:-

a) A candidate against whom a FIR has been lodged by the University or any of the constituent colleges or by any other competent authority / officer of the University.

b) A candidate who has been convicted of a criminal offence or has been released on bail in connection with a criminal offence and against whom a case is pending in a court of law.

c) A candidate who has indulged in misbehavior with his Teacher / staff or with any authority of the University.

3.11 Foreign students are normally admitted under the category of ICAR nominee. No self-financing foreign student shall be given admission unless his case is supported either by the Government of India / International Organisations / respective Governments and approved by the ICAR provided they fulfill other prescribed qualifications and requirements.

3.12 Foreign students sponsored / nominated through ICAR shall be required to pay institutional economic fee as prescribed from time to time in addition to the normal fees charged by the College / University from Indian students.

3.13 Following categories of candidates are exempted from appearing in the written test:

i) Seats reserved under ICAR nominee.

ii) Candidates who have qualified for JRF and nominated by ICAR.

iii) Other sponsored candidates deputed by the MPUAT, Udaipur or the Government of Rajasthan.

3.14 Admission in M.Tech.*in faculty of Technology and Engineering shall be based on valid GATE Score w.e.f. academic session 2017-18. In case of non-availability of GATE candidates the seats shall be filled on the basis of Merit cum Interview, as per the criterion**fixed by the University as follows-

	Secondary	**Sr. Secondary**	**UG (B.E./ B.Tech.)**	**GATE**	**Experience**	**Interview**	**Total**
M.Tech.**	10% (10)	10% (10)	50% (50)	10% (10)	10% (10)	10% (10)	100% (100)

*As per Notification No. CTAE/Gen./2016/5051-57 dated 16.08.2016.
***As per letter no. F.MPUAT/DRI/ME/2008/1464 dated 20.08.2008.*

3.15 Admission in Ph.D.* in faculty of Technology and Engineering shall be through written (screening) test. Those candidates who score 50% or above marks in the written test shall only be eligible for admission based on merit-cum-interview as per the criterion**fixed by the University as mention below. The Sponsored candidates need not to appear in the written test.

	Secondary	**Sr. Secondary**	**UG (B.E./B.Tech.)**	**PG (M.E./M.Tech.)**	**Experience**	**Interview**	**Total**
Ph.D.**	10% (10)	10% (10)	30% (30)	30% (30)	10% (10)	10% (10)	100% (100)

*As per Notification No. CTAE/Gen./2016/5051-57 dated 16.08.2016.
***As per MPUAT/AC-36/2012-02/05.*

Note:

i) For admissions in Agricultural Engineering disciplines/branches, combined merit list shall be prepared for all the Agricultural Engineering disciplines/branches namely FMPE, REE, SWE, IWM and PFE; as a student is eligible to apply in any branch of these.

ii) For experience, two marks for minimum one year of experience and thereafter for each additionalyear's or part of years' experience, two marks proportionately will be given, subject to maximum marks of ten. For consideration of experience, production of Form '16' from concerned organisations where the candidate has worked will be mandatory.

3.16 Eligibility qualifications for admission in faculty of Technology and Engineering: Master's Programme (M.Tech.) and Doctoral Programme (Ph.D.)

S.No.	**Branch/Discipline**	**Specialization**	**Code**	**Seats**	**Qualifying Degree**
Master of Technology (M.Tech.) Programs					
1.	Agricultural Engineering	Farm Machinery & Power Engineering	FMP	6	BE/B.Tech.(Ag./Mech.)
2.	Agricultural Engineering	Renewable Energy Engineering	REE	6	BE/B.Tech.(Ag./Mech./Elect./ Chemical/ Electronics/Civil/ Renewable Energy & Environmental Engg.)

S.No.	Branch/Discipline	Specialization	Code	Seats	Qualifying Degree
3.	Agricultural Engineering	Soil & Water Conservation Engineering	SWC	6	BE/B.Tech.(Ag./Civil)
4.	Agricultural Engineering	Irrigation Water Management Engineering	IWM	6	BE/B.Tech.(Ag./Civil)
5.	Agricultural Engineering	Processing & Food Engineering	PFE	6	BE/ B.Tech. (Ag./Chemical/ Mech./ Electrical)
6.	Mechanical Engineering	CAD/ CAM	ME	8	B.E./B.Tech. (Mechanical/ Production & Industrial Engg.)
7.	Electrical Engineering	Power Electronics	EE	8	B.E./B.Tech. (Electrical / Electronics & Communication)
8.	Electronics & Comm. Engineering	Communication Engineering	ECE	8	B.E./B.Tech. (Electronics & Communication Engg.); Graduateship (AMIETE) examination of IETE
9.	Computer Science& Engineering	Computer Science &Engineering	CSE	8	B.E./B.Tech. (CSE /CE/IT)
10.	Mining Engineering	Mine Planning	MI	8	B.E./B.Tech. (Mining)
11.	Civil Engineering	Structural Engineering	CE	8	B.E./ B.Tech.in Civil Engg.
Doctoral (Ph.D.) Programs					
1.	Agricultural Engineering	Farm Machinery & Power Engineering	FMP	4*	ME /M.Tech(Ag. Engg.) in FMP/ REE
2.	Agricultural Engineering	Renewable Energy Engineering	REE	4*	ME /M.Tech (Ag. Engg.) in FMP/REE/PFE; ME /M.Tech in Electrical/Electronics/ Mech./ Chemical/ Civil
3.	Agricultural Engineering	Soil & Water Conservation Engineering	SWC	4*	ME/M.Tech.(Ag. Engg.) in SWC/IWM; ME/ M.Tech.inHydraulics/Irrigation/ Aquatic/Aquaculture Engg.
4.	Agricultural Engineering	Irrigation Water Management Engineering	IWM	4	ME/M.Tech. (Ag. Engg.) in SWC/ IWM; ME /M.Tech. in Hydraulics/ Irrigation
5.	Agricultural Engineering	Processing & Food Engineering	PFE	4*	M.E./M.Tech. (Ag. Engg.) in PFE
6.	Mechanical Engineering	Mechanical Engineering	ME	4	M.E./M.Tech. (Mechanical)
7.	Electrical Engineering	Electrical Engineering	EE	3*	M.E./M.Tech. (Electrical Engg)
8.	Electronics & Communication Engineering	Electronics & Communication Engg.	ECE	4	ME/M.Tech.(Electronics & Comm. Engg.)
9.	Computer Science &Engineering	Computer Science &Engineering	CSE	4	M.E./M.Tech.(CSE/ IT)

S.No.	Branch/Discipline	Specialization	Code	Seats	Qualifying Degree
10.	Mining Engineering	Mining Engineering	MI	4	M.E./M.Tech. (Mining Engg./ Rock Mechanics / Environmental Engg.)

* Two additional seats are available in each of these specializations from the Academic Session 2017-18 under Quality Improvement Programme for teachers of AICTE approved Degree level Engineering Institutions. The admission procedure shall be as per norms & guidelines of QIP.

Notes:

i) The actual number of admission/seats may be decreased or no admissions may be made in a particular Ph.D./ Masters' program in a particular year depending upon availability of faculty expertise in a particular programme/ discipline.

ii) In M.Tech. programme, there is provision of supernumerary seats as per past practice in each programme for sponsored candidates (as approved by MPUAT/AC-36/2012-02/06).

iii) There is provision of 2 supernumerary seats in each Ph.D. programme across the faculties for in-service candidate's w.e.f. 2012-13 session (as per the academic council's decision i.e. MPUAT/AC-35/2012-01/08).

iv) The candidates seeking admission in M.Tech.(Ag.Engg.) or PhD. (Ag. Engg.) programmes from discipline other than Agricultural Engineering, will be required to take additional pre-requisite courses, as per rules.

v) The candidates seeking admission under Sponsored Category Seats in M.Tech. and Ph.D. shall have to satisfy the following requirements:

(a) The candidates must have a minimum of two years of full-time work experience in responsible capacity in a Registered Firm/Company/ Industry/Educational and Research Institution/Govt./Quasi Govt./ Autonomous Organisation in the relevant field in which admission is being sought.

(b) In case of Industry, the Firm/Company/Industry shall either be a public sector undertaking or a public limited company registered in a stock exchange or a private concern whose annual turnover during the past two years exceeds Rs. 5 crores. Further, the Industry sponsored candidates shall be required to fee a higher fee of 1.25 times the normal fees.

(c) The Educational Institution should be recognized by AICTE/ICAR.

(d) Letter of appointment and Form – 16 for two years of service is required from the employer at the time of written test / interview. In addition, the candidate must submit an undertaking that he/she will continue to submit Form – 16 for the subsequent years till he/she completes the programme.

(e) The candidate shall be required submit a suitable undertaking for sponsoring by the sponsoring institution.

vi) The candidates applying as Sponsored candidates shall not be considered for non-sponsored seats. They should submit a separate application with fee, if they want to be considered for normal seats. However, they still have to submit sponsorship certificate and other documents as required for sponsored candidates.

4.0 ADVISORY SYSTEM

4.1 A major advisor shall be assigned to each student admitted in the P.G. programme by the respective departmental committee. A Major advisor can have maximum of 5 candidates under his / her supervision irrespective of M.Tech. / Ph.D. at any point of time. The HOD shall invite application from each PG student in choosing the field of research, indicating preferences of 3 fields in the department. The departmental committee shall consider the preferences of the students on the basis of vacancy and availability of Major advisor on the basis of merit. There is no ban on having major advisor from the outside station considering the problems of research, facilities available at out station in which the major advisor is to be appointed and preference of the student.

4.2 There shall be an advisory committee for each P.G. student constituted by the Director, Resident Instructions (After making such changes as he deems necessary) on the recommendation of the major advisor in consultation with the Head of Department.

4.3 The advisory committee shall consist of minimum 3 accredited teachers from the P.G. faculty which shall consist normally of the major advisor and one advisor from major and minor field each and a nominee of Director, Resident Instructions (from the same or related faculty/fields) in master's programme. The advisory committee of the candidate for Ph.D. degree will consist of minimum 4 accredited members with a major advisor and one member from major field, 2 from minor/supporting fields and 1 DRI nominee. Major advisor will be the Chairman of the committee. The advisory committee should be constituted within one month of 1st Semester.

4.4 If the student's programme of study so requires, he may have an additional major advisor, called co-major advisor. Such co-major advisor would be compulsory if student undertakes post-graduate programme in which MPUAT, Udaipur and some other SAU or institute collaborate.

4.5 Major advisor, Co-major advisor shall be teachers accredited for guiding master's or Ph.D. thesis and members of P.G. faculty.

4.6 Major advisor shall convene the meeting of the advisory committee at least once in each semester to assess the progress of the student and shall maintain a record of it. It should advise the student in such a manner as it deems fit and to ensure that the student can complete the work within the stipulated time.

4.7 The advisory committee will function until the student graduates from that particular programme or is dropped from the rolls of University or College. The DRI nominee must keep a keen eye on the role of advisory committee and would apprise the DRI about the deviations made, if any, from the prescribed procedure. He will also submit a confidential report to DRI.

4.8 The Director, Resident Instructions can replace a member of advisory committee during a programme, if the member including major advisor or co-advisor:-

i) ceases to be member of P.G. faculty.

ii) has requested to be replaced.

iii) is prevented by illness to function properly.

iv) any other valid reasons.

4.8.1 In case of retirement/leaving of chairman next senior person in the discipline in the advisory committee will become chairman of the students' advisory committee and for advisor/member, another member would be recommended by the Head of the Department.

4.8.2 The caretaker HOD/ Dean is permitted to sign the thesis whenever regular HOD/ Dean is out of station or on leave even for a single day after going through the relevant records of the concerned students. Whenever such situation arises, permission be obtained from the competent authority in individual case.

4.8.3 An alternative to major advisor will be provided for conducting viva-voce at a time when major advisor is out of station or he / she is not available for some unavoidable reasons. Whenever such situation arises, permission of HVC should be sought.

4.8.4 The requirement of attending synopsis seminar, pre-thesis seminar and viva-voce on the part of co-major advisor from other institute / organisation is relaxed.

4.9 Function of Advisory Committee:-

4.9.1 The advisory committee shall prepare a programme of study of the student after giving due consideration to his/her academic background and aptitude. He/she may also be required to undertake non-credit courses to overcome any deficiency in his/her academic standard. Successful completion of such non-credit courses would be compulsory.

4.9.2 It shall also discuss the research problem of the student and guide him/her to prepare synopsis and recommend the same through Head, for approval by the Director, Resident Instructions after the student has given a seminar on the subject.

4.9.3 It shall monitor the progress of the student during the programme and advice him/her for maintaining his/her academic standing by suggesting courses to be taken and to plan his/her schedule. For this a meeting of the advisory committee shall be scheduled by major advisor once in each semester and proper record of proceedings be kept.

4.9.4 It shall examine the student for comprehensive or preliminary examination.

4.9.5 It shall approve the standard and quality of the thesis before submission of the thesis to Director, Resident Instructions for external evaluation after the student has presented the work in a seminar.

4.9.6 It shall examine the student in a viva-voce examination on the thesis after due recommendation of the external examiner(s).

4.9.7 No change in the programme of studies shall normally be permitted. However under special circumstance, the Director Resident Instructions on the recommendation of the Advisory Committee, Head of the Department and the Dean of the College concerned with specific reasons to be specified may permit change in the programme of studies.

5.0 ADMISSION TO DEGREE PROGRAMME

5.1 A student admitted to a post-graduate programme shall have to successfully complete the following before award of a degree:

a) An approved programme of study prepared by his/her advisory committee.

b) A comprehensive or preliminary examination.

c) Pre-thesis seminar

d) Submission of thesis and its evaluation.

e) Thesis viva-voce examination.

f) Minimum residential requirement.

g) Minimum OGPA requirement.

5.2 A student for master's programme shall be required to complete a minimum of 57 credit hours for the degree

Title	Approved Load
Major courses (Core & optional)	20-27 Credit Hours (with 12 credit as core)
Minor & Supporting Courses	9-14 Credit Hours
Seminar	1 Credit Hour
Non-Credit Compulsory Courses	2 Credit Hours (as proposed by ICAR)
Total	**37**
Comprehensive	NC
Research	20 Credit Hours

5.3 A student of Ph.D. programme shall be required to complete a minimum of 74 credit hours for the degree. The distribution of courses for Ph.D. would be as under:

Title	Approved Load
Major courses (Core & optional)	18 Credit Hours (with 6 credit as core)
Minor & Supporting Courses	9 Credit Hours
Seminar	2 Credit Hour
Non-Credit Compulsory Courses*	2 Credit Hours (as proposed by ICAR)
Total	**29**
Preliminary	NC
Research	45 Credit Hours

**Exempted for those who have cleared these in Master's programme*

Note:

a) Preliminary will be held but will not be graded / credited towards credit load of the student.

b) Research will be graded as satisfactory.

5.4 The minimum duration of Ph.D. and master's programme shall be 6 and 4 semesters, respectively.

Note: The period for engineering graduates to complete master's programme including remedial courses will be two and half years i.e. 5 semesters.

5.5 A student for master's and Ph.D. programme shall be required to complete a minimum period of 4 semesters and 5 semesters in residence, respectively. However, in case of MOUs with other University, where the research scholar will complete their research work in their parent University, they will be allowed after completion of comprehensive examination. No M.Tech. or Ph.D. student shall be allowed to discontinue the academic programme without completing minimum

residential requirement and research work. For PG diploma residence requirement would be atleast 2 semesters. However, this shall not debar the University from developing residential instructions in varying proportions for the future P.G. courses.

5.6 A student shall have to complete all the requirements including submission of thesis within 8 and 12 semesters for Master's and Ph.D. programmes, respectively, which will also include period of scholastic probation or temporary withdrawal from the semesters, failing which the admission shall stand cancelled. However, extra semesters with penalty fee will be allowed for 2 semesters in both Master's and Ph.D. programmes.

5.7 A student shall be required to secure a grade point 6.0 out of 10.00 for passing in any course and a minimum OGPA of 6.50 out of 10.00 for the degree.

6.0 REGISTRATION

6.1 A student admitted to a programme shall have to register in the college in the semester admitted within the stipulated time indicated in the notice of admission, failing which his admission will stand cancelled.

6.2 Every post graduate student in good academic standing, unless granted a formal temporary withdrawal by the Dean of College, shall be required to register with the College of his admission in each semester until the completion of all requirements for the degree for which he is admitted.

6.3 A regular student shall be allowed to register upto 18 credit hours but not less than 9 credit hours of courses in any semester. However, in M.Tech. (Ag.) and in the last semester of course work of other programmes he/she may be permitted to register upto 20 credit hours to complete the programme of study.

6.4 The minimum limit of credit hours to be registered in a semester shall not apply to students after completion of minimum residential requirement.

6.5 A Ph.D. student shall be permitted to add courses within 2 weeks or withdraw from courses within 10 weeks of commencement of the semester in such a way that the limits of maximum/ minimum credit hours in that semester have not been crossed.

6.5.1 Attendance in courses joined later shall however, be counted from the date of registration in the semester and it will be the responsibility of the student to maintain minimum attendance requirement.

6.6 Temporary withdrawal from the programme:

6.6.1 A student with good academic standing shall be permitted by the Dean of the College to withdraw from a programme for a specific period not exceeding two semesters on the recommendations of the Major Advisor and Head of the Department, provided he/she makes a written request. Withdrawal in firstsemester of a programme is not permissible.

6.6.2 The Vice-Chancellor on a written formal application submitted by the student seven days before the expiry of the withdrawal period and duly recommended by the Head of Department and the Dean of College may further grant an extension of withdrawal for one more semester to him/her on the grounds of some compelling situation to be specified.

6.6.3 Failure to register or to obtain formal permission to withdraw from university/college will constitute presumptive evidence that a student has withdrawn from the college and his/her admission shall stand cancelled.

6.6.3.1 No student shall leave the College/ University without obtaining formal permission from the Dean of the College.

6.6.4 Students granted formal permission of temporary withdrawal may be exempted from all fees during the period of their withdrawal. If he/she withdraws in the middle of a semester, the semester fee will not be refunded. Those who do not obtain formal permission shall be charged full fees for the semesters missed before re-registration.

7.0 AWARD OF GRADES

7.1 Grade point 0 to 10.0 shall be awarded to a student in each course on the basis of marks obtained by him/her in mid-term test and the final semester examination. For other cases following abbreviations shall be used to denote the performance of a student in a course:

F-	Fail	US-	Unsatisfactory (for thesis & Preliminary / Comprehensive only)
W-	Withdrawn	NC-	Non Credit courses
R-	Repeated	DE-	Detained
S-	Satisfactory (for thesis & Preliminary/ Comprehensive only)	UM-	Unfair means

7.2 Grade DE shall be awarded to a student in a course in which he/she is detained from appearing in the final semester examination on account of shortage in attendance. Grade "DE" will also be equivalent to point "0" (Zero) in 10 point for calculation of "OGPA".

7.3 Grade "W" shall be awarded to a student in a course from which he/she drops from his/her schedule within the time stipulated i.e. 10 weeks from the commencement of semester. Credit hours for this course will not be included for computing OGPA.

7.4 Grade "UM" shall be awarded to a student who has used unfair means in test/final semester examination, and that shall be treated as "0" (Zero) in 10- point scale.

7.5 A student shall be awarded zero in examination/ tests in which he/she fails to appear for any reasons whatsoever. The final grade shall be reported on the basis of marks obtained in other tests/ examinations and the final grade point shall be reported accordingly.

8.0 ACADEMIC STATUS AND SCHOLASTIC PROBATION

8.1 A student shall be required to secure atleast a grade point 6.0 in a course for its successful completion.

8.2 A student shall be required to attain a minimum OGPA of 6.5 separately in credit and non-credit courses (deficiency) without F/DE/UM in any course to be on good academic standing.

8.3 A student awarded grade 'F' in a course shall repeat the course to pass it, the grade of repeat course shall replace the earlier one with an `R' associated with it.

8.4 A student with grade 'F' in a course shall be permitted to appear in both the theory and practical examination alongwith the final semester examination of the consecutive semester. This permission shall be granted for two courses only at a time provided a written request is made within 10 weeks of date of registration in the semester.

8.5 A student with grade 'DE' in courses shall be permitted to repeat it as a regular in the next semester when offered before taking up new courses without affecting the normal schedule of the courses offered in that semester. In case of clash, he/she shall drop the new course (s).

8.6 A student who could not obtain an OGPA of 6.5 at the end of any semester shall be permitted to take a maximum of two courses as back log including the one in which he/she secured GPA of less than 6.5 whenever next offered. The grade of repeated course shall replace the original one with `R' associated with it.

8.7 A student with an OGPA of less than 6.0 at the end of 1stacademic yearand onwards, he/she will be automatically dropped.

8.8 A student with an OGPA of 6.0 to 6.49 or grades "F", "DE", "UM" in any course at the end of a semester shall be placed on scholastic probation in the subsequent semester. The period of scholastic probation shall be for one semester only.

8.9 A student after being on scholastic probation for three times and dropped from the college, shall be permitted to apply for a mercy petition to the Vice - Chancellor through Dean of the college within 5 days from the date of registration of the next semester. A committee constituted by the Vice – Chancellor, after considering all aspects of the case, shall either recommend the continuation of the student on scholastic probation for one more semester or reject the mercy petition. The committee may review its decision on detection of a patent error or facts.

8.10 A student recommended to continue for one more semester on scholastic probation shall be registered without late fee within seven days of the order and with prescribed fee (revised time to time) for a further period of 3 days or upto last date of registration with late fee whichever is later.

9.0 ATTENDANCE RULES

9.1 A student shall be permitted to appear in the final semester examinations after a minimum attendance of 75% separately for theory and practical in each course from the date of registration in that course.

9.2 Enmasse absence shall be treated as absent in the attendance record of the student.

9.3 A further relaxation of 10% may be granted on the minimum attendance of 75% by the Vice-Chancellor on cogent grounds on the recommendation of the Dean of the College.

9.4 Attendance to the extent of number of lectures/ practicals missed in a course with a maximum of 8 days of absence in a semester shall be credited on production of certificate to the student deputed to represent college and University in co/extra curricular activities of the college/district/state/national level.

10.0 TESTS AND EXAMINATIONS

10.1 There shall be one mid term tests of 20 marks. Courses with theory as well as practical components and courses with theory only shall be examined in written mid term test. Courses with only practicals shall be examined in practicals in the test.

If any student fails to appear in the mid term test on account of hospitalisation (duly supported by hospitalisation certificate from a Govt. Hospital) or for any legitimate reason (including student's deputation for University official programme) duly recommended by course teacher and HoD and approved by the Dean, he/she shall be given the advantage of proportionate marks based on his/her performance in final theory/practical examination as the case may be.

10.1.1 Mid term test shall be held in the mid of the semester and on completion of about 50% of the course.

10.1.2 The duration of Mid semester theory examination (for courses having theory and practical) shall be of one hour. If a course consists entirely of practical, the Mid semester test will be based on practical and will of two hour duration.

10.2 There shall be a final semester examination at the end of a semester consisting of written theory examination of 2 hours duration and practical examination of 3 hours duration or more.

10.3 The distribution of marks in the test and final semester examination shall be:

Mid term test theory/practical 20 Marks

Final Semester Examination 80 Marks

a) Theory 50

b) Practical 30

Where there is no practical prescribed, the final theory examination shall be of 80 marks and vice - versa.

10.4 Final semester theory examination shall be conducted by the University.

10.4.1 The external examination for theory portion of PG level core courses shall be conducted by the University. While, the practical will be conducted by a senior faculty member and one more teacher to be nominated by HOD. Where the core paper is totally practical, an external examiner shall be nominated.

10.4.2 The question papers of optional papers shall be set confidentially for each course by the concerned teacher.

10.4.3 The evaluation of answer books of these optional papers shall be done internally by the concerned teachers and grades awarded by them.

10.4.4 Question papers shall contain short and detailed subjective questions as given in the guideline. No choice except internal shall be given.

10.5 Mid term test and practical examination shall be conducted by the office of the Dean of the College on scheduled dates as announced in the academic calendar.

10.6 General Rules:

10.6.1 No tests/examinations shall be postponed on the grounds of failure of electricity supply.

10.6.2 No special test/examination shall be held for students who miss it on grounds like being in police custody or attendance in a court.

10.6.3 Separate rules are prescribed for cases of unfair means and indiscipline in the test/examination.

10.6.4 The coordination committee of the Vice-chancellors has decided that the decision to reconduct the examination in the papers in which students have staged walk out or boycott shall rest with the Chancellor. The students therefore, need not approach the university authority in this regard.

10.6.5 Interested PG students may be shown their answer book(s) within two days of declaration of results for checking totaling and for marking if any answer has been left unmarked.

11.0 SEMINARS

A student in master's programme shall deliver one seminar in 3rd semester.

The course number and number of seminars to be given in Ph.D. programme for 2 credits of seminar allotted should be given as abbreviation of the department followed with 691 & 692 with a credit load of 1 to each seminar course. The studentswill give 2 seminars under each course. The average/ total marks of 2 seminars will be considered for grade point.

12.0 COMPREHENSIVE EXAMINATION FOR MASTER'S DEGREE

12.1 A student on good academic standing shall be allowed to appear in a comprehensive examination whenever next scheduled after successful completion of atleast 75 per cent of course work prescribed.

12.2 The comprehensive examination will consist of two parts; a written examination will be followed by oral examination. The written part will consist of two papers of 100 marks each. The first paper will include questions from major subjects and the second paper will include questions from minor subjects. The papers will be set internally and shall be evaluated internally. The minimum pass marks for written examination shall be 60% in major and minor separately.

12.3 The oral comprehensive examination, in which a student shall be graded as satisfactory / unsatisfactory, shall be conducted by the student's advisory committee under the overall control of the Head of Department.

12.4 If the student's performance is found unsatisfactory, he/she shall re-appear in the comprehensive examination whenever scheduled in the next semester but not earlier than 3 months of first examination.

12.5 No student who has not passed comprehensive examination and all semester examinations, and has not achieved satisfactory grades in each course (Including non-credit deficiency or compulsory courses) shall not be permitted to submit thesis.

13.0 PRELIMINARY EXAMINATION FOR Ph.D. DEGREE

13.1 A student on good academic standing shall be allowed to appear in a preliminary examination, whenever next scheduled after successful completion of 75% course work prescribed.

13.2 The preliminary examination shall consist of two parts, a written examination followed by an oral examination. The written examination shall consist of three papers of 100 marks each. The first two papers will include questions from major subjects and the third paper will include questions from minor subjects. The papers will be set internally and shall be evaluated internally. The minimum pass marks for written examination shall be 60% in each paper separately.

13.3 A student shall appear in oral preliminary examination, if eligible whenever scheduled after the written examination preferably within two months to be conducted by the student's advisory committee and an external examiner and attain a satisfactory performance.

13.4 If a student's performance in oral preliminary examination was unsatisfactory, he shall be required to reappear in oral examination whenever, scheduled next but not earlier than 3 months of previous examination.

13.5 No student shall be permitted to submit thesis unless, he/she achieves satisfactory performance in preliminary examinations.

14.0 SYNOPSIS OF PROPOSED RESEARCH WORK

14.1 A student shall select as far as possible a research topic for his thesis having relevance to the need of the state of Rajasthan.

14.2 The objective of the master's degree research should be to train the student in the research methodology and to develop his/her potential in conducting research, whereas the Ph.D. degree research should be indicative of the student's capacity for independent constructive thinking and interpretation as well as independent research work. The research work carried-out for Ph.D. degree should be a definite contribution to the advancement in the area and of a quality meriting publication in national and international journals of repute.

14.3 A student shall prepare a synopsis of proposed research work under the guidance of the Major Advisor and the supervision of the advisory committee in the prescribed format and submit the same after giving a seminar in the department where presence of all the members of the advisory committee is must, within the time period prescribed. The synopsis would also have to include in addition to the work plan and justification for taking up the thesis subject, a survey of existing literature on the subject and a list of references.

14.4 The synopsis shall be got examined and shall have to be recommended by the University professor in the subject in MPUAT, Udaipur before final approval by the respective Dean for Master's and by the Director, Resident Instructions for Ph.D. (after making changes, if needed). In the absence of a Professor in the University the Ph.D. research synopsis shall be referred to an outside expert of the rank of University Professor and above for his recommendation about the scope and suitability of the proposed research work. The synopsis of master's degree research shall be recommended by the concerned Head of the Department.

14.5 The synopsis for Master’s and Ph.D. programme should be got approved in II semester.

14.6 The minimum time between synopsis approved and thesis submission shall be two years for Ph.D. and one semester for Master’s programme.

14.7 Once the synopsis has been approved, major changes in the title and/or in the detailed outline shall not be allowed without prior permission of the Director, Resident Instructions. If the major changes are permitted, the student shall submit thesis only after 4 months of approval of the changes. Whereas the minor changes, which do not affect the quantum and quality of work and has been permitted by the Director, Resident Instructions, the time bar shall not be applicable.

14.8 A student shall not start the research work prior to final approval of the synopsis by the Director, Resident Instructions.

14.9 The research work shall normally be carried-out at the campus of student's registration. However, if the departmental committee on the advice of major advisor recommends the conduct of research work at any approved research stations of MPUAT, Udaipur or elsewhere, where facilities for it exist, the student shall be permitted to work there.

15.0 THESIS PREPARATION AND SUBMISSION

15.1 The student's advisory committee shall approve the quantum and quality of research work as per the synopsis approved in a seminar to be given by the student, before he/she starts writing the thesis. The seminar will be open to all the students and faculty members.

15.2 A student shall submit 3 copies of paper bound thesis for master's degree and 5 copies of paper bound thesis for Ph.D. degree along with a soft copy in computer CD together with abstract and required certificates to the Director, Resident Instructions through Major Advisor, Head of Department and Dean of the College.

15.3 The last day for submission of thesis in a semester shall be the last working day, which shall be a day prior to the start of next semester.

15.4 A student shall be permitted to write his thesis in either English or Hindi. A thesis written in English should also carry its title and abstract in Hindi and vice- versa. However for student wanting to submit thesis in Hindi his Major Advisor would have to be satisfied that the particular thesis topic is such that thesis can be written in Hindi and that sufficient literature and Hindi technical words exist regarding the particular topic.

15.5 A student who has successfully completed all requirements including completion of entire research work and presentation of a seminar there on except submission of thesis may be permitted by the Director Resident Instructions to withdraw from the College to resume duties or to accept an employment (this will not be applicable to in-service candidates who have been permitted to carryout research work at the main campus or elsewhere under rule 14.9). He/ She shall, however, have to submit the thesis after completion of all the requirements including comprehensive examination for master's degree and preliminary examination for Ph.D. degree subject to the maximum permissible period prescribed for each degree programmes. He/she shall be required to register in the semester in which thesis has to be submitted

15.6 A student for master's degree may submit thesis within the maximum permissible period after completion of all the requirements. He/she shall be required to register in the semester in which thesis has to be submitted.

15.7 At the time of submission of unbound thesis for evaluation, a student will be required to submit proof and copies of research paper (one from Master's and two from Ph.D. thesis) submitted for publication in a reputed journal.

15.8 The format for thesis laser typing will be as under:

(i) Font size 12 on one and half spacing.

(ii) 1½ inch margin on left and one inch in all other three sides.

(iii) Times New Roman font style.

15.9 It is mandatory for the students to acknowledge Major advisor, members of advisory committee, HOD and Dean by name in the acknowledgement page of thesis as per the proforma outlined in Appendix- XXII .

16.0 COLLABORATIVE PROGRAMME

16.1 A student may be permitted to complete course requirement or research work for his degree in part or full at any ICAR or other institutions having similar programmes provided a MOU to be signed between MPUAT, Udaipur and these institutions on reciprocal basis after approval by the Academic Council on the recommendation of P.G. Faculty. The period spent by the student at these institutions shall be counted towards his/her residential requirement.

16.1.1 A candidate may be sent to any research station of the University or Institute of repute where research facilities and staff are available for conducting research work if in the opinion of the departmental committee the field of candidate's specialization is available away from the campus. The co-major advisor shall be required to be stationed at the place where the candidate carries out research investigation, subject to condition that the scientist is also accredited. The co-major advisor will have to attend synopsis seminar, pre-thesis seminar and thesis viva-voce examination of the concerned student. The TA and DA for attending these activities will be born from the source of his/her salary.

16.1.2 Internal staff appointed as co-major advisor, advisor and who are posted outside the headquarter on their attending these activities (synopsis seminar, pre-thesis seminary and viva-voce) will draw their TA and DA from the source of their salary. The Officer Incharge should invariable relieve them for these activities.

16.2 A candidate from other SAUs admitted to a Ph.D. degree programme may be permitted to carry out research work for the thesis in his/her home University after completion of all requirements including preliminary examination under an approved and qualified co-advisor of his/her home University on reciprocal basis provided a MOU has been signed.

16.3 When a student is permitted to migrate from any SAUs to MPUAT, Udaipur in the middle of a programme. He shall submit a character certificate, transcript of courses taken and grades obtained in that institution. The Director Resident Instructions shall appoint a committee to examine his/her case and make recommendations about the exemption of credits after a proficiency test, if considered necessary. The exemption of credits permitted by the Director Resident Instructions shall not be greater than 12 credit hours.

16.3.1 The overall grade point average shall be based on the course(s) taken and grades obtained in this University.

16.3.2 The residential requirement for such student shall be determined by the Dean and approved by the Director Resident Instructions in each case separately and shall not be less than two semesters.

17.0 SCHOLARSHIPS PROVIDED BY THE UNIVERSITY

17.1 A student must obtain minimum OGPA of 7.0 out of 10.0 in the first semester at Master's and Ph.D. level. For continuance of scholarship, the candidate is required to maintain OGPA more than 7.0 during Master's and Ph.D. courses. The scholarship shall be discontinued if the student obtains OGPA less than 7.0 but shall be restored on obtaining OGPA more than 7.0 in subsequent examination.

17.2 The SRFs working in Research Schemes may be allowed to pursue their Ph.D. being on fellowship subject to following conditions:

a) The candidate cannot be allowed to complete coursework while being SRF. If he/she is admitted in Ph.D., he/she has to leave the SRF.

b) A Ph.D. scholar can avail SRF only after he/she completes the course work prescribed for Ph.D. However, in such cases the consent of Major Advisor as well as P.I. of the concerned project is mandatory.

18.0 AUTHORITY TO INTERPRET THE RULES

Any question about interpretation of these rules shall be decided by the Vice-chancellor, who may if he so desires consult the Board of Management to seek any necessary clarification.

Note: For any other rules & regulations which have not been covered herein, the students shall refer PROSPECTUS of MPUAT, which is published annually by the University.

APPENDIX **- I**

Format for Accreditation of Teachers for P.G.Teaching &Guiding

Maharana Pratap University of Agriculture & Technology, Udaipur

Application for approval for Post Graduate Teaching and Thesis Guiding

I, hereby apply for the approval of one or more of the following:- (Cross out whichever is not required and if you are already approved for any of the following. Mention order: Notification number and date.)

S.No.	PROGRAMME	CODE	Reference of Approval
1.	Teaching Master's degree programme Only	(R-01)	
2.	Teaching & Guiding Master's degree programme	(R-02)	
3.	Teaching & Guiding Master's degree programme and Teaching Ph.D.'s degree programme.	(R-03)	
4.	Teaching and Guiding Master's and Ph.D. degree programme	(R-04)	

1. Name of the applicant _____
2. Designation _____
3. Department _____
4. Place of present posting _____
5. Present address (Official) _____
6. Academic qualification:

Examination/degree	Year	Board/University	Division & % of marks obtained (OGPA)
Bachelor's ……..			
Master's ……			
Ph.D. …….			
Specify other details(if any)			

7. Titles of thesis submitted for any degree with year of submission:
   _____
   _____
   _____
   _____

8. Experience:

A. Teaching Period No. of Years PG.UG. Class Institution

_____

_____

_____

B. Research/Extension Period No. of Years Institution Remarks

_____

_____

_____

(Attach a list of Research papers published with journals).

9. Number of Students guided:- (a) Master's._____ (b) Ph.D._____

10. Mention below the field of your specialisation and number of years in each:

1. _____
2. _____
3. _____

Dated : _____

Signature of applicant

Recommendation of the Head of Department with justification:

_____

_____

_____

PROF. & HEAD OF THE DEPARTMENT

Remarks of the Dean/Director

_____

_____

_____

DEAN/DIRECTOR

OFFICE OF THE DIRECTOR RESIDENT INSTRUCTIONS

Approved For _____

Code No. _____

DIRECTOR
RESIDENT INSTRUCTIONS
MPUAT, UDAIPUR

APPENDIX – II

----------(**Name of department)**
College of Technology and Engineering
Maharana Pratap University of Agriculture & Technology, Udaipur

No. _____ Dated :_____

PROFORMA FOR THE APPROVAL OF THE ADVISORY COMMITTEE OF PG STUDENTS

Name of the Student : _____
Registration No. : _____
Degree Programme (with subject) : _____
Name of the Major advisor : _____
No. of student under guidance of major advisor (Including present one) : Masters_____ Ph.D_____
Proposed Advisory Committee:

S.No.	Name & Designation	Department	Status	PG Code No.	Signatures
1.					
2.					
3.					
4.					
5.					

Signature of the Major Advisor

No. _____ Date : _____

Forwarded and recommended to the Dean, CTAE.

Professor and Head

No. _____ Date : _____

Forwarded and recommended to the Director, Resident Instructions, Maharana Pratap University of Agriculture & Technology, Udaipur for nominating his nominee and approval of the advisory committee.

DEAN

No. DRI/MPUAT/ Dated: _____

Nominee of Director of Resident Instructions

Name & Designation Department PG Code No.
_____ _____ _____

Proposed Advisory committee is approved

Director, Resident Instructions
MPUAT, Udaipur

APPENDIX - III

College of Technology and Engineering

Maharana Pratap University of Agriculture & Technology, Udaipur

FORMAT FOR APPROVAL OF MASTER'S COURSE PROGRAMME

1. Degree in which admitted ..... Subject ..... Faculty .....
2. Name of the student in full (Block letters) .....
3. Father's Name .....
4. College of admission .....
5. Semester and Year of Admission ..... Category .....
6. Registration: (a) Date ..... (b) Reg.No. ..... (c) Enroll No. .....
7. Permanent address (brief) .....
8. Institution last attended .....
9. Date and place of Birth .....
10. Qualifying degree ..... Aggregate % or OGPA .....
11. Employer's name, if any .....

Above information's are correct.

Signature of student .....

Certified that the academic attainments of the student prior to joining of the aforesaid programme have been assessed properly and the advisory committee recommends the course mentioned in this form including compulsory, deficient, non-credit and or exempted courses

ADVISORY COMMITTEE

S.No	Status	Name & Designation	Deptt.	PGCodeNo.	Signature
1.	Major Advisor				
2.	Member/ Co Major advisor				
3.	Member				
4.	Member				
5.	Member				

For Courses see on the reverse.

Signature of Clerk

Contd.....

MASTER'S COURSE PROGRAMME APPROVED BY THE ADVISORY COMMITTEE

Course No.	Title of the Course	Credit Hrs.
	MAJOR COURSES **(A) Core (12 Cr. Hrs.)**	
	(B) Optional (8 to 15 Cr. Hrs.)	
	Total	
	MINOR & RELATED COURSES (9 to 14 Cr. Hrs.)	
	Total	
	Non Credit Courses (Minimum 2 Cr. Hrs.) : If exempted, write order No. and date	
	Remedial Courses, if any	
	Seminar..... ..... Comprehensive Non Credit Research.....	01 NC 20
	(Minimum 57 Cr. Hrs. are required) **Grand Total**	

Forwarded & Recommended

Head
(Name & Signature)

Dean
(Name & Signature)

Above course Programme is approved.

Director, Resident Instructions

APPENDIX - IV

College of Technology and Engineering

Maharana Pratap University of Agriculture & Technology, Udaipur

FORMAT FOR APPROVAL OF Ph.D.'S COURSE PROGRAMME

1. Degree in which admitted Ph.D.....Subject.....Faculty.....
2. Name of the Student in full (Block Letters) .....
3. Father's Name .....
4. College of admission .....
5. Semester and Year of Admission .....Category .....
6. Registration : (a) Date. ..... (b) Reg. No. ..... (c) Enroll No. .....
7. Permanent address (brief) .....
8. Institution last attended .....
9. Date and place of Birth .....
10. Qualifying degree ..... Aggregate % or OGPA .....
11. Employer's name, if any .....

Above information's are correct.

Signature of student .....

Certified that the academic attainments of the student prior to joining of the aforesaid programme have been assessed properly and the advisory committee recommends the course mentioned in this form including compulsory, deficient, non-credit and or exempted courses :

ADVISORY COMMITTEE

S.No	Status	Name & Designation	Deptt.	PG Code No.	Signature
1.	Major Advisor				
2.	Member/ CoMajor advisor				
3.	Member				
4.	Member				
5.	Member				
6.	Member				

For Courses see on the reverse.

Signature of Clerk

Contd.....

Ph.D. COURSE PROGRAMME APPROVED BY THE ADVISORY COMMITTEE

Course No.	Title of the Course	Credit Hrs.
	MAJOR COURSES **(A) Core (6 Cr. Hrs.)**	
	(B) Optional (Minimum 12 Cr. Hrs.)	
	Total	
	MINOR & RELATED COURSES (Minimum 9 Cr. Hrs.)	
	Total	
	NON CREDIT COURSES (Minimum 2 Cr. Hrs.) : **If exempted, write order No. and date**	
	Seminar .... Preliminary ..... Research	02 NC 45
	(Minimum 74 Cr. Hrs. are required) **Grand Total**	

Forwarded & Recommended

Head
(Name & Signature)

Dean
(Name & Signature)

Above course Programme is approved.

Director, Resident Instructions

APPENDIX - V

Format for submission of Ph.D. Synopsis

Maharana Pratap University of Agriculture & Technology, Udaipur

SYNOPSIS

1. Name of Scholar_____ Class _____
2. Registration No._____ Date of Registration _____
3. Title of Thesis _____
4. Department and College _____
5. Expected duration of the work _____
   (give the period form ..... to .....)
6. Objectives
7. Importance of proposed investigation.
8. Review of Literature.
9. Proposed Plan of work
10. Facilities existing including farm, equipment, laboratories etc. with details.
11. Location of area, if field work
12. Literature cited (Signature of the student at the end of Literature cited with date & place).
13. Certificate in the format given below:

The members of Advisory Committee of Mr./Miss/Mrs..... met on ..... at ..... in which the candidate presented the synopsis of his/her research work entitled ..... to be carried out for Ph.D. degreein ……. in the form of a seminar. After discussion, the committee has recommended the synopsis for approval.

ADVISORY COMMITTEE

S.No.	Name & Designation	Status	P.G. Code No.	Signature
1.		Major Advisor		
2.		Advisor		
3.		Advisor		
4.		Advisor		
5.		DRI Nominee		

We have gone though synopsis critically and fully satisfied with the quantum and quality of proposed research work for Ph.D. (course work) and the same is recommended and forwarded for approval.

Dean
College of Technology and Engineering

Head
Department of .....
College of Technology and Engineering

The synopsis is hereby approved/not approved/to be revised.

Director, Resident Instructions

APPENDIX - VI

Format for submission of Master's Synopsis

Maharana Pratap University of Agriculture & Technology, Udaipur

SYNOPSIS

1. Name of Scholar_____ Class _____
2. Registration No._____ Date of Registration _____
3. Title of Thesis _____
4. Department and College _____
5. Expected duration of the work _____

   (give the period from ..... to .....)
6. Objectives
7. Importance of proposed investigation
8. Review of Literature
9. Proposed Plan of work
10. Facilities existing including farm, equipment, laboratory etc. with details
11. Location of area, if field work
12. Literature cited (Signature of the student at the end of Literature cited with date & place)
13. Certificate in the format given below:

The members of Advisory Committee of Mr./Miss/Mrs.....met on ..... at ..... in which the candidate presented the synopsis of his/her research work entitled ..... to be carried out for Master's degree in ……. in the form of a seminar. After discussion, the committee has recommended the synopsis for approval.

ADVISORY COMMITTEE

S.No.	Name & Designation	Status	P.G. Code No.	Signature
1.		Major Advisor		
2.		Advisor		
3.		Advisor		
4.		DRI Nominee		

I have gone though synopsis critically and fully satisfied with the quantum and quality of proposed research work for Master's degree and the same is recommended and forwarded for approval.

Head
Department of .....
College of Technology and Engineering

The synopsis is hereby approved/not approved/to be revised.

Dean

APPENDIX – VII-A

Format of Certificate for submission of report of Comprehensive Examination

CERTIFICATE OF COMPREHENSIVE EXAMINATION FOR MASTER'S PROGRAMME

SEMESTER I/II, 20_____

This is to certify that Mr./Miss/Mrs._____a student of the College of Technology and Engineering in the subject of _____was examined by the following members of the committee for oral comprehensive examination held on _____at the College of Technology and Engineering. On the basis of his/her performance, the members of the committee have awarded her/him the following marks and grade:

Comprehensive (for Master's degree):

			Marks obtained
a)	Written examination:	Major (MM100) =	……
		Minor (MM 100) =	……
b)	Oral examination: Satisfactory / Unsatisfactory	(MM 100) =	……

1. Major Advisor
(Name & Signature)

2. Advisor
(Name & Signature)

3. Advisor
(Name & Signature)

4. Advisor
(Name & Signature)

Head of Department
(Name & Signature**)**

No. …….. Date: ……..……

CC: i) The Director, Resident Instructions, Maharana Pratap University of Agriculture & Technology, Udaipur.
ii) The Controller of Examinations, Maharana Pratap University of Agriculture & Technology, Udaipur.
iii) The Dean, College of Technology and Engineering, Udaipur
iv) The Student's file in the department.

HEAD OF DEPARTMENT

APPENDIX – VII-B

Format of Certificate for submission of report of PreliminaryExamination

CERTIFICATE OF PRELIMINARY EXAMINATION FOR Ph.D. DEGREE

SEMESTER I/II, 20_____

This is to certify that Mr./Miss/Mrs._____a student of the College of Technology and Engineering in the subject of _____was examined by the following members of the committee for oral preliminary examination held on _____ at the College of Technology and Engineering. On the basis of his/her performance, the members of the committee have awarded her/him the following marks and grade:

Preliminary (for Ph.D. degree):

			Marks obtained
a)	Written examination:	Major I (MM100) =	……
		Major II (MM 100) =	……
		Minor (MM100) =	……
b)	Oral examination: Satisfactory / Unsatisfactory	(MM 100) =	……

1. Major Advisor
(Name & Signature)

2. Advisor
(Name & Signature)

3. Advisor
(Name & Signature)

4. Advisor
(Name & Signature)

5. Advisor
(Name & Signature)

External Examiner
(Name & Signature)

Head of Department
(Name & Signature**)**

No. …… Date: ……..

CC: i) The Director, Resident Instructions, Maharana Pratap University of Agriculture &Technology, Udaipur.
ii) The Controller of Examinations, Maharana Pratap University of Agriculture &Technology, Udaipur.
iii) The Dean, College of Technology and Engineering, Udaipur.
iv) The student's file in the department.

HEAD OF DEPARTMENT

APPENDIX- VIII

Format of thesis to be followed

1. Title cover-outer (Covered with plastic sheet)
2. Title cover-inner
3. Title page
4. Certificate - I (Comprehensive/Preliminary Examination)
5. Certificate - II
6. Certificate - III
7. Certificate - IV (Correction Certificate)
8. Acknowledgement
9. Contents
10. List of Tables
11. List of figures and graphs
12. List of appendices
13. Introduction
14. Review of Literature
15. Material and Methods (May be divided into
16. Results suitable chapters
17. Discussion depending upon the
18. Summary problems)
19. Literature cited
20. Abstract in English
21. Abstract in Hindi
22. Appendices

Note :- (i) The size of the thesis should be A4 (8 ½" x 11")

(ii) Thesis should be submitted with computer laser typesetting in 1½spacing using 12 point size letter.

(iii) The page from Introduction to Literature cited are numbered in Arabic and appendices in Roman (bold face) numbers.

(iv) The bound thesis should have a plastic cover.

(v) The faculty-wise colour-coding of the title cover be as follows:

a)	Agriculture	:	Light Green / Olive Green
b)	**Technology & Engineering**	**:**	**Sky blue / Light blue**
c)	Home Science	:	Light Pink / Pink
d)	Dairy & Food Science Technology	:	Cream
e)	Fisheries	:	Navy Blue
f)	Horticulture & Forestry	:	Golden

APPENDIX - IX

Hint	Format of outer & inner Cover of Master's Thesis
Title in English	**Design Development and Performance Evaluation of Low Cost Hybrid Dryer cum Cooker for Household Usage**
Title in Hindi	**घरेलू उपयोग के लिए कम लागत संकर शुष्कक कुकर की संरचना, विकास और प्रदर्शन मूल्यांकन**
Full Name of Student	*Chaudhary Rameshbhai Harjibhai*
Full Name of Degree (Subject)	**Thesis** **Master of Technology in Agricultural Engineering** **(Renewable Energy Engineering)**
Emblem of the University	
Year	**2016**
Name of the Department & College	**Department of Renewable Energy Engineering** **College of Technology and Engineering** **Maharana Pratap University of Agriculture & Technology, Udaipur**

APPENDIX-X

Format of title page of Master's Thesis

Hint	
Title in English	**Design Development and Performance Evaluation of Low Cost Hybrid Dryer cum Cooker for Household Usage**
Title in Hindi	**घरेलू उपयोग के लिए कम लागत संकर शुष्कक कुकर की संरचना, विकास और प्रदर्शन मूल्यांकन**
Requirement of	**Thesis** **Submitted to the** **Maharana Pratap University of Agriculture & Technology, Udaipur**
Name of Degree in Full (Subject)	**In Partial Fulfillment of the Requirement for the Degree of** **Master of Technolgy in Agricultural Engineering** **(Renewable Energy Engineering)**
Emblem of the University	
Full Name of the Student	By *Chaudhary Rameshbhai Harjibhai*
Year of Submission	2016

APPENDIX - XI

Format of outer & inner Cover of Ph.D. Thesis

Hint	
Title in English	**Studies on Air Assisted Variable Rate Spraying with Ultrasonic Scanning for Orchard Crops**
Title in Hindi	**फलों के बागों हेतु अल्ट्रासोनिक स्कैनिंग युक्त वायु सहायक परिवर्तनीय दर छिड़काव का अध्ययन**
Full Name of Student	Mr. Sachin Vilas Wandkar
Full Name of Degree (Subject)	**Thesis** **Doctor of Philosophy in Agricultural Engineering** **(Renewable Energy Engineering)**
Emblem of the University	
Year of submission	**2016**
Name of the Department & College	**Department of Farm Machinery and Power Engineering** **College of Technology and Engineering** **Maharana Pratap University of Agriculture & Technology, Udaipur**

APPENDIX - XII

Format of title page of Ph.D. Thesis

Hint	
Title in English	**Studies on Air Assisted Variable Rate Spraying with Ultrasonic Scanning for Orchard Crops**
Title in Hindi	**फलों के बागों हेतु अल्ट्रासोनिक स्कैनिंग युक्त वायु सहायक परिवर्तनीय दर छिड़काव का अध्ययन**
Requirement of	**Thesis** **Submitted to the** **Maharana Pratap University of Agriculture & Technology, Udaipur**
Name of Degree in Full (Subject)	**In Partial Fulfillment of the Requirement for the Degree of** **Doctor of Philosophy in Agricultural Engineering** **(Farm Machinery and Power Engineering)**
Monogram of the University	
Full Name of the Student	By Mr. Sachin Vilas Wandkar
Year of Submission	2016

APPENDIX - XIII

Format of Certificate - I to be included in the Thesis

COLLEGE OF TECHNOLOGY AND ENGINEERING
MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY, UDAIPUR

CERTIFICATE - I

Date: _____

This is to certify that _____ student of _____had successfully completed the comprehensive/preliminary examination held on_____ as required under the regulation for Post-Graduate Studies.

(Signature & Date)
Name of the Head of Deptt.
College of Technology and Engineering

Note: While typing include what is applicable only.

APPENDIX - XIV

Format of Certificate - II to be included in the Thesis

COLLEGE OF TECHNOLOGY AND ENGINEERING

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY, UDAIPUR

CERTIFICATE - II

Date: _____

This is to certify thatthis thesis entitled _____

_____ submitted for the degree of _____ in the subject of _____embodies bonafide research work carried-out by Mr./Miss/Mrs. _____

(first name) (middle name) (surname)

under my guidance and supervision and that no part of this thesis has been submitted to any other degree. The assistance and help received during the course of investigation have been fully acknowledged. The draft of the thesis was also approved by the advisory committee on _____ .

....

(Head of Department) (Major Advisor)

Name & Signature Name & Signature

.....

(Dean of the College)

Name & Signature

APPENDIX - XV

Format of Certificate - III to be included in the Thesis

COLLEGE OF TECHNOLOGY AND ENGINEERING
MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY, UDAIPUR

CERTIFICATE - III

Date: _____

This is to certify thatthis thesis entitled _____

_____ submitted by Mr./Miss/Mrs. _____ to Maharana Pratap University of Agriculture & Technology, Udaipur in partial fulfillment of the requirement for the degree of _____ in the subject of _____ after recommendation by the external examiner was defended by the candidate before the following members of the examination committee. The performance of the candidate in the oral examination held on _____was found satisfactory, we therefore, recommend that the thesis be approved.

.....	.....
(Major Advisor)	(Advisor)
Name & Signature	Name & Signature
.....	.....
(Advisor)	(Advisor)
Name & Signature	Name & Signature
.....	.....
(Advisor)	(Advisor)
Name & Signature	Name & Signature
.....	…….
(Head of the Department)	Dean
Name & Signature	

Approved

DIRECTOR RESIDENT INSTRUCTION
MPUAT, UDAIPUR

APPENDIX - XVI

Format of Certificate - IV to be included in the Thesis

COLLEGE OF TECHNOLOGY AND ENGINEERING
MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY, UDAIPUR

CERTIFICATE - IV

Date: _____

This is to certify that Mr./Miss/Mrs. _____ student of _____(class) _____ (Department) has made all corrections / modifications in the thesis entitled _____ _____ which were suggested by the external examiner and the advisory committee in the oral examination held on _____. The final copies of the thesis duly bound and corrected were submitted on _____.

.....	.....
(Head of Department)	(Major Advisor)
Name & Signature	Name & Signature

APPENDIX - XVII

Format of Certificate for Submission of Viva-Voce Report of Master's thesis

……..……..……(Name of department)

COLLEGE OF TECHNOLOGY AND ENGINEERING

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, UDAIPUR

Date _____

This is to certify that the thesis entitled_____ submitted by Mr./Miss./Mrs./ _____to the Maharana Pratap University of Agriculture & Technology, Udaipur, in partial fulfillment for Masters degree in _____ and recommended by the external examiner was examined orally by the committee consisting of undersigned. The committee recommends that:

*(i) The performance of the candidate has been found satisfactory. We recommend the acceptance of the thesis for the award of degree.

*(ii) The performance of the candidate has been found unsatisfactory. The candidate be asked to re-appear in the oral examination.

.....	.....
(Major Advisor)	(Advisor)
Name & Signature	Name & Signature
.....	.....
(Advisor)	(Advisor)
Name & Signature	Name & Signature
.....	.....
(Advisor)	(Advisor)
Name & Signature	Name & Signature

Forwarded by the Head, Department of _____ to:-

1. The Director Resident Instructions, MPUAT, Udaipur with five copies of bound thesis.
2. The Dean, College of Technology and Engineering, Udaipur.

Head of Department
(Name & Signature)

* Do not include, which is not applicable or strike-out.

** Please note that full name of the Head, Major Advisor and Advisors must be printed.

APPENDIX - XVIII

Format of Certificate for Submission of Ph.D. Thesis Viva-Voce Report

……(Name of Department)

COLLEGE OF TECHNOLOGY AND ENGINEERING

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE AND TECHNOLOGY, UDAIPUR

Date_____

This is to certify that the thesis entitled _____ submitted by Mr./Miss./Mrs. _____ to the Maharana Pratap University of Agriculture & Technology, Udaipur, in partial fulfillment of the Ph.D. degree in _____ (subject) of the faculty of _____ and recommended by both the external examiners was examined orally by the committee consisting of undersigned. The committee recommends that:

*(i) The performance of the candidate has been found satisfactory. We recommend the acceptance of the thesis for the award of degree.

*(ii) The performance of the candidate has been found unsatisfactory. The candidate be asked to re-appear in the oral examination.

.....	.....	.....
(Major Advisor)	Director Resident Instructions/	(Advisor)
Name & Signature	Dean of the College	Name & Signature
.....	.....	.....
(Advisor)	(External Examiner**)**	(Advisor)
Name & Signature	Name & Signature	Name & Signature
.....		.....
(Advisor)		(Advisor)
Name & Signature		Name & Signature

Forwarded by the Head, Department of …….to:-

1. The Director Resident Instructions, MPUAT, Udaipur with five copies of bound thesis and the certificate of incorporation of corrections & suggestions.
2. The Dean, College of Technology and Engineering, Udaipur.

Head of Department
(Name & Signature)

* Do not include, which is not applicable or strike-out.

** Please note that full name of the Head, Major Advisor, Advisors and Dean must be printed.

APPENDIX – XIX

POST GRADUATE SCHEDULE

MASTER'S PROGRAMME

Semester		Activities	Time limits
First	a)	Fresh admission and registration	As scheduled
	b)	Appointment of Major Advisor	15 days
	c)	Formation of Advisory Committee and its approval from Director Resident Instructions	First month
	d)	Meeting of Advisory Committee to chalk course programme	Second month
	e)	Course program approval from Director, Resident Instructions	Third month
Second	a)	Registration in second semester as per the course programme approved by Director, Resident Instructions	As scheduled
	b)	Allotment of research problem	First month
	c)	Seminar on synopsis.	Second month
	d)	Submission of synopsis of the research problem for approval of Director Resident Instructions.	Third month
Third	a)	Request for comprehensive examination	Last month
	b)	Beginning of the research	
Fourth	a)	Beginning of the research	
	b)	Comprehensive examination.	
	c)	Thesis submission.	Last month
Fifth		Thesis submission *	

*Issue of warning to student, if not submitted.

Note: Above time limits are the upper limits by which specified activities must be completed. Efforts be made to adhere with the above prescribed schedule so that all the requirements are timely fulfilled. In case of unusual delay, reason (s) for the same be recorded.

APPENDIX – XX

POST GRADUATE SCHEDULE

Ph.D. PROGRAMME

Semester		Activities	Time limits
First	a)	Appointment of Major Advisor and Advisory Committee	15 days
	b)	Approval of advisory Committee by Director, Resident Instructions	First month
	c)	Meeting of Advisory Committee to chalk-out courseprogramme	Second month
	d)	Course program approval from Director, Resident Instructions	Third month
Second	a)	Registration to second semester as per the course programme approved by DRI	As scheduled
	b)	Allotment of research problem	First month
	c)	Seminar to finalize synopsis of the research work and approval of synopsis by Director, Resident Instructions	Second month
Third	a)	Beginning of the research	First month
	b)	Request for preliminary examination	
	c)	Written preliminary examination	Second month
	d)	Oral preliminary examination	Third month
Fourth		Thesis work	
Sixth		Thesis submission*	

*Issue of warning to student, if not submitted.

Note: Above time limits are the upper limits by which specified activities must be completed. Efforts be made to adhere with the above prescribed schedule so that all the requirements are timely fulfilled. In case of unusual delay, reason (s) for the same be recorded.

APPENDIX - XXI

PROFORMA TO BE USED FOR SIGNING M.O.U. FOR COLLABORATIVE STUDENT'SPROGRAMMES

MEMORANDUM OF UNDERSTANDING

Between …….....……. and MPUAT, Udaipur for carrying out research work at ……..……for Master's and Doctoral Degrees.

1. This memorandum of understanding is executed on …….. (date) between Maharana Pratap University of Agriculture and Technology, Udaipur (hereinafter referred to as the First Party) and …… (hereinafter referred to as the Second Party) for Doctoral and Master's Degrees Research in the field of …….
2. Master's and Doctoral research project will be carried out at the premises of the First Party and the Second Party as per the requirement. The students will complete the project work and prepare the thesis and submit it to the First Party for their respective degrees.
3. There may be periodical meetings of the supervisor at the premises of Second Party or First Party by mutual consultation of both the parties. All the expenditures towards TA/DA of the supervisors to attend such meetings will be borne from the source of the salary.
4. Second party will provide hostel facilities to the students and guest house facilities to the supervisor on payment basis subject to the availability of accommodation in the hostel / guest house.
5. The Second Party would make available the existing facilities like Library, Laboratory, Workshop, fields, etc. to the student for their project works during such timings as are applicable to other institute's employees. There will be no financial liability on the part of First Party (MPUAT) on account of chemicals / glassware or any other expenditure incurred by the second party during the course of Master's/ Doctoral research work.
6. After the thesis is submitted and viva-voce is over, the First Party will provide two copies of the thesis to the Second Party, one for Library and the other for the Co-Major Advisor.
7. The information generated through such project work shall deem to be the credit of both the First Party and the Second Party. In the event of any publication of these results / data, the Co-Major Advisor of Second Party will be one of the authors.
8. The Co-major Advisor will have to attend in person following activities pertaining to Master's/ Doctoral programme of the concerned student for which TA/DA and other expenditure will be charged from the source of his salary:
   a) Synopsis Seminar
   b) Pre-thesis Seminar
   c) Thesis Viva-voce

(Signature of First Party) (Signature of Second Party)

DEAN Dean / Associate Dean

DIRECTOR Dean (PG) / Director Instruction
RESIDENT INSTRUCTION,MPUAT, UDAIPUR

REGISTRAR REGISTRAR

APPENDIX - XXII

ACKNOWLEDGEMENT

I take it to be my proud privilege to avail this opportunity to express my sincere and deep sense of gratitude to my learned major advisor _____for his stimulating guidance, constructive suggestions, keen and sustained interest and incessant encouragement bestowed during the entire period of investigation, as well as critically going through the manuscript.

I am gratified to record sincere thanks to the members of the advisory committee; Dr. _____ Department of _____,

Dr. _____ Department of _____,

Dr. _____ Department of _____, College of _____ and

Dr. _____, Associate Professor (Department _____) DRI Nominee for their generous gestures and valuable suggestions in planning and execution of this study.

The author is indebted to Dr. _____ Professor & Head, Department of _____, College of _____, Udaipur for providing me facilities and encouragement during the course of investigation.

I am privileged to express sincere and deep sense of gratitude to Dr. _____, Dean, College of _____, Udaipur for his due attention and encouragement during the study period and also for providing me the necessary facilities during the course of research.

Words can hardly register the sincere and heartfelt feeling which I have for Dr. _____, Dr._____, Dr. _____ and other staff members for their kind cooperation and help as and when needed.

I am much obliged to thank _____ in providing me the necessary funds for my post-graduate studies.

I can not forget to thank _____ for his ever willing co-operation and nice laser typesetting of the manuscript.

I feel short of words to express my gratitude to my family members for their utmost co-operation, sacrifice and encouragement during the course of this work.

Place: Udaipur
Date: _____

(Signature &Name of student)

APPENDIX - XXIII

LITERATURE CITED

Variation in **"Literature Cited"** chapter in synopsis / thesis have been observed. In order to maintain uniformity, henceforth following pattern in chapter "Literature Cited" be followed:

Sharma, A.K. and Gautam, B.P. 1999. Integrated pest management strategy against bollworm complex of cotton. *Indian Journal of Entomology* **64** : 623-626.

Rajkhowa, D.J., Kandali, R., Barua, I.C, and Deka, N. C. 2005. Integrated weed and nutrient management practices in wheat + rapeseed intercropping system. *Indian Journal of Weed Science* **37** : 139-141.

Sankaran, S., Jayakumar, R. and Kempuchetty, N. 1993. Herbicide residues. Gandhi Book House, Coimbtore pp. 79-85.

Tiwari, J.P., Kurchania, S.P. and Paradhkar, N.R. 1995. Impact of small canary grass dominated weed eco-system on wheat and effect of isoproturon on sustainable yield. *In* : *Proceedings of Biennial Conference, Indian Society of Weed Science* held at Annamalai during February 9-10,1995, pp. 34-35.

Bellaki, M.A., Badanur, V.P., Faroda, A.S., Joshi, N.L., Kathju, S. and Kar, Amal. 1999. Integrated nutrient management for sustainable crop production. *In: Proceedings of Symposium on Recent Advances in Management of Arid Ecosystem* held at Jodhpur in March,1997. Faroda, A.S., Joshi, N.L. and Kathju, S. (Eds) pp 271-276.

Jat, R.S. 2002. Effect of weed control and method of sowing on productivity of wheat *(Triticum aestivum* L.) in sub-humid southern plain and Aravalli hills zone of Rajasthan. Ph.D. thesis submitted to Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.

Therefore in concise way following points be taken into consideration:

- Surname of authors be pointed first. Spellings of names of author(s) at two places (text and Literature cited) should correspond
- Year without brackets
- 2nd line from 5th letter of 1stline
- Journal Symposium/ Conference name in full and in italic letters
- Vol. No. should be bold
- Avoid issue number
- Pages 139-141 instead 139-41
- Pages for book ref. as pp. 79-85

APPENDIX - XXIV

DIRECTORATE OF RESIDENT INSTRUCTIONS

Maharana Pratap University of Agriculture andTechnology, Udaipur

Rules and Guidelines for award of Gold Medal during University Convocation

Eligibility

1. Each faculty will nominate students double the number of gold medal to be awarded by the respective faculty.
2. Ph.D candidates who have obtained a minimum OGPA of 7.5 or above. The course work should have been completed in semester programme without any ‘’F’’ grade/ Backlog and any in disciplinary case against him/her.
3. Thesis is compulsory requirement, one extra semester may be allowed for completion and approval of thesis. (Total 7 Semesters).
4. Gold Medal will be given faculty-wise to Ph.D students after competition; minimum number of students for eligibility should not be fixed.

Nomination of names from faculty

1. The names of such selected candidates from each College will be identified by respective Chairman of the faculty through faculty level screening based upon academic achievements, thesis evaluation report submitted by the external examiner and presentation of the research work through seminar by the students in front of the Committee constituted by the Chairman of the faculty.
2. Names of nominated students should be submitted by due date.

Criteria and procedure for final selection of Ph.D.candidates for Gold Medal award

1. For awarding Gold Medal at Ph.D degree level students will be identified through

   University level screening considering following three criteria as under:

   - Academic record
   - Thesis work of the student and Examiners report
   - Presentation of research work

2. The weightage given to these 3 components would be:

	Ph.D.
Academic record	50%-50 marks
Thesis work and report	20%-20 marks
Seminar Presentation	30%-30 marks

3. For award of marks in Academic record, OGPA of the student is to be multiplied by 5. It will form the score of participant's academic record.
4. For award of 20 marks in thesis work, thesis and its evaluation report by external examiner will be given to a committee common for all the faculties. The committee under the chairmanship of DRI shall have 3 Deans nominated by Hon'ble Vice- Chancellor as members. Committee members will individually assign marks out of 20.The marks assigned by the 3 members will be pooled for overall assessment.
5. For remaining 30 marks, students will present a seminar for 10 minutes duration before all the faculty members.
6. The evaluation of students seminar will be done by the Jury approved by Hon'ble Vice-Chancellor comprising of very senior scientist or educationist / technocrats. One of these will act as Chairman of this Jury. The Jury will comprise of 4 members including chairman.
7. The assessment of seminar presentation will be based on following criteria:

			Ph.D.
i.	Language	20 %	6 marks
ii.	Articulation	20 %	6 marks
iii.	Research findings	40%	12 marks
iv.	Conclusion	10%	3 marks
v.	Use of AV aids	10%	3 marks
	Total	100%	30 marks

8. Each member of the jury will assess the performance of the student individually, which will be pooled for overall assessment.
9. In case of tie, the gold medal will be awarded on the basis of academic achievements at UG/ Masters' level and Ph.D. level as the case may be.
10. At stage, warning lights will be arranged where green,yellow and red bulbs will indicate comfortable time, warning time and time up period respectively. Comfortable time will be of 8 minutes. After 8 minutes, yellow light will indicate the warning period and just at the end of 10^{th} minute the red light will signal for time up. A timer bell to indicate the comfortable, warning and time up period will be used in case the lights are not possible. A grace of 15 seconds shall be allowed to finally stop the presentation. After this grace period, negative marking will start; the negative marking will be in the form of deduction of one mark each 15 second slot and the fraction thereof.
11. The evaluation criteria will be explicitly announced in the hall before the start of competition.
12. The cut off for awarding Gold Medal will be as per eligibility criteria i.e. 75 % or more.

APPENDIX - XXV

Dress Code in the University Convocation

क्र.सं.	श्रेणी	ड्रेस कोड	
1.	कुलपति एसं कुलसचिव	(i)पुरुष–	सफेद/ऑफ व्हाईट/क्रीम कलर का जोधपुरी सूट, मेवाड़ी पगड़ी एवं काले जूते
		(ii)महिला–	सफेद/ऑफ व्हाईट क्रीम कलर की साड़ी मय लाल कलर का बॉर्डर व ब्लाऊज एवं काले सेंडिल/स्लीपर
			इस श्रेणी हेतु लाल कलर का स्टॉल्स (मय चमकीला बॉर्डर) एवं बैज उपयोग करेंगे।
2.	विश्वविद्यालय के अधिकारी/प्राधिकारी	(i)पुरुष–	सफेद/ऑफ व्हाईट/क्रीम कलर का जोधपुरी सूट, मेवाड़ी पगड़ी एवं काले जूते
		(ii)महिला–	सफेद/ऑफ व्हाईट क्रीम कलर की साड़ी मय लाल कलर का बॉर्डर व ब्लाऊज एवं काले सेंडिल/स्लीपर
			इस श्रेणी हेतु लाल कलर का स्टॉल्स (मय चमकीला बॉर्डर) एवं बैज उपयोग करेंगे।
3.	बिन्दु संख्या 2 के अतिरिक्त अन्य प्राधिकारी यथा जन प्रतिनिधि, विभिन्न नामित व्यक्ति (Non-officials)	(i)पुरुष–	सफेद/ऑफ व्हाईट/क्रीम कलर का जोधपुरी सूट, मेवाड़ी पगड़ी एवं काले जूते
		(ii)महिला–	सफेद/ऑफ व्हाईट क्रीम कलर की साड़ी मय लाल कलर का बॉर्डर व ब्लाऊज एवं काले सेंडिल/स्लीपर
			इस श्रेणी हेतु लाल कलर का स्टॉल्स (मय चमकीला बॉर्डर) एवं बैज उपयोग करेंगे।
4.	डिग्री / मैडल प्राप्त करने वाले विद्यार्थी	(i)पुरुष–	सफेद कलर का कुर्ता–पायजामा/पेंट–शर्ट/धोती–कुर्ता तथा काले जूते
		(ii)महिला–	सफेद साड़ी/सलवार–सूट लाल कलर का बॉर्डर व ब्लाऊज एवं चुन्नी/दुपट्टा एवं काले सेंडिल/स्लीपर
			इस श्रेणी हेतु लाल कलर का स्टॉल्स (मय चमकीला बॉर्डर) एवं बैज उपयोग करेंगे।

नोट:सर्दियों के मौसम में गहरे मैरून रंग का जैकट उपयोग में लिया जाये।

APPENDIX - XXVI

College of Technology and Engineering

Maharana Pratap University of Agriculture & Technology, Udaipur

Guidelines/ Summary of PG Rules to be followed by the PG students during their course of studies (indicative only, subject to change)

Semester	Particulars	M. Tech.	Ph.D	Remarks
	Core Courses	4	2	Resolution No. MPUAT/AC/24/2008-01/07
I	Admission & Registration	As per schedule	As per schedule	
	Appointment of Major Advisor	15 days	15 days	
	Advisory committee formation & it's approval	1st month	1st month	
	Meeting of advisory committee to chalk out course programme	2nd month	2nd month	
	Course programme approval from DRI	3rd month	3rd month	
II	Registration	As per schedule	As per schedule	
	Allotment of research problem	1st month	1st month	
	Seminar to finalize synopsis of the research work	2nd month	2nd month	
	Submission of Synopsis & it's approval	3rd month	2nd month	For M.Tech. submit five copies, approval by DRI. For Ph.D. initially send only one copy to the DRI (only when there is no professor in the department)
III	Beginning of the research	√	1st month	
	Request for comprehensive examination	Last month	-	To Dean for writtenand oral
	Request for preliminary examination	-	1st month	To Dean for written and to DRI for oral for appointment of external examiner (thro' the Dean).
	Written preliminary examination	-	2nd month	Resolution No. MPUAT/AC/24/2008-01/14
	Oral preliminary examination	-	3rd month	By the external examiner appointed by DRI

IV	Research	Continued	-	
	Comprehensive examination	1st month	-	By the advisory committee
	Written preliminary examination	-	2nd month	
	Thesis submission	Last month	-	
	Oral examination	Through LCD presentation in front of the advisory committee	-	After evaluation & receipt of thesis from the external examiner
	Final bound thesis submission	After oral examination	-	Incorporating necessary corrections. Also submit 2 sets of requisite certificates
V	Thesis, if not submitted	*	-	
IV-VI	Research / Thesis work	-	Continued	
VI	Thesis submission	-	*	
	Ph.D. thesis viva-voce	-	Through LCD presentation in front of the external examiner & advisory committee	After evaluation & receipt of the thesis from the external examiners
	Final bound thesis submission	-	After Ph.D. thesis viva-voce	Incorporating necessary corrections. Also submit 2 sets of requisite certificates

*Issue of warning to student, if not submitted.

Note:

1. Above time limits are the upper limits by which specified activities must be completed. Efforts be made to adhere prescribed schedule so that all the requirements are timely fulfilled. In case of unusual delay, reason(s) for the same be recorded.
2. Guidelines for conduct of M.Tech./Ph.D. thesis viva-voce you may refer DRI letter No.F/DRI/MPUAT/2008/1046-85 Dt.04.04.08.
3. For PDC/Result, submit 2 sets of requisite certificates (along with letter of approval from DRI) to the Dean, CTAE.

IMPORTANT

Any dispute arising out of anything connected with the University/ College and its activities including admission/ operation of semester rules will be subject to the jurisdiction of the courts situated in Udaipur.

DISCLAIMER

The statement made in the “Post Graduate Studies Regulations and Course Description” and all information contained herein is believed to be correct at the time of publication. However the university, the DRI and the college reserves the right to make any change and/or addition to the regulations, conditions governing the conduct of students, requirement for degree, fee and any other information, or statements contained in this at any time without notice. No responsibility will be accepted by the university or the College for any hardship or expenses incurred by its students or any other person or persons for such changes, additions, omissions or errors, no matter how they are caused.

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COURSE DESCRIPTION

(SECTION-II)

M. Tech. and Ph.D.

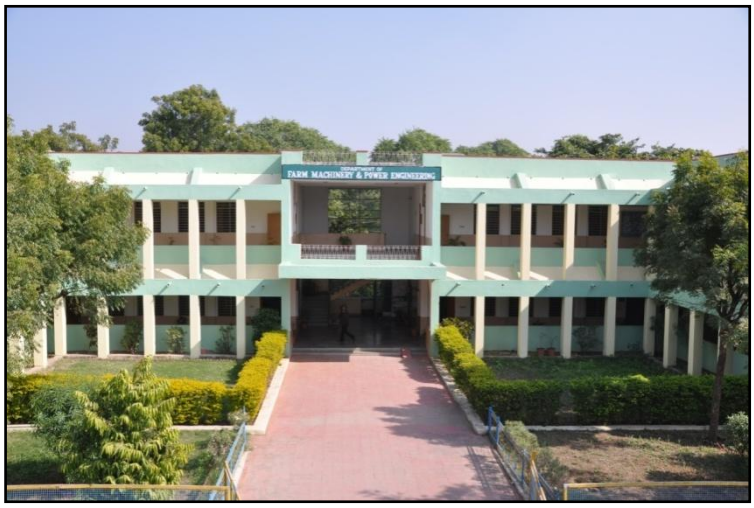
FARM MACHINERY AND POWER ENGINEERING
PROCESSING AND FOOD ENGINEERING
RENEWABLE ENERGY ENGINEERING
SOIL AND WATER CONSERVATION ENGINEERING
IRRIGATION WATER MANAGEMENT ENGINEERING

Effective from 2016-17

COLLEGE OF TECHNOLOGY AND ENGINEERING
MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY
UDAIPUR (Rajasthan) 313001

CONTENTS

DEPARTMENT OF FARM MACHINERY AND POWER ENGINEERING



VISION

The vision of the Department is to excel in teaching, research and extension of Farm Machinery and Power Engineering by providing education of international standards, conducting research at cutting edge to meet the current and future technological challenges, providing trainings of high standard and transfer of technology to the lowest level of use.

MISSION

- To produce highly-trained graduates, develop cutting-edge and appropriate technologies, and provide expertise in the field of Farm Machinery and Power Engineering for national and international development.

- To promote entrepreneurial skills through training programmes and commercialization of agriculture and to promote adoptive ‘‘On Farm Research’’ and technological assessment refinement and its transfer through participatory approaches by promoting institute village linkage programme.

Semester-wise Scheme for Post Graduate Programme in Farm Machinery & Power Engineering

Details of courses offered for the award of M.Tech. (Ag.), FMPE

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV
Core Courses: Total 12 credits; 2 courses in first semester (6 credits) and 1 course each in second and third semester (3 credits each) to be evaluated externally.						
Soil Dynamics in Tillage and Traction	FMPE 511	3 (2+1)	3	-	-	-
Design of Farm Machinery	FMPE 512	3 (2+1)	3	-	-	-
Testing and Evaluation of Tractors and Farm Equipment	FMPE 521	3 (2+1)	-	3	-	-
Farm Power and Machinery Management	FMPE 531	3 (2+1)	-	-	3	-
Optional Courses: Total 15 credits; two courses in first & second semester each (6 credits in each semester) and one course in third semester (3 credits).						
Applied Instrumentation in Farm Machinery and Stress Analysis	FMPE 513	3 (2+1)	3	-	-	-
Dimensional Analysis and Similitude	FMPE 514	3 (2+1)	3	-	-	-
Tractor Design	FMPE 515	3 (2+1)	3	-	-	-
Horticulture and Forestry Equipment	FMPE 516	3 (2+1)	3	-	-	-
Controlled Environment Agriculture	FMPE 522	3 (3+0)	-	3	-	-
Power Hydraulics	FMPE 524	3 (2+1)	-	3	-	-
Product Manufacturing Technology	FMPE 525	3 (2+1)	-	3	-	-
Earth Moving Machines	FMPE 526	3 (2+1)	-	3	-	-
Ergonomics and Safety in Farm Operations	FMPE 535	3 (2+1)	-	-	3	-
Farm Machinery Dynamics, Noise and Vibration	FMPE 536	3 (2+1)	-	-	3	
Organic Farming Management	FMPE 537	3 (3+0)	-	-	3	-
Minor & Supporting Courses: Total 9 credits; one course in first, second and third semester each (3 credits in each semester).						
Statistical Methods	AST 510	3(2+1)	3	-	-	-
Engineering Properties of Food Materials	PFE 512	3(2+1)	3	-	-	-
Higher Mathematics	BS 515	3(3+0)	3	-	-	-
CAD/ CAM	MED 518	3(2+1)	3	-	-	-
Advance Programming with C^{++}	CSE 511	3(2+1)	3	-	-	-
Agro/Energy Audit and Management	REE 515	3(3+0)	3	-	-	-
Methods of Numerical Analysis	BS 521	3(3+0)	-	3	-	-
Alternate Fuels and Applications	REE 524	3(3+0)	-	3	-	-
Design and Analysis of Renewable Energy Conversion Systems	REE 522	3(3+0)	-	3	-	-
System Engineering and Productivity	SWCE 526	3(2+1)	-	3	-	-

Energy Management in Agriculture	REE 537	3(3+0)	-	-	3	-
Direct Energy Conversion Technology	REE 535	3(2+1)	-		3	-
Post Harvest Processing of Grains	PFE 535	3(2+1)	-		3	-
Design of Pumps for Irrigation and Drainage	SWC 536	3(2+1)	-		3	-
Dry land Technology	SWC 537	3(2+1)	-		3	-
Others						
Compulsory Courses; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/502...	1	NC	NC		
Seminar (0+1)	FMPE532	1	-	-	1	-
Comprehensive	FMPE 533	NC			NC	
Research (Thesis). Thesis minimum duration 2 semesters	FMPE 534	20	-	-	-	20
Total credits to be offered (for Master Programme)		**57**	**15**	**12**	**10**	**20**

COURSE SUMMARY

Courses	**No. of Courses**					**Credit Hours**
	Semester					
	I	**II**	**III**	**IV**	**Total**	
Core	2	1	1	-	4	12
Optional	2	2	1	-	5	15
Minor & Supporting	1	1	1	-	3	9
Seminar	-	-	1	-	1	1
Comprehensive	-	-	-	1	1	Non Credit (graded as satisfactory/ non satisfactory)
Research (Thesis)	-	-	-	1	1	20* (graded as satisfactory/ non satisfactory)
Compulsory Courses (PGS Series)	1	1	-	-	2	Non Credit
Total	**6**	**5**	**4**	**2**	**17**	**57**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

Details of courses offered for the award of Ph.D. (Ag. Engg.) FMPE

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV-VI
Core Courses: Total 6 credits (3 credits in each semester); one course in first semester and one course in second semester to be evaluated externally.						
Advances in Farm Machinery and Power Engineering	FMPE 611	3 (2+1)	3		-	-
Agricultural Mechanization and Management	FMPE 621	3 (2+1)	-	3	-	-
Optional Courses: Total 12 credits (6 credits in each semester); two course in first and second semester each.						
Applied Instrumentation in Farm Machinery and Stress Analysis	FMPE 513	3 (2+1)	3	-	-	-
Dimensional Analysis and Similitude	FMPE 514	3 (2+1)	3	-	-	-
Tractor Design	FMPE 515	3 (2+1)	3	-	-	-
Horticultural and Forestry Equipment	FMPE 516	3 (2+1)	3	-	-	-
Machinery for Natural Resource Management and Precision Farming	FMPE 612	3 (2+1)	3		-	-
Application of Ergonomics in Designing of Farm Machines	FMPE 613	3 (2+1)	3		-	-
Advances in Hydraulic Controls for Agricultural Machines	FMPE 614	3 (3+0)	3		-	-
Computer Aided Analysis and Design of Farm Machines	FMPE 615 /MED 615	3 (2+1)	3		-	-
Controlled Environment Agriculture	FMPE 522	3 (3+0)	-	3	-	-
Power Hydraulics	FMPE 524	3 (2+1)	-	3	-	-
Product Manufacturing Technology	FMPE 525	3 (2+1)	-	3	-	-
Earth Moving Machines	FMPE 526	3 (2+1)	-	3	-	-
Machinery for Special Farm Operations	FMPE 623	3 (2+1)	-	3	-	-
Vibrations in Agricultural Machines	FMPE 624	3 (2+1)	-	3	-	-
Experimental Stress Analysis	FMPE 625	3 (2+1)	-	3	-	-
Ergonomics and Safety in Farm Operations	FMPE 535	3 (2+1)	-	-	3	-
Farm Machinery Dynamics, Noise and Vibration	FMPE 536	3 (2+1)	-	-	3	
Organic Farming Management	FMPE 537	3 (3+0)	-	-	3	-
Minor & Supporting Courses: Total 9 credits; two courses in first semester (6 credits) and one course in second semester (3 credits).						
Statistical Methods	AST 510	3(2+1)	3	-	-	-
Engineering Properties of Food Materials	PFE 512	3(2+1)	3	-	-	-
Higher Mathematics	BS 515	3(3+0)	3	-	-	-
CAD/ CAM	MED 518	3(2+1)	3	-	-	-
Advance Programming with C++	CSE 511	3(2+1)	3	-	-	-
Agro/Energy Audit and Management	REE 515	3(3+0)	3	-	-	-
Finite Element Analysis	MED 610	3(2+1)	3	-	-	-
Methods of Numerical Analysis	BS 521	3(3+0)	-	3	-	-
Alternate Fuels and Applications	REE 524	3(3+0)	-	3	-	-
Design and Analysis of Renewable Energy Conversion Systems	REE 522	3(3+0)	-	3	-	-
System Engineering and Productivity	SWCE 526	3(2+1)	-	3	-	-
Data Structures and Algorithms	CSE 621	3(2+1)	-	3	-	-
Energy Management in Agriculture	RES 537	3(3+0)	-	-	3	-

Direct Energy Conversion Technology	RES 535	3(2+1)	-		3	-
Post Harvest Processing of Grains	PFE 535	3(2+1)	-		3	-
Design of Pumps for Irrigation and Drainage	SWC 536	3(2+1)	-		3	-
Dry land Technology	SWC 537	3(2+1)	-		3	-
Others						
Compulsory Courses+; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/ 502...	1	NC	NC		
Seminar	FMPE 691/692	1 (0+1)	1	1	-	-
Preliminary	FMPE 633	NC			NC	
Research (Thesis). Thesis minimum duration 4 semesters	FMPE 634	45	-	-	-	45
Total credits to be offered		**74**	**16**	**13**	**-**	**45**

Note: A Ph.D. student must take two 600 series core courses.A student may choose optional/minor & supporting courses of 500 series courses if not studied during Masters Programme as per ICAR guidelines.

\+ Exempted for those who have cleared these in Master's Programme (permission to be sought from the Dean, CTAE).

COURSE SUMMARY

Courses	No. of Courses							Credit Hours
	Semester							
	I	II	III	IV	V	VI	Total	
Core	1	1	-	-	-	-	2	6
Optional	2	2	-	-	-	-	4	12
Minor & Supporting	2	1	-	-	-	-	3	9
Seminar	1	1	-	-	-	-	2	2
Preliminary	-	-	1	-	-	-	1	Non Credit (graded as satisfactory/ non satisfactory)
Research (Thesis)	-	-	-	-	-	1	1	45* (graded as satisfactory/ non satisfactory)
Compulsory Courses** (PGS Series)	1	1	-	-	-	-	2	Non Credit
Total	**7**	**6**	**1**	-	-	**1**	**15**	**74**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

**Exempted for those who have cleared these in Master's Programme.

SYLLABUS

FARM MACHINERY AND POWER ENGINEERING

CORE COURSES

Soil Dynamics in Tillage and Traction

FMPE 511 **3 (2+1)**

Course Outcome: The student will acquire knowledge regarding mechanics of tillage tools, scouring of soil and importance, determine Kc and Kϕ using plate shrinkage test, wheel slip and its role in traction mechanism, slip measurement and slip control method, rolling resistance and effect of tyre size inflation pressure and lug height on tractive performance, study of effect of soil compaction by agricultural machinery.

Syllabus: Mechanics of tillage tools: Introduction : Inclined, Vertical, Wide blades, Cutting of soil. Scouring of soil and its importance, Soil compaction by Agricultural machines and Tractors.Remedies for soil compaction.Techniques for measuring terrain values and load sinkage relationship.Determination of Kc and Kφ using plate sinkage test.Shear stress, displacement relationship in sinkage and horizontal deformation, slip, sinkage and vertical load.Motion resistance of a rigid wheel and a track. Tractive efforts developed by a wheel and a track. Wheel slip and its role in traction mechanics. Slip measurement & slip control method. Mobility number & effect of mobility number on tractive effort. Rolling resistance & effect of tyre size inflation pressure and lug height on tractive performance. Matching of power, weight, speed and slip to obtain optimum power transmission.

Practicals

1. To study the effect of soil compaction by agricultural machines.
2. Determination of soil movement on M.B. Plough.
3 Measurement of terrain parameters required for tractive performance for prediction of off – road vehicles.
4 Determination of pull-slip curve for a tarmacadam and field condition.
5. Determination of pull-slip curves for a farm tractor on different terrains.
6. Study of rolling resistance and tractive efficiency of rigid, pneumatic and track types vehicles.

Suggested Readings

1. Gill, W.R. and Vanden Berg, Soil Dynamics in Tillage, Handbook No. 316, US Department of Agriculture, 1968.
2. Bekker, M.G. Theory of Land Locomotion, University of Michigan Press, USA, 1956.
3. Bekker, M.G., Off-Road Locomotion, University of Michigan Press USA, 1969.
4. Bekker, M.G., Introduction of Terrain Vehicle System, Michigan, USA, 1969.
5. Karafaith, L.L., and A.A, Nowatzki, Soil Mechanics for Off–Road Engineering,Tran Tech. Pub., Switzerland, 1978.
6. Wong, J.Y., Theory of Ground Vehicle, John Willey & Sons, New York, 1978.
7. Mohesin N.N. 1970. Physical properties of plant and animal materials “Gorden& Breach Science Publishers, New York.

Design of Farm Machinery

FMPE 512 **3(2+1)**

Course Outcome: The student will be able to learn about farm machinery design principles, design of working components of M. B. plough, secondary tillage equipment, types of metering devices and their working, design of thresher cylinder and safety devices for tractor and farm implements.

Syllabus: Farm machinery design principles. Design of working components of a M.B. Plough: share. Forces acting on the M.B. Plough. Design of working component of a disc plough: disc and forces acting on disc. Design of secondary tillage equipments:- Disc harrow. Seeding machines: - types of metering devices and their working. Procedure of design of fluted roller, horizontal plate type metering devices and seed and fertilizer boxes. Forces acting on a cutter bar of a reaper, design of threshing cylinder.Safety devices for tractors and farm implements.Reliability criteria in design of farm machinery.

Practicals

1. Statement and formulation of design problems.
2. Design of share of mould board plough.
3. Design of disc plough.
4. Design of seed metering mechanism.
5. Design of seed hopper for seed drill.
6. Design of cylinder for a multi-crop thresher.
7. Study of various safety devices for tractors and agricultural implements.

Suggested Readings

1. Liljedahl, B.J., Turnquist, P.K, Smith, W.D. and HokiVaketo. Tractor and Their Power units, Fourth Edition, Avi Publications, New York, 1989.
2. Ralph Alcock. Tractor Implement System. AVI Pub. 1986.
3. Bernacki, H., Kanafozski, O and T. Karvowski. Agriculture machines: Theory and Construction. Vol. I and II, translated and published by US Deptt. of Agriculture, 1976.
4. Bosoi, E.S., Vermiaev, OV, Smirnov, I.I. and Sultan –Shakh, E.G. theory, construction and calculation of agriculture machines, A.A Balkema Pub., Rotterdam, 1988.
5. Gyachev, L.V., Theory of surfaces of plow bottoms, A.A Balkema Pub., Rotterdam, 1987.
6. Kepner, R.A., Bainer, Ray and E.L. Barger. Principle of Farm Machinery, AVI Pub., 1978.
7. Nartov, P.S. Disc Soil Working implements, A.A. Balkema Pub. Rotterdam, 1986.
8. Kurtz. G., Thompson, L. and P.Claar. Design of Agricultural Machines, John Willey and sons, 1984.
9. Sharma, D.N. and Mukesh S. Farm Machinery Design: Principles and problems. Jain Brothers, East Park Road, New Delhi.

Testing and Evaluation of Tractors and Farm Equipment

FMPE 521 **3(2+1)**

Course Outcome: Gaining knowledge about testing of agricultural machines and testing of farm tractor, tractor test code BIS: ISO: OECD and Nebraska

Syllabus: Importance and significance of testing and types of tests. Testing of agricultural machines like: M.B. Plough, Disc Plough, Rotavator, Cultivator, Disc Harrow, Seed cum fertilizer drill & planters,manual and power operated weeders, reaper, thresher and chaff cutter,combine harvesters. Plant protection machines. Testing of farm tractor – Tractor test codes:BIS: ISO: OECD and Nebraska.

Practicals

1. Testing of various agricultural machines following test codes.
2. Plough, Harrows, Seed cum fertilizer drill & planters, Weeders, mower, thresher and chaff cutter.
3. Combine harvesters.
4. Plant protection machines.
5. Interpretation of machine and tractor test results BIS: ISO: OECD: Nebraska.

Suggested Readings

1. BIS test codes for farm machines and tractors
2. ISO test code for farm machines and tractor
3. Nebraska tractor test code
4. OECD tractor test code
5. RNAM test codes for farm machines
6. Testing manual, CIAE, Bhopal.

Farm Power and Machinery Management

FMPE 531 **3(2+1)**

Course Outcome: After completing this course student will be acquainted with importance and objectives of farm mechanization in Indian agriculture, estimation of operating cost of tractor and farm machinery, tractor power performance terms, selection of farm machinery, selection of proper power and related problem, reliability of agricultural machinery, replacement of farm machinery and inventory control, spare parts, system approach to farm machinery management and application.

Syllabus: Importance and objectives of farm mechanization in Indian Agriculture, its impact, strategies, myths and future needs. Estimation of operating cost of tractors and farm machinery. Management and performance of power, operator, labour, economic performance of machinery, field capacity, field efficiency and factors affecting field efficiency.Tractor power performance in terms of PTO, drawbar and fuel consumption.Power requirement problems to PTO, DBHP. Selection of farm machinery, size selection, timeliness of operation, optimum width and problem related to its power selection; selecting proper power level and problem related to it. Reliability of agricultural machinery.Replacement of farm machinery and inventory control of spare parts. Systems approach to farm machinery management and application of programming techniques to farm machinery selection and scheduling.

Practicals

1. Study of latest development of different agricultural equipment and implements in India and other developing countries.
2. Size selection of agricultural machinery.
3. Experimental determination of field capacity of different farm machines.
4. Study of farm mechanization in relation to crop yield.
5. Determination of optimum machinery system for field crop and machine constraints.

Suggested Readings

1. Culpin, C, Profitable farm mechanization, Lock Wood & Sons, London, 1996.
2. Hunt, D, Farm Power and Machinery Management, Iowa State University Press, USA, 1979.
3. Singh, S. and Verma, S.R. Farm Machinery Maintenance and Management. DIPA, ICAR, KAB-I, New Delhi.
4. Carveille, L.A. (1980). Selecting farm machinery.Louisiana Cooperative Extn. Services publication.
5. Watters, W.K. (1980) Farm Machinery Management guide. Pennsylvania Agri. Extn. Services Spl. Circular No 192.
6. FAO (1980). Agricultural Engineering in develop: selection of mechanization inputs, FAO, Agri service Bulletin.

Advances in Farm Machinery and Power Engineering

FMPE 611 **3 (2 + 1)**

Course Outcome: To identify the need of comparative analysis of human, bullock, IC engine and other sources of farm power, analysis of force in tractor implement combination under two dimensional condition, principle of design and development of agriculturalmachines and wear in agricultural machines.

Syllabus: Comparative analysis of human, bullock, IC engine and other sources of farm power. Modern transmission system on farm tractor, power losses in tractor, analysis of forces in tractor implement combination under two dimensional conditions, tractor test codes. Mechanics of Animal Traction. Introduction to biofuels for farm engines.Principles of design and development of agricultural machines.Design of seed drills, threshing cylinder, reel and cutter bar, root harvesting machines and graders.

Wear in agricultural machines.

Practicals

1. Design of metering devices for cereals, pulses and oils seeds.
2. Design of cell plates for planters.
3. Design of various components and testing of a multi-crop thresher for cereals, pulses and oil seeds.
4. Estimation of wear of a plow share.
5. Testing of a 5hp IC engine.
6. Study of various transmission system used on farm tractor.
7. Study of properties of biofuel.
8. Engine testing using biofuel.

Suggested Readings

1. Bosoi, E.S. Vermiaev, OV, Smirnov, I-I and Sultan Shakh, E.G. Theory, Construction and Calculation of Agricultural Machines, A.A. BalkemaPoub. Rotterdam, 1988.
2. Gyachev, L.V., Theory of surface of plow bottoms, A.A. Balkema Pub., Rotterdam, 1987.
3. Kanafozski, O and T. Karwowski, Agricultural Machines: Theory and Construction. Vol. I & II, Translated and published by US Deptt. of Agriculture, 1976.
4. Kepner, R.A. Bainer, R, and Barger E.L. Principles of Farm Machinery, AVI Pub., 1978.
5. Kolchin, A. and Dominov, V., Design of Automotive Engines, Mir Publication, Moscow, 1984
6. Liljedahl, B.J., Turnquist, P.K, Smith, W.D. and HokiVaketo. Tractor and Their Power units, Fourth Edition, Avi Publications, New York, 1989.
7. Obert F. Edward, Internal Combustion Engines and Air Pollution. Published by Harper & Row Publishers. London, 1973.
8. BIS test codes for tractors.

Agricultural Mechanization and Management

FMPE 621 **3 (2+1)**

Course Outcome: After completing this course student will be acquainted with concept and objectives of farm mechanization, importance in developed and objective developing countries, mechanization of operation and process in Indian agriculture, farmer mechanization problem, estimation of operating cost, requirement of good management of labour and machinery, economic performance of agricultural machines, quality performance and performance testing problem

related to its power performance, machinery selection, timeliness of operations selecting proper power level and problem related to it.

Syllabus: Concept and objectives of farm mechanization, its importance, myths and concept meaningful and appropriate mechanization. Importance in developed and developing countries, mechanization of operation and process in Indian Agriculture; need, impact and research trends. Relationship between farm mechanization and crop yield for a farming district in India.General effect of farm size in relation of mechanization individual.Farmers mechanization problems. Mechanization management in relation to overall farm management.Estimation of operating costs.Use of efficiency standards.Requirement of good management of labour and machinery.Choice of requirement, capital investment for machines. Labour requirement and machinery cost. Economic performance of agricultural machines.Capacity, concept for predicting capacity of row crop machines.Field efficiency & factors affecting field efficiency. Quality performance and performance testing problem related to its power performance. Tractor power, tractor power measurement & tractor engine performance. PTO performance, drawbar performance& fuel consumption. Power requirement problem related to PTO, SRAF, DBPAP. Operator performance, amount, value and labour cost determination.

Machinery selection: Size selection, Replacement of machine, Timeliness of operation, optimum width and problem related to it. Power selection; selecting proper power level and problem related to it.

Practicals

1. Estimation of horse power per hectare of country and of different states.
2. Study of latest development of different agricultural equipment and implements in India and other developing countries.
3. Size selection of agricultural machinery.
4. Experimental determination of field capacity of different farm machines.
5. Study of farm mechanization in relation to crop yield.
6. Determination of optimum machinery system for field crop and machine constraints.

Suggested Readings

1. Culpin, C, Profitable farm Mechanization, Lock Wood & Sons, London, 1996.
2. Hunt, D, Farm Power and Machinery Management, Lows State University Press, USA, 1979.
3. Carville LA. Selecting Farm Machinery. Louisiana Cooperative Extension Service Pub. 1980.

MAJOR COURSES

Applied Instrumentation in Farm Machinery and Stress Analysis

FMPE 513 **3 (2+1)**

Course Outcome: Gaining knowledge about strain and stress relationship, various methods of determining strain/stress experimentally, measuring device for displacement, strain gauges application, introduction to functional element of instrument, static and dynamic characteristics of instruments, recording device and their types, data storage and their applications.

Syllabus: Strain and stress.Strain relationship, strain gauges; Mechanical, optical, electrical acoustical and pneumatic etc. and their use. Various methods of determining strain/stress experimentally. Measuring devices for displacement (linear and rotational), velocity, force, torque and shaft power. Strain gauges: types and their application in two and three dimensional force measurement.

Introduction to functional elements of instruments.Active and passive transducers, analog and digital modes.Static and dynamic characteristics of instruments.Devices for measurement of temperature, relative humidity, pressure, flow, sound and vibration.Recording devices and their types.Measuring instruments for calorific value of solid, liquid and gaseous fuels.Data acquisition system, micro computers, data storage and their application.

Practicals

1. Bonding of gauge, lead wire installation and testing of gauge.
2. Study of temperature compensating gauge and their circuits.
3. Study of characteristics of equipment needed for static and dynamic strain measurements.
4. Calibration of instruments.
5. Measurement of velocity, force, torque and shaft power.
6. Study of modern trends in micro computer and data storage.

Suggested Readings

1. Dove, R.C., and P.H. Adams, Experimental stress analysis and motion measurement Prtentice-Hall of India Pvt. Ltd., New – Delhi.
2. Lee, G.H. An Introduction to Experimental Stress Analysis
3. Perry C.C., and H.R., Lissner, The strain gauge Primer., McGraw Hill Book Co.
4. Beckwith T.G. Mechanical Measurements. Addison Wesley.
5. Nachtigal C.L. Instrumentation and Control. Fundamentals and Applications. John Wiley and Sons.

Dimensional Analysis and Similitude

FMPE 514 **3 (2+1)**

Course Outcome: This course will give the knowledge about the basic parameters to be considered in the design of the machineries also transformation of product, various possible forces and it's extents on the model in working. It will help students the way of testing of model from similitude design. Also student will study the behavior of fluids to be used in the model, heat transfer and electromagnetic phenomenon in application of similitude.

Syllabus: Scope of dimensional analysis. Transformation of units of measurement. Dimensional homogeneity. Complete sets of dimensionless products. Buckingham Pi theorem. Determinants. Transformation of dimensionless products. Similarity and model testing. Dimensional analysis applied to problem of stress and strain. Fluid mechanics.Heat transfer and electromagnetic theory.Similitude studies and applications.

Practicals

1. Study of method of transformation of units of measurement.
2. Calculation of dimensionless homogeneity.
3. Calculation of dimensionless products.
4. Calculation of problems related to Pi theorem and its application.
5. Method for finding out determinants.
6. Methods for transformation of dimensionless products.
7. Study of procedure for model testing.
8. Problem solving related to stress and strain, fluid mechanics, heat transfer and electromagnetic theory.

Suggested Readings

1. Langhaar, I. Henry I. Dimensional Analysis and Theory of Model. Published by John Wiley and Sons. Inc. London, 1951.
2. Modi and Seth. Hydraulic and Fluid Mechanics, published by Standard Book House, New Dehli, 1991.
3. JagdishLal, Hydraulic and Fluid Mechanics. Published by Metropolitan Book Co. Dehli, 1983.
4. Glenn Murphy, Dimensional Analysis.

Tractor Design

FMPE 515 **3 (2+1)**

Course Outcome: This course will give detailed study of tractor design and various types of tractors with their specification and development. It will give design of various parts of the tractor components, merits and demerits of different types of tractors. It will introduce new sophisticated technologies introduced in tractors to increase the efficiency. Also, study of power transmission system and different parts engaged in power transmission system and study of different control systems of tractor.

Syllabus: Technical specifications of tractors in India, tractor development and its types. Design of IC engine components: piston, piston pin and rings, connecting rod, crankshaft,cam shaft. Valves, engine block, cylinder and cylinder liners, cylinder head studs and valve spring, fuel injection systems and types, merits and demerits of each type, supercharging–general, turbo charging units and system. Transmission system: Types, transmission line, features of gear boxes used for farm tractor. Differentials, final drives and axles, power take of shaft.

Practicals

1. Design of various IC engine components.
2. Experimental determination of Centre of gravity.
3. Performance evaluation of response time of automatic: depth control.
4. Automatic draught control on a farm tractor.
5. Study of various hydraulic components in relation to design of hydraulic system of a farm tractor.
6. Study of performance evaluation of different transmission system.
7. Problems showing utilisation of hydraulics in farm machines.

Suggested Readings

1. Kolchin, A. and Dominov, V., Design of Automotive Engines, Mir Publication, Moscow, 1984.
2. Liljidahl, B.J. Turnquist, P.K. Smith, W.D. and Hoki, Makato. Tractor and there power units, Forth Edition, Avi Publications, New York, 1989.
3. Litcy, C.V., Internal Combustion Engines, McGraw Hill Pub., New York, 1951.
4. Maleev, V.L., Internal Combustion Engines, McGraw Hill Pub., New York, 1951.

Horticulture and Forestry Equipment

FMPE 516 **3(2+1)**

Course Outcome: This course will introduce the students with different types of mechanical aids to be used for plantation crops from planting to harvesting and to transport the forest products. Also, students will study the cost estimation of different horticultural operations using various equipment and different management techniques to minimize the cost of operation. Also it will help students to design the various horticultural operations with specific purpose.

Syllabus: Mechanization of plantation crops, forestry operations, forestry machines and equipment. Machines for posthole digging, seeding, planting, plant protection, circular saw, shearing blades, slasher, winches, beams, ripper, bunchers, tree felling. Forest cleaning and reclamation, logging, stump blasting.Fire control, fire line and their maintenance. Development of resources, ditching and dewatering of ponds. Use of dozers, wheel loaders, motor graders,

scrappers, knock down beams and ripper, forest transport machinery. Cost estimation of forestry operations, management techniques to minimize cost of operation.

Fundamentals of horticultural operations-land preparation, sowing, planting, transplanting, plant propagation and harvesting. Fundamentals of tools and equipment used for land preparation, nursery bed preparation, bed making/digging, sowing of seeds of fruits, vegetables and flowers, raising of nursery, planting/transplanting of seedling, plant propagation-prunning, budding, grafting, cutting etc. Plant protection and harvesting equipment.

Practicals

1. Study of different, hand tools for horticulture and forestry.
2. Study of different equipment for horticulture and forestry.
3. Identification of operations in forestry and horticulture for which new tools need to be designed and developed.
4. Field testing of different equipment used for horticulture and forestry.

Suggested Readings

1. Hopfen, H.J. (1995). Small Farm Implements. FAO Agricultural Development Paper No. 32.
2. Lovergrove, H.T. (1971). Crop Production Equipment. Hutchinson Educational Ltd., London.
3. Robertson, J. (1974). Mechanizing Vegetable Production. Ipswich Farming Press.
4. Hawker, M.F.J. (1977). Horticultural Machinery. 2/e Longman.

Machinery for Natural Resource Management and Precision Farming

FMPE 612 **3 (2+1)**

Course Outcome: This course introduces the students with precision farming technologies and different types of conservation agricultural machineries for natural resource management. It will give the different engineering fundamentals of conservation machineries, construction and operation of different machineries and their suitability for operations and different types of related computer programmes such as critical path methods (CPM).

Syllabus: Functional design, specifications, requirements and working of farm machinery needed for natural recourses management like rotavator, precision sowing and planting machines, laser guided leveler, power sprayer and combine harvester. An introduction to precision farming, issues and conditions.

Engineering fundamentals related to earth-moving machinery, swell and shrinkage, type of compacting equipment, Land clearing equipments, Power shovel: Construction and operation of power shovel, size selection of power shovel, factors affecting the output of a power shovel. Dragline:types of dragline, size, basic parts and operation of a dragline, output of a dragline, estimation of output, effect of different factors on output, numerical problems.

Clam shell:Basic parts and operation of a clam shell, application, size and output of a clam shell.

Trenching machines: types, construction and operation of wheel and ladder type trenching machines, selection of suitable equipment for excavating trenches and production rates of trenching machines. Job planning and management: project network analysis, definitions of terms used in critical path method (CPM), critical path scheduling, AOA diagram, computerized scheduling.

Practicals

1. Study of power shovel, drag line, clamshell.
2. Earth work estimation.
3. Problems related to land development using CPM, machines used for natural recourses management and precision farming.

Suggested readings

1. Peurifoy R.L.-Construction, Planning, Equipment and Methods.
2. Verma Mahesh- Construction equipment and its planning and application.
3. Michael, A.M.-Irrigation theory and practices.
4. Kuhar, J.E. 1977. The precision farming guide for agriculturalist. Lori J. Dhabalt, USA.

Application of Ergonomics in Designing of Farm Machines

FMPE 613 **3(2+1)**

Course Outcome: Students will learn the design criteria of machineries understanding the man and machine relationship for optimum mutual adjustments of man and his work, study of anthropometric and strength data of various regions. Assessment of physical and mental environments of humans and it's limitations to stress and demands of working environments. It is also helpful to study the various safety standards at work place, machine and farm safety. It is helpful in design of hand operated machineries using anthropometric and strength data of particular region.

Syllabus: Concept and design criteria for optimum mutual adjustments of man and his work. Anthropometric and strength data; their method of measurement, analysis and application.Assessment of physical and mental loads; their methods of measurement.Human limitations in relation to stress and demands of working environments.Mechanical environment; noise and vibration and their physiological effects, thermal environments, heat stress, general guidelines for designing visual display.Safety standards and work place, machine safety , farm safety legislation, DMRA. Design aspects of farm machines using anthropometric data. Design of operators seat for tractor and agricultural equipments.

Practicals

1. Assessment of physical load and measurement of sub maximal aerobic capacity.
2. Anthropometric and strength measurements of agricultural workers.
3. Assessment of heat stress in farm operations.

4. Assessment of human response to dust, noise and vibrations.
5. Design of hand tools using Anthropometric and strength data.
6. Design of operator's seat for agricultural tractors.

Suggested Readings

1. Astrant, P.O. and K. Rodhal. A text book of work physiology McGraw Hill Book Co., New York, 1970.
2. McCormic, E.J., Human Factors in Engineering Design, Tata McGrew Hill Pub., Co., New Delhi, 1979.
3. Roebuck, J.A., Kronor, K.H.E. and M.S. Thomas. Engineering Anthropometry Methods, John Willey & Sons, New York, 1975.
4. Zander J. Principles of Ergonomics. Elsevier. 1972.
5. Zander J. Ergonomics in machine design. Elsevier. 1972.

Advances in Hydraulic Controls for Agricultural Machines

FMPE 614 **3 (3+0)**

Course Outcome: This course is useful for the students to study the different types of hydraulic fluids and their properties in designing of hydraulic control systems for agricultural machines,also studying and design of various mechanical components coming in contact with hydraulic control, hydraulic circuit design and safety control of hydraulic motors.

Syllabus: Fluid power, its advantages, properties of hydraulic fluids, viscosity**,** bulk modulus density. Concepts of energy of hydraulic systems, laws of fluid flow, distribution system, pressure rating of tubing and hoses, basics of hydraulic flow and hydraulic circuit analysis- pumps, types and theory and operation, fluid power actuators, hydraulic rams, gear motors, piston motors and their performance characteristics.

Directional pressure safety and servo valves, hydraulic circuit design, regenerative pump unloading, pressure intensifier circuits. Speed control of hydraulic motors, mechanical hydraulic servo systems for tractors.

Suggested Readings

1. Anthony Esposito. Fluid power with applications. PearsonsEdu. 2003.
2. Majumdar S.R. Oil hydraulic system. Tata McGraw Hill. 2003.
3. Merritt H.E. Hydraulic control system. John Wiley and Sons. 1991.

Computer Aided Analysis and Design of Farm Machines

FMPE 615/MED 615 **3 (2+1)**

Course Outcome: This course introduces students with the computer Aided Design (CAD) and design process using CAD. It helps in exchange of modeling data, feasibility analysis and cost analysis of models. It is helpful in use and application of CAD software in design of farm machinery.

Syllabus: Introduction to CAD-the design process – modeling using CAD, geometric modeling – geometric construction methods – representation of curves – desirable modeling CAD standards, graphical standard system, exchange of modeling data. System analysis – relevance of system approach to engineering systems.Role of a system analyst in design of a system and development of a computer system. Feasibility study – steps in feasibility analysis – cost analysis. Application to farm machinery scheduling problems.Design of far machinery with the help of CAD.

Practicals

Uses and application of CAD software in design of farm machinery.

Suggested Readings

Chris McMohan and Jimmie Browne.CAD/CAM/Principles, Practice and Manufacturing Management. Pearson Edu. 2000.

Radha Krishnan P, Subramanyan S. and Raju V. CAD/CAM/CIM.New Age International. 2003.

Rao PN. CAD/CAM Principles and Applications.Tata McGraw Hill. 2002.

Controlled Environment Agriculture

FMPE 522 **3(3+0)**

Course Outcome: This course helps students in knowing the growing of various crops in different regions controlling the various environmental factors such as temperature, humidity, irrigation, wind speed etc. and increasing the productivity. It will help the student in detail design of greenhouses by considering various factors. It is also useful for studying the various growth yield parameters in greenhouse and appropriate resource (natural) management in growing the crops.

Syllabus: Introduction of controlled environment agriculture (CEA) as an agricultural alternative; Greenhouse: Concept and Applications, Constituents of greenhouse, Classification of greenhouses, Greenhouse Construction, Heating and cooling of greenhouse, Root media, Soil-Water-Plant relationships, Instrumentation and Automation for greenhouses, Insects and diseases in greenhouse, Nutrient management.

Suggested Readings

1. Salaokhe V.M. and Sharma, A.K. Greenhouse: Technology and Applications, Agrotech Publishing Academy, Udaipur 2006.
2. Nelson, Paul V. Greenhouse: Operation and Management, Fifth Edition, Prentice Hall, Upper Saddle River, New Jersey, USA 1998.
3. Aldrich, R.A. and Bartok Jr. J.W.. Greenhouse Engineering. Natural Resource, Agriculture and Engineering Service, Cooperative extension, 152 Riley-Robb Hall, Ithaca, NY 14853-570, 1994.

Power Hydraulics

FMPE 524 **3(2+1)**

Course Outcome: Students will be able to study the basic principles of hydraulic system, different types of control valves used in the hydraulic system, different types of cylinders and hydraulic motors. It is also useful in studying the properties of the hydraulic fluids and its scope in further development causes of contamination and their control measures. It is helpful in studying the filtration technology and avoiding leakage and controlling it, also, in use of power systems in agricultural machineries. It will help students to study the running heavy and rigid machineries with the help of hydraulic fluids of different grades with appropriate pressure system.

Syllabus: Hydraulic principles. Hydraulic pumps-types, circuits and drives. Hydraulic valves-pressure control valves, flow control valves, directional control valves, cartidge valves and strength calculations. Hydraulic cylinders – displacement, single and double acting, acceleration and deceleration of cylinder loads, cylinder mounting and strength calculation.Semi-rotary actuator – type and control.Hydraulic motors and circuit.Hydraulic fluids – properties and future development.Fluids contamination –types and control. Filter construction and filtration technology. Leakage control in hydraulic system. Control system – servo control, valve servo system, pump servo system and proportional valves. Use of hydraulics and pneumatic drives in agricultural systems: power steering, power brakes and tractor hydraulics.

Practicals

1. Study of various hydraulic pumps.
2. Study of hydraulic valves.
3. Study of directional control valves.
4. Study of hydraulic cylinder piston arrangements.
5. Study of engineering properties of hydraulic fluids.
6. Study of hydraulic system of tractor.
7. Study of hydraulic steering system.
8. Study of problem related to hydraulic control system.
9. Study of hydraulic motors.

Suggested Reading

1. Liljedahl, B.J. Turanquist, P.K., Smith W.D. and HokiVaketo. Tractor and Their Power Units. AG publication, Fourth Edition, New York, 1989.
2. Michael, J.P. and John, G.A. Power Hydraulics. Prenlice Hall, New York.
3. Hydraulics, Fundamentals of Service. John Deere Service Publications, 1979. John Deere Road, Moline, 61265.

Product Manufacturing Technology

FMPE 525 **3(2+1)**

Course Outcome: The students will acquire knowledge regarding construction of material and their characteristics, structure and properties of material, equilibrium diagram, time temperature transformation curves, heat treatment,types like metal, non-metal, alloy, non-alloy ,measurement and quantity assurance, inspection and testing, casting process, forming process, material removal process, joiningprocess,numeric control and process and techniques related to manufacturing.

Syllabus: Construction of material and their characteristics. The structure of material, properties of material, equilibrium diagram, time temperature transformation curves, heat treatment, ferrous metals and alloys, Non-ferrous metals and alloys, non-metallic material; plastic, elastomers, cermaics and composites, material selection, surface treatment and finishing. Measurement and quality assurance: Measurement and inspection, non-destructive inspection and testing, process capability and quality control, tolerance limits and clearances.

Casting Process: Fundamentals of casting, patterns and sand moulds, continuous casting, shell moulding, lost wax or investment casting, plaster moulds, centrifugal casting, permanent mould casting, die casting, electro forming, the Shaw process and powder metallurgy.

Forming processes: The fundamentals of metal forming mechanism of hot and cold working, Hot rolling of metals, forging processes, extrusion, cold rolling, cold forging, cold drawing, forming of plastic ceramic and composites, dies, shearing and blanking and dies: bending and drawing.

Material removal processes: Machining process, cutting tools for machining, turning and boring and related processes, drilling and related hole making processes, milling, broaching-sawing-filing, abrasive machining processes, work holding devices, machining centres, thread, manufacture, gear manufacturing and non-traditional machining processes (FCM, EDH, LBM, AJM, Wire EDM).

Joining processes: Gas flame processes: welding, cutting and straightening, Arc processes, welding and cutting, resistance welding, brazing and soldering, adhesive, bonding and mechanical fasteners, manufacturing concerns in welding and joining.

Numeric control: Command system, codes, programme, cutter position X and Y incremental movements, linear contouring, Z movement and commands.

Processes and Techniques related to manufacturing: Manufacturing system and automation, production systems and integrated Manufacturing Production system.

Practicals

1. Study of physical and mechanical properties of material tensile test, hardness, impact, material fatigue and endurance limit.
2. Study of metalographic structures of metals, determination of carbon and sulphur content, carburizing and hardening of plain and medium carbon steel by heating and annealing.
3. Study and use of measuring and inspection tools, study of limits, tolerances and geometric dimensioning.
4. Study and use of optical comparator, vision system measurement, co-ordinate measuring machine, surface roughness measurement, non-destructive inspection and testing and statistical process control
5. Study of pattern and sand moulding techniques, preparation of small moulds and carry out sand casting, study of different casting processes.
6. Design and development of simple tolling for shearing, bending and deep drawing and use them in workshop, study of different hot and cold working processes.
7. Practice on different machines like lathe, drill press, milling machine, slotting machine, shaper planers and grinders.
8. Study of non-traditional machining processes.

9. Study the tool geometry and their angles for different chip machining processes.
10. Study and practice on gas, arc, resistance, Mig and Tig welding, soldering, brazing and braze welding processes.
11. Study and design of different types of joints for welding. Welding of different materials ferrous, cast iron, non-ferrous and strainless stell.
12. Developing a programme for CNC machines (turning and milling) and practice on operation of turning and milling centres.
13. Study of surface finishing methods, cleaning, coaling and paint application. Carry out the practice on powder coating and painting by different methods.

Suggested Readings

1. Polukin, P.; Gringerg, B.; Kantenik, S.; Zhadan, V. and Vasilye, D. Metal Process Engineering, MIR Publishes. Moscow.
2. Fundamentals of Tool Design. American Society of Tool and Manufacturer Engineers. Gupta, R.B. Production Technology.
3. Jain, R.K. Production Technology: A Textbook for Engineering Students. Khanna Publishers, New Delhi 1994.
4. Myron; Begeman, L. and Amstead, B.H. Manufacturing Processes.
5. Chapman, (Part III). Working Technology.

Earth Moving Machines

FMPE 526 **3 (2+1)**

Course Outcome: Students will be able to study the land levelling: Criteria and methods; Plane, profile & plan inspection; Earth work calculations; types, construction, capacity and working of the machines like Bulldozer; Scraper; Grader; Shovel; Dragline, calmshell, trenching machine & compactors, Drilling and drilling tools; basting and types of explosive & stemming; Transportation and handling of explosive; Application of CPM; Safety engineering for construction.

Syllabus: Land levelling: Criteria and methods; Plane profile & plan inspection; Contour adjustment, Earth work calculations; types, construction, capacity and working of the following machines: Bulldozer; Scraper; Grader; Shovel; Dragline, calmshell, trenching machine & compactors, Drilling and blasting: Air operated drilling tools; Jack hammer; Drifter; Wagon drill selection of drilling equipment, Types of explosive & stemming, Blasting caps & storage; Transportation and handling of explosive; Job planning and management; Application of CPM; Safety engineering for construction

Practicals

1. Preparation of contour map for land leveling.
2. Land levelling by various methods.
3. Study and operation of bulldozer.

4. Study, operation of the following machinery.
5. Power shovel.
6. Drag line.
7. Study of various type of trenching machines.
8. Practice of drilling a hole with a pneumatic drill and putting explosive in the hole.
9. Blasting practice in hard soils with the help of explosives.

Suggested Readings

1. Michael, A.M. Irrigation: Theory and Practice. Vikas Publishing House Pvt. Ltd., New Delhi, 1987.
2. Nichols, H.L.Moving the Earth, Second Edition, Golotia Publishing house, New Delhi-1, 1962.
3. Peurifoy, R.L. Construction, Planning Equipment and Methods, Third Edition, McGrew Hill International Book Co., 1979.

Machinery for Special Farm Operations

FMPE 623 **3 (2+1)**

Course Outcome: This course will help students in knowing the machines for land development, machines for laying drainage system,subsoilers and decompactors. Machines for plant protection, safety aids of operator, machinery for horticultural crops, crop specific machines for cotton, sugarcane, fruits and vegetables. Manure spreader, laser land leveller, sleeve boom sprayer, machines for processing and handling of agricultural products.

Syllabus: Machines for land development. Tractor operated and self propelled; machines for laying drainage system,subsoilers and decompactors. Machines for plant protection.Jet, pneumatic, thermal type sprayers, aero spraying and other methods of spraying, electrostatic charging disinsectification of seed beds by micro waves.

Safety aids of operator and advances in plant protection method.Machinery for horticultural crops.Field plot machinery and its importance.Crop specific machines for cotton, sugarcane, fruits and vegetables. Manure spreader, laser land leveller, sleeve boom sprayer, machines for processing and handling of agricultural products. Oil extraction sugarcane juice extraction seed cleaning and grading and silage and hay making machines.

Practicals

1. To study the performance of a axial flow blower using AAS system for orange crop.
2. To study the performance of a axial flow blower using AAS system for cotton crop.
3. Design and testing of a different types of nozzles used in sprayer.
4. To evaluate a electrostatic charging machine for duster.
5. To study a mechanical tomato harvester.
6. To evaluate a combined tillage system for planning of a crop.
7. To study pick type baler for handling of the harvested material.
8. Design of mechanical oil expression process.

9. Design of a pneumatic conveying system.
10. Study of solvent extraction process for separation of oil.
11. Study and field operation of Laser Beam system for land levelling and trenching .

Suggested Readings

1. Bosoi, E.S. Vermaiev, O.V. Smirnowe, I.I. and Sultan Shakh, E.G. theory, Construction and Calculation of Agricultural Machines, A.A. BalkmanPoub., Rotterdam, 1988.
2. Gyachev, L.V, Theory of Surface of Plow Bottom, A.A. Balkman Pub., Rotterdam, 1987.
3. Kanafozski, C and Karwowikii. Agricultural Machines: Theory and Construction. Vol. I & II, Translated and published by US Deptt. of Agriculture, 1976.
4. Kepner, R.A. Bainer, R and Barger E.L. Principles of Farm Machinery, AVI Pub. 1978.
5. Nartov, P.S.Disc Soil Working implements, A.A. Balkema Pub., Rotterdam, 1986.

Vibrations in Agricultural Machines

FMPE 624 **3(2+1)**

Course Outcome: Students will be able to study the definition, units and parameters of measurement and importance of noise vibrations theory, types of vibrations, analysis of types of vibrations using Newton's law of motion, energy, method, Raleigh's method, Lagrange equation. Introduction of transient vibrations in systems, balancing of rotating and reciprocating parts of an engine.

Syllabus: Noise and vibration theory – definition, units and parameters of measurement and their importance. Types of vibration free and forced, undamped and damped, analysis of one, two and multiple degree of freedom systems and their solution using Newton's motion, energy, method. Longitudinal, transverse and torsional vibration, Raleigh's method, Lagrange equation.

Introduction of transient vibrations in systems, vibrations of continuous media.Balancing of single rotating weight and number of weights in same plane and different planes. Complete balancing of reciprocating parts of an engine.

Practicals

1. Study of vibration measurement and analysis equipment.
2. Study of different vibration measurement methods and evaluation.
3. Measurement and analysis of vibrations on different components of thresher, combine, reaper, power tiller and tractor.
4. Determination of modulli of elasticity, Rigidity and MI by free vibration test.
5. Evaluation of logarithmic decrement and damping factor. Whirling of shafts. Beat motion in two-pendulum system.
6. Detailed analysis of multi-degree of freedom system.

Suggested Readings

1. Meirovitch, L. Elements of Vibration Analysis. 2nd Ed. McGraw Hill 1986.
2. Kelly, S.G. Fundamentals of Mechanical Vibrations. 2nd Ed. McGraw Hill 2000.
3. Harris, C.M. and Crde, C.E. Shock and Vibration Handbook. McGraw-Hill Publishing Co., New York 1976.
4. ISO Standard Handbook of Mechanical Vibration and Shock.
5. Steidel. Introduction to Mechanical Vibrations, 2/e., Revised Printing. Wiley International & ELBS Editions 1986.

Experimental Stress Analysis

FMPE 625 **3(2+1)**

Course Outcome: Students will be able to study strain and stress measurements; analysis, types of gauges for strain indication, principle of working, properties of strain gauge. Basic strain gauges techniques, selection of a proper gauge, method of bonding a gauges, testing and calibration of the installed gauge circuit, balanced and unbalanced strain gauge circuits, strain-stress theory, moisture proofing of strain, strain gauge subjected to nuclear radiations strain, photo elasticity and photo elastic gauge; introduction, optical theory, methods and stress optical relationship, photo elastic gauges construction, strain indication with brittle coatings.

Syllabus: Introduction to strain and stress measurements; strain and stress analysis, extensometers, mechanical, optical electrical, bonded, piezoresistive, photo-elastic strain gauge for strain indication, principle of working, magnification and suitability Bety, Huggen-berger, SR-4 and whittemore types of gauge, properties of strain gauge.

Basic strain gauges techniques; gauges factor, gauges materials, gauges bounding materials, selection of a proper gauges, method of bonding a gauges, testing the installed strain gauges, calibrating the gauges circuit, wire and foil strain gauges construction, balanced and unbalanced strain gauges circuits, temperature compensation of gauges circuit, study of different instruments used in static and dynamic strain measurements.

Strain-stress theory and strain rosettes; theory of strain stress related to gauge, Mohr circle, theory of rectangular delta, resettes and problems related to them, error in misalignment of gauge, transverse sensitivity of gauge.

Moisture proofing of strain, gauge, long time indoor installation for saturated humidity and direct splash, gauge submerged in water and other media, strain gauges subjected to nuclear radiations strain, measurements at high and low temperatures and at high pressures, measurement of strain on low modules, measurement of large cycle and transient strains, zero drift, its determination, effects and minimization.

Photo elasticity and photo elastic gauge; introduction, optical theory, Moire Fringe method, stress optical relationship, equipment and models, static stress analysis in two dimensional model techniques; introduction to dynamic and thermal stress analysis.

Photo elasticity gauges construction, rectangular and circular type, gauges installation techniques, surface coating techniques.

Strain indication with brittle coatings, Basic stress coat techniques, lacques selection and application, test procedure and crack intensification, quantitative precision of stress coat.

Practicals

1. Experimental determination of gauges factor.
2. Bonding of gauges, lead wire installation and testing of gauges.
3. Study of temperature compensating gauge and their circuits.
4. Study of characteristics of equipment needed for static and dynamic strain measurements.
5. Computation of stress from strain in bi-axial stress field.
6. Study of strain distribution using the brittle lacquer method.
7. Study of plastic strain distribution using Moire fringe method.
8. Study of elastic strain distribution using the brittle lacquer method.
9. Study and analysis of dynamic strains as affected by various operating variables.

Suggested readings

1. Dove, R.C., and P.H. Adams, Experimental stress analysis and motion measurement Prtentice- Hall of India Pvt. Ltd., New – Delhi.
2. Dally, J.W. & Riley, Experimental Stress Analysis.
3. Heteny, M. " hand book of Experimental Stress Analysis".
4. Lee, G.H. An Introduction to Experimental Stress Analysis.
5. Perry C.C., and H.R. , Lissner., The strain gauge Primer., McGraw Hill Book Co,

Ergonomics and Safety in Farm Operations

FMPE 535 **3 (2+1)**

Course Outcome: Students will be able to study the human factors, importance, objectives, scope, methods, procedure and techniques for their measurements, ergonomic models, human tracking and human metabolism,physiological parameters, their nature and measurement techniques,muscular work efficiency, fatigue and rest pauses,human factors in tractor seating, comfort and entry system and its control,anthropometry and its application,heat and cold stress,measurement of energy; direct and indirect methods,calibration of subjects load and its assessment, scaling of load, modes of work importance of postures for safety consideration in design of farm machinery,effect of vibration on man, vibration measurement and control,effect of illumination, atmosphere, visibility, noise, dust concentration and toxicity on human being application of time motion study in agricultural operations. BIS codes for safety of tractor and machine.

Syllabus: Human factors, importance, objectives, scope, methods, procedure and techniques. Human being in man made world. Ergonomic models.Human tracking and human metabolism.Physiological parameter.Physical and mental stress, their nature and measurement techniques. Muscular work efficiency, fatigue and rest pauses. Human factors in tractor seating, comfort and entry system.Control, shape, colour coding, appearance, dial and indicators.Anthropometry and its application.

Heat and cold stress.Measurement of energy; direct and indirect methods. Calibration of subjects.

Physical load and its assessment, scaling of load, Modes of work importance of postures for safety consideration in design of farm machinery. Safety consideration in farm operation.Effect of vibration on man, vibration measurement and vibration control.Effect of illumination, atmosphere, visibility, noise, dust concentration and toxicity on human being Application of time motion study in agricultural operations. Modern technology used for comfort in driving places. BIS codes for tractor and machine safety.

Practicals

1. Measurement of body dimensions of agricultural workers and relationship between them.
2. Calibration of human subject on bicycle ergometer for its energy output and physiological parameters like heart rate, oxygen consumption rate under laboratory conditions.
3. Calibration of human subject on tread mill for its energy output and physiological parameters like heart rate and oxygen consumption rate under laboratory conditions.
4. Evaluation of heat stress while calibrating the subject.
5. Determination of human requirements for field operation with manually operated equipments.
6. Determination of muscular fatigue for selected agricultural tasks.
7. Assessment of mental load for a specific agricultural operation.
8. Study of noise levels for engine / tractor.
9. Study of vibrations in farm tractors and agricultural machines.
10. Study of standard time for selected farm operations.

Suggested Readings

1. Astrant, P.O. and K. Rodhal. A text book of work physiology McGraw Hill Book Co., New York, 1970.
2. McCormic, E.J., Human Factors in Engineering Design, Tata McGrew Hill Pub., Co., New Delhi, 1979.
3. Bridger RS, Introduction to ergonomics. McGraw Hill. 1995.
4. IS 12239. Tractors and Machinery for Agriculture and Forestry: Technical Means for Ensuring Safety. 1999.

Farm Machinery Dynamics, Noise and Vibration

FMPE 536 **3 (2+1)**

Course Outcome: After completing this course student will be acquainted with principles of soil working tools: shares, discs and shovels and blades,metering of seeds and granular fertilizers with various mechanisms,electrostatic spraying and dusting, spray distribution patterns, kinematics of reapers, parameters affecting performance of threshers,noise and vibration theory – definitions, units and parameters of measurements and their importance,types of vibrations and balancing of single rotating weight in same plane, balancing of reciprocating parts of engine.

Syllabus: Principles of soil working tools: shares, discs and shovels and blades. Metering of seeds and granular fertilizers with various mechanisms, effect of various parameters on distribution of seed and fertilizer in seed cum fertilizer drills and planters.Electrostatic spraying and dusting, spray distribution patterns, kinematics of reapers, parameters affecting performance of threshers.

Noise and vibration theory – definitions, units and parameters of measurements and their importance.Types of vibrations – free and forced vibrations. Balancing of single rotating weight in same plane, balancing of reciprocating parts of engine.

Practicals

1. Study of vibration measurement and analysis equipment.
2. Study of different vibration measurement and evaluation.
3. Measurement and analysis of vibration on different components of thresher and tractors.
4. Evaluation of damping factor.
5. Study of modulus of elasticity of a given material.

Suggested Readings

1. Bosoi, E.S. Vermiaev, OV, Smirnov, I-I and Sultan Shakh, E.G. Theory, Construction and Calculation of Agricultural Machines, A.A. BalkemaPoub. Rotterdam, 1988.
2. Kanafozski, O and T. Karwowski, Agricultural Machines: Theory and Construction. Vol. I & II, Translated and published by US Deptt. of Agriculture, 1976.
3. Kepner, R.A. Bainer, R, and Barger E.L. Principles of Farm Machinery, AVI Pub., 1978.
4. Grover GK. Mechanical Vibrations. New Chand and Broths. Roorkee. 1996.
5. Meirovitch L. Elements of vibration analysis. II Edition. Mcgraw Hill. 1986.

Organic Farming Management

FMPE 537 **3(3+0)**

Course Outcome: After completing this course student will be acquainted with organic agriculture and its extension; cluster approach, organic producers, groups, organic agro service centres; on farm fertility management; practices: soil environment and plant growth, soil physical properties, soil biology, human formation and nutrient dynamics, green manures, ex-situ manures, fertility management by improved agronomical practices, biological-intensive nutrient management;

organic eco-system; heath & environmental awareness, soil improvement and amendment, land reclamation; agricultural equipment and automation; sprays, green houses, harvest machinery; improved agricultural machinery, organic processing their handling and labeling.

Syllabus: Organic agriculture introduction and extension;cluster approach, organic producers, groups, organic agro service centres; on farm fertility management; practices; soil environment and plant growth, soil physical properties and fertility, soil chemistry & plant nutrition, soil biology, human formation and nutrient dynamics, green manures, ex-situ manures, fertility management by improved agronomical practices, biological-intensive nutrient management; organic eco-system; heath & environmental awareness, food quality, land degradation & revival, pesticides contamination, sewage/urban waste recycling, environment pollution; land development, field preparation techniques-full farm conversion; soil & water planning & management; field preparations, physical conditions and desired development practices, soil improvement and amendment, land reclamation; agricultural equipment and automation; sprays, green houses, harvest machinery; improved agricultural machinery, organic processing handling and labeling: general principles, ingredients, processing methods, pest & disease control, packaging, labeling standards, cleaning, disinfecting & sanitizing standards, standards for processing of textiles.

Suggested Readings

1. IFOAM Manual.
2. Somai, L L 2004. Organic Farming, Agrotech Publishing Academy, Udaipur.
3. A.K. Dahama- Organic Farming, Pub. Agrobios, India, 2002.
4. Arun Kr. Sharma-A Handbook of Organic Farming. Pub. Agrobios (India), 2002.

Note:

1. For supporting courses course description, which are offered by other departments, refer separately syllabus of that particular department.
2. For syllabus of Non-Credit Compulsory Courses, see at the end.

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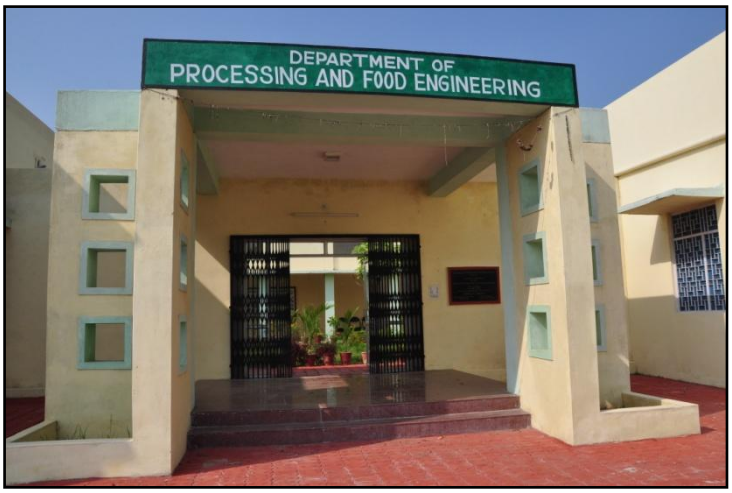
DEPARTMENT OF PROCESSING AND FOOD ENGINEERING



VISION

To be a centre of excellence which integrates all facets of processing and food engineering.

MISSION

- To produce business leaders, develop competitive processes, technologies and practices in the area of food engineering, entrepreneurship and management.
- To be a prime academic institution and to carry out R&D in frontier areas of food engineering.
- To offer training to enhance skill in research by consultation with the stake holders.

Programme Educational Objectives

1. To offer post graduate programme in agricultural processing and food engineering leading to M. Tech. (Ag.) degree in Processing and Food Engineering.
2. To offer courses in agricultural processing and food engineering leading to Ph. D degree in Processing and Food Engineering.
3. To conduct research in agricultural processing and food engineering leading to process control, product and equipment development.

Programme Outcome

1. Develop skill and expertise in post graduate scholars to work on projects for value addition of various food products.
2. Generate adequate trained man power to work in food processing industries.
3. Develop cadre of research scholars for achieving entrepreneurial skills and self employment opportunities in food processing sector.

Semester-wise Scheme for Post Graduate Programme in Processing and Food Engineering

Details of courses offered for the award of M.Tech. (Ag.), PFE

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV-VI
Core Courses: Total 12 credits; 2 courses in first semester (6 credits) and 1 course each in second and third semester (3 credits each) to be evaluated externally.						
Unit Operations in Food Process Engineering	PFE 511	3(2+1)	3	-	-	-
Engineering Properties of Food Materials	PFE 512	3(2+1)	3	-	-	-
Fruits & Vegetable Process Engineering	PFE 521	3(2+1)	-	3	-	-
Processing of Oilseeds, Cereals and Pulses	PFE 531	3(2+1)	-	-	3	-
Optional Courses: Total 15 credits; two courses in first & second semester each (6 credits in each semester) and one course in third semester (3 credits).						
Food Process Engineering	PFE 513	3(2+1)	3	-	-	-
Food Packaging	PFE 514	3(2+1)	3	-	-	-
Meat Processing	PFE 515	3(2+1)	3	-	-	-
Drying and Dehydration of Foods	PFE 516	3(2+1)	3	-	-	-
Transport Phenomena in Food Processing	PFE 522	3(2+1)	-	3	-	-
Food Processing Equipments Design	PFE 523	3(2+1)	-	3	-	-
Farm Structures and Environmental Control	PFE 524	3(2+1)	-	3	-	-
Storage and Handling of Agricultural Products	PFE 525	3(2+1)	-	3	-	-
Post Harvest Processing of Grains	PFE 535	3(2+1)	-	-	3	-
Food Chemistry & Microbiology	PFE 536	3(2+1)	-	-	3	-
Biochemical & Process Engineering	PFE 537	3(2+1)	-	-	3	-
Minor & Supporting Courses: Total 9 credits; one course in first, second and third semester each (3 credits in each semester).						
Higher Mathematics	BS 515	3(3+0)	3	-	-	-
Statistical Methods	AST 510	3(2+1)	3	-	-	-
Advance Programming with 'C^{++}'	CSE 511	3(1+2)	3	-	-	-
CAD/CAM	MED 518	3(1+2)	3	-	-	-
Methods of Numerical Analysis	BS 521	3(2+1)	-	3	-	-
Energy Management in Food Process Engineering	REE 523	3(3+0)	-	3	-	-
Alternate Fuels & Application	REE 524	3(3+0)	-	3	-	-
Energy, Ecology and Environment	REE 525	3(3+0)	-	3	-	-
Energy Management in Agriculture	REE 537	3(3+0)	-	-	3	-
Renewable Sources of Energy	REE 531	3(2+1)	-	-	3	-
Energy Lab	REE 536	3(0+3)	-	-	3	-
Others						
Compulsory Courses; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/502/...	1	NC	NC		
Seminar (0+1)	PFE532	1	-	-	1	-
Comprehensive	PFE 533	NC			NC	
Research (Thesis). Thesis minimum duration 2 semesters	PFE 534	20	-	-	-	20
Total credits to be offered (for Master Programme)		**57**	**15**	**12**	**10**	**20**

COURSE SUMMARY

Courses	No. of Courses					Credit Hours
	Semester					
	I	II	III	IV	Total	
Core	2	1	1	-	4	12
Optional	2	2	1	-	5	15
Minor & Supporting	1	1	1	-	3	9
Seminar	-	-	1	-	1	1
Comprehensive	-	-	-	1	1	Non Credit (graded as satisfactory/ non satisfactory)
Research (Thesis)	-	-	-	1	1	20* (graded as satisfactory/ non satisfactory)
Compulsory Courses (PGS Series)	1	1	-	-	2	Non Credit
Total	**6**	**5**	**4**	**2**	**17**	**57**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

Details of courses offered for the award of Ph.D. (Ag. Engg.), PFE

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV-VI
Core Courses: Total 6 credits (3 credits in each semester); one course in first semester and one course in second semester to be evaluated externally.						
Advances in Food Processing	PFE 611	3(2+1)	3	-	-	-
Post Harvest Engineering	PFE 621	3(2+1)	-	3	-	-
Optional Courses: Total 12 credits (6 credits in each semester); two course in first and second semester each.						
Food Process Engineering	PFE 513	3(2+1)	3	-	-	-
Food Packaging	PFE 514	3(2+1)	3	-	-	-
Meat Processing	PFE 515	3(2+1)	3	-	-	-
Drying and Dehydration of Foods	PFE 516	3(2+1)	3	-	-	-
Transport Phenomena in Food Processing	PFE 522	3(2+1)	-	3	-	-
Food Processing Equipments Design	PFE 523	3(2+1)	-	3	-	-
Farm Structures and Environmental Control	PFE 524	3(2+1)	-	3	-	-
Storage and Handling of Agricultural Products	PFE 525	3(2+1)	-	3	-	-
Post Harvest Processing of Grains	PFE 535	3(2+1)	-	-	3	-
Food Chemistry & Microbiology	PFE 536	3(2+1)	-	-	3	-
Biochemical & Process Engineering	PFE 537	3(2+1)	-	-	3	-
Advances in Drying of Food Materials	PFE 612	3(2+1)	3	-	-	-
Mathematical Models in Food Processing	PFE 613	3(3+0)	3	-	-	-
Advanced Process and Food Engineering	PFE 614	3(2+1)	3	-	-	-
Milling of Food materials	PFE 615	3(2+1)	3		-	-
Design of grain storage structures	PFE 622	3(2+1)	-	3	-	-
Design of Food Process Equipments	PFE 623	3(2+1)	-	3		
Rheology of Foods	PFE 624	3(2+1)		3	-	-
Agricultural Waste and by-product Utilization	PFE 625	3(2+1)	-	3	-	-
Minor & Supporting Courses: Total 9 credits; two courses in first semester (6 credits) and one course in second semester (3 credits).						
Higher Mathematics	BS 515	3(3+0)	3	-	-	-
Statistical Methods	AST 510	3(2+1)	3	-	-	-
Advance Programming with 'C^{++}'	CSE 511	3(1+2)	3	-	-	-
CAD/CAM	MED 518	3(1+2)	3	-	-	-
Methods of Numerical Analysis	BS 521	3(2+1)	-	3	-	-

Energy Management in Food Process Engineering	REE 523	3(3+0)	-	3	-	-
Alternate Fuels & Application	REE 524	3(3+0)	-	3	-	-
Energy, Ecology and Environment	REE 525	3(3+0)	-	3	-	-
Energy Management in Agriculture	REE 537	3(3+0)	-	-	3	-
Renewable Sources of Energy	REE 531	3(2+1)	-	-	3	-
Energy Lab	REE 536	3(0+3)	-	-	3	-
Environmental Pollution & Control	REE 614	3(0+3)	3	-	-	-
Finite Element Methods	MED 610	3(2+1)	3	-	-	-
Data Structure and Algorithm	CSE 621	3(2+1)	-	3	-	-
Computer Languages for Engineering Applications	CSE 622	3(2+1)	-	3	-	-
Others						
Compulsory Courses+; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/ 502/...	1	NC	NC		
Seminar	PFE 691/ 692	1 (0+1)	1	1	-	-
Preliminary	PFE 633	NC			NC	
Research (Thesis). Thesis minimum duration 4 semesters	PFE 634	45	-	-	-	45
Total credits to be offered		**74**	**16**	**13**	**-**	**45**

Note: A Ph.D. student must take two 600 series core courses. A student may choose optional/minor & supporting courses of 500 series courses if not studied during Masters Programme as per ICAR guidelines.

+ Exempted for those who have cleared these in Master's Programme (permission to be sought from the Dean, CTAE).

COURSE SUMMARY

Courses	No. of Courses							Credit Hours
	Semester							
	I	II	III	IV	V	VI	Total	
Core	1	1	-	-	-	-	2	6
Optional	2	2	-	-	-	-	4	12
Minor & Supporting	2	1	-	-	-	-	3	9
Seminar	1	1	-	-	-	-	2	2
Preliminary	-	-	1	-	-	-	1	Non Credit (graded as satisfactory/ non satisfactory)
Research (Thesis)	-	-	-	-	-	1	1	45* (graded as satisfactory/non satisfactory)
Compulsory Courses** (PGS Series)	1	1	-	-	-		2	Non Credit
Total	**7**	**6**	**1**	-	-	**1**	**15**	**74**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

**Exempted for those who have cleared these in Master's Programme.

SYLLABUS

PROCESSING AND FOOD ENGINEERING

Unit Operations in Food Process Engineering

PFE 511 **3(2+1)**

Course Outcomes: The students willacquire knowledge of size reduction, evaporation, drying, fluid flow and food freezing.

Syllabus: Review of basic engineering mathematics; units and dimensions; mass and energy balance.

Principles of Fluid Flow - Introduction to stress strain behaviour in materials; properties of fluid viscosity; capillary tube viscometer; power law equation for pseudoplastic; newtonian and dilatant fluids; flow in pipes-friction, laminar and turbulent flow equations, considerations in pumping fluid.

Size Reduction-Principles, types of equipments, applications and energy laws, sorting & grading equipment.

Mixing: Objectives, equipments for solid, liquid mixing; energy requirements, mixing indices.

Food freezing - Properties of frozen foods; freezing point depression, general introduction to enthalpy change during freezing, Plank's equation for predicting freezing time; food freezing equipment such as air blast freezers; plate freezers and immersion freezers.

Evaporation - Thermodynamics of evaporation; boiling point elevation; heat transfer during evaporation; heat transfer coefficients, design of evaporation system; retention time; single effect and multiple effect system; thermo-compression systems.

Psychrometry - Principles, air properties; application in drying of foods.

Food dehydration - Basic principles of dehydration; constant rate and falling rate periods of dehydration; equilibrium moisture content; fixed bed dehydration; drum dehydration, and fluidized bed drying; spray drying of liquid foods, different types of dryer and their specific applications in food processing sector.

Practicals

1. Study of fluid flow properties.
2. Study of heat exchangers.
3. Applications of psychrometric chart.
4. Determination of EMC.
5. Experiments on different types of driers and numerical problems.
6. Experiments on size reduction equipments.
7. Experiments on cleaning and sorting equipments.
8. Study of mixing equipments.
9. Calculation of kinetics of reaction for fruits and vegetables dehydration.

Suggested Readings

- Berk Z. 2009. Food Process Engineering and Technology. Elsevier.
- Brennan JG, Butters JR, Cowell ND & Lilly AEI. 1990. Food Engineering Operations. Elsevier.
- Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
- Fellows P. 1988. Food Processing Technology: Principle and Practice. VCH Publ.
- Heldmen DR &Hartel RW. 1997. Principles of Food Processing. Springer.
- McCabe WL & Smith JC. 1999 Unit Operations of Chemical Engineering. McGraw-Hill.
- Sahay KM & Singh KK. 1994. Unit Operation of Agricultural Processing. Vikas Publ. House.
- Singh RP &Heldman DR. 1993. Introduction to Food Engineering. Academic Press.
- Sun Da Wen. 2006. Handbook of Frozen Food Processing and Packaging. Francis and Taylor, CRC press.
- Toledo RT. 2007. Fundamentals for Food process Engineering. Springer.

Engineering Properties of Food Materials

PFE 512 **3(2+1)**

Course Outcomes: The students will learn about different techniques of measurement of engineering properties and their importance in the design of processing equipments, determine physical, aerodynamic and thermal properties of food; identify the causesof mechanical damage.

Syllabus: Importance and brief description of mechanical; thermal; electrical and optical properties;Physical characteristics - shape; size; charted standards; roundness; sphericity; axial dimensions and projected area.; volume and density - Platform scale; specific gravity balance; pycnometer method; porosity and surface areas - leaf and stalk surface area; fruit surface area; egg surface area and specific surface in porous pack.

Basic concepts of Rheology, physical states of material; Rheological models and Rheological equations, Maxwell, Kelvin, 4-element model, Generalized Maxwell and Generalized Kelvin models; viscoelastic characterization of materials - stress; strain behaviour; creep, stress relaxation and dynamic tests.

Textural and structural mechanics of food materials, effect of age, water content and temperature on texture of foods, introduction to rheological characteristics of agricultural, dairy and food products.

Mechanical Damage - Economic importance; causes; detection and evaluation of mechanical damage.Impact damage and its mechanics; vibration damage and stress cracking; Maximum allowable load for Agri. Products.

Aero- and Hydro-dynamic characteristics - Drag coefficient; terminal velocity; separation of foreign materials; pneumatic transport and handing; effect of moisture on frictional properties, angle of internal friction; angle of repose, application of frictional properties in design of handling and processing machines such as screw conveyors and oscillating conveyors.

Practicals

1. Determination of physical properties like, length, breadth, thickness, surface area.
2. Determination of bulk density, porosity and true density.

3. Determination of coefficient of friction and angle of repose.
4. Determination ofcolour for various food grains, fruits, vegetables, spices and processed foods.
5. Determinationof thermal properties like specific heat of food materials.
6. Determination of rheological properties likefirmness and hardness of grain and fruits.

Suggested Readings

- Bourne, M. 2002. Food Texture and Viscosity – Concept and Measurement. Academic Press.
- Mohesenin NN. 1980. Physical Properties of Plant and Animal Materials. Gordon & Breach Science Publ.
- Mohesenin NN. 1980. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publ.
- Peleg M &Bagelay EB. 1983. Physical Properties of Foods. AVI Publ. Co.
- Rao MA & Rizvi SSH. (Eds). 1986. Engineering Properties of Foods. Marcel Dekker.
- Rao MA, Rizvi SSH &Datta ADK. 2005. Engineering Properties of Food. Francis and Taylor, CRC press.
- Sahin S &Sumnu SG. 2006. Physical Properties of Food. Springer.
- Singhal OP & Samuel DVK. 2003. Engineering Properties of Biological Materials. SarojPrakasan.

Fruits & Vegetables Process Engineering

PFE 521 **3(2+1)**

Course Outcome: The studentswill be acquainted with processing of fruits and vegetables; blanch fruit & vegetables for reducing enzymatic browning; prepare pickles and dry fruits and vegetables.

Syllabus: Fruits and vegetables -Washing fruits and vegetables; scalding and blanching; peeling fruits and vegetables for canning; object of grading; effect of variety and maturity; effect of temperature; grading for quality; changes in concentration of syrup after canning; size grading fruits and vegetables; quality control; sugar used in canning and preparation of syrup for canning; syruping machine; brines and brining; object of exhausting; relation of temperature of exhausting to degree of vacuum; measuring vacuum; type of exhaust boxes; filling cans and vapour sealing principles of processing of canned fruits and vegetables; theoretical and practical processing times. Introduction to processing methods and equipment; flow diagram of canning for apples; cherries; grapes; pears; plums; orange; pineapples canned dried fruits and vegetable; raw products canning; flow charts for green beans, carrots, corn, lime, beans, peas, tomatoes and spinach; spoilage of canned foods; discoloration, corrosion and perforation of the plate; general introduction to micro organisms causing spoilage.

Sun drying - Sun drying of fruits, equipment for sun drying.

Dehydration - Dehydration of fruits such as apples, bananas, cherries; dehydration of vegetables.

Pickling -Types of pickles; introduction to flow diagram for production of pickles of cucumber, onion etc.

Freezing - Physical changes during freezing and thawing, rates of cooling and freezing; methods of freezing; storage temperature; use of sulphur dioxide in frozen pack fruits; ascorbic and citric acids; brief description for freezing of fruits and vegetables such as apples, apricots, grapes, mangoes, peaches, cherries, pineapple, fruit juices concentrates, cauliflower, carrot, peas, tomatoes and potato, types of freezers.

Practicals

1. Determination of sugar-acid ratio of fruits.
2. Performance evaluation of washer.
3. Performance evaluation of grader.
4. Study of packaging methods.
5. Experiments on drying of fruits and vegetables.
6. Experiments on pickling of fruits and vegetables.
7. Experiments on freezing time of foods.
8. Studies on canning of fruits and vegetables.
9. Visit to fruit and vegetables processing industries.
10. Determination of TSS, pH and acidity in fruits and vegetables.

Suggested Readings

- Barrett MJ, Somogyi L &Ramoswamy H. 2005. Processing Fruits- Science and Technology. Francis and Taylor, CRC press.
- Cruess, W.V.2000.Commercial Fruit and Vegetable Products. McGraw Hills Book Company, Inc., New York.
- Girdhari Lal &Tandon, G. L. 1986. Preservation of Fruits and Vegetables Published by Publications and Information Division, ICAR, New Delhi-12.
- Sun Da Wen. 2006. Handbook of Frozen Food Processing and Packaging. Francis and Taylor, CRC press.

Processing of Cereals, Pulses and Oilseeds

PFE 531 **3(2+1)**

Course Outcome: The students will learn about post-harvest technology of cereals, pulses and oilseeds with special emphasis on their equipments.

Syllabus: Production and utilization of cereals and pulses, grain structure, chemical composition, effect of temperature on quality of grains, physical properties, thermal and aerodynamic properties.

Principles of parboiling of paddy and wheat; physicochemical changes during parboiling, effect of parboiling on milling; nutritional and cooking qualities of rice, methods of parboiling of paddy, introduction of major process such as crystal rice process, Jadavpur University process; AVORIO Process, RPEC method, sodium chromate method, Kisan parboiling and pressure parboiling, parboiling of wheat; principles and process.

General considerations in milling– Cleaning and separation, effectiveness of separation, husking of grain, factors affecting and effectiveness of husking, grinding and effectiveness of grinding machinery used in cereal grinding.

Hydrothermal treatment/conditioning of cereal grains, Rice milling- traditional rice milling machine, modem rice milling machinery, general principles of cleaning, open double sieve cleaner and single scalper, drum cleaner, paddy cleaner with stirrer, husking machinery such as impact type paddy husker, rubber roll husker (Japan type), paddy separator (Japan and European type), whitening of grain, vertical and horizontal whitening machines, friction type whitening machine.

Milling of corn, wheat and pulses - Wet and dry milling of corn, wheat milling and milling of pulses.

Utilization of rice bran and other by products -Principles of storage and utilization of rice bran, methods of utilization including dry and wet heat treatment, rice bran stabilizer developed in India, extraction of rice bran oil, solvent and batch extraction methods, refining of crude rice bran oil, solvent and batch extraction methods, refining of crude rice bran oil into edible grade oil, uses of bran, bran oil and various constituents.

Practicals

1. Determination of physical propertiesof cereals and pulses.
2. Studies on thermal properties of cereals and pulses.
3. Evaluation of raw and milled products quality.
4. Experiments on parboiling and drying.
5. Study of paddy, wheat, pulses and oilseeds milling equipments.
6. Study on refining of crude rice bran oil using different methods.
7. Experiment on size reduction and numerical problems.
8. Grain size analysis – effectiveness of sieves.
9. Determination of cooking quality of rice.

Suggested Readings

- Asiedu JJ.1990. Processing Tropical Crops. ELBS/MacMillan.
- Chakravorty A, Majumdar AS &Raghavan GSV. 2003. Handbook of Post Harvest Technology. 2003. Marcel Dekker Inc.
- Chakravorty A. 1995. Post-harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH.
- Pandey PH. 1994. Principles of Agricultural Processing. Kalyani.
- Pillaiyar P. 1988. Rice - Post Production Manual. Wiley Eastern.
- Rahman MS. 2007. Handbook of Food Preservation. Francis and Taylor, CRC press.
- Sahay KM & Singh KK. 1994. Unit Operations in Agricultural Processing. Vikas Publ. House.
- Tewari G &Juneja VK. 2007. Advances in Thermal and Non-thermal Food Processing. Blackwell publication.

Food Process Engineering

PFE 513 **3(2+1)**

Course Outcomes: The students will be made familiar with different food processing such as extrusion, thermal processing &filtration and their design features.

Syllabus: Kinetics of biological reactions - Kinetics of reaction occurring in processed foods, reaction velocity constant; order of reaction; quality changes during storage of foods; application of Arrhenius equation to the biological reaction.

Thermal processing - Death rate kinetics, thermal process calculations, methods of sterilization and equipments involved, latest trends in thermal processing. Commercial sterility; chilling, pasteurization and sterilization methods based on slowest heating region; determination of the process time based on region of greatest temperature lag; Process equivalence in terms of minutes at 121.1°C, aseptic canning process, hydrostatic sterilizer and aseptic packaging practices.

Mechanical separation process - Filtration, design of filtration system; constant rate filtration, constant pressure filtration, mechanism of filtration, design of filtration sedimentation and centrifugation; basic equations, rate of separation, liquid - liquid separation, particle - gas separation.

Water in foods - Water activity, moisture sorption isothems, moisture hysteresis, Rault's law, Henry law, moisture sorption models such as BET, GAB, Henderson; methods of developing moisture sorption isotherm, use of moisture isotherm in storage conditions and shelf life estimation.

Extrusion - Theory of extrusion, types of extruders, advantages of twin screw extruders, components of extruders, pressure measurement in extruders.

Practicals

1. Calculation of kinetices of reactions.
2. Solving problems on time estimation in thermal processing.
3. Experiments on water activity measurement.
4. Determination of moisture sorption isotherms.
5. Determination of shelf-life of foods.
6. Studies on separation processes in food industry.
7. Determination of expansion ratio of extruded foods.

Suggested Readings

- Berk Z. 2009. Food Process Engineering and Technology. Elsevier.
- Brennan JG. 2006. Food Processing Handbook. Wiley-VCH Publication.
- Coulson JM & Richardson J F. 1999. Chemical Engineering. Vol. II & IV. The Pergamon Press.
- Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
- Fellows P. 1988. Food Processing Technology: Principle and Practice. VCH Publ.
- Geankoplis J Christie. 1999. Transport Process and Unit Operations. Allyn& Bacon.
- Heldmen DR &Hartel RW. 1997. Principles of Food Processing. SpringerBarbosa-Canovas 2002. Novel Food Processing Technologies. CRC.
- Henderson S & Perry SM. 1976. Agricultural Process Engineering, 5th Ed. AVI Publ. Co.
- McCabe WL & Smith JC. 1999 Unit Operations of Chemical Engineering. McGraw-Hill.
- Sahay KM & Singh KK. 1994. Unit Operation of Agricultural Processing. Vikas Publ. House.
- Singh RP &Heldman DR. 1993. Introduction to Food Engineering. Academic Press.
- Singh RP. 1991. Fundamentals of Food Process Engineering. AVI Publ.
- Toledo RT. 2007. Fundamentals for Food process Engineering. Springer.

Food Packaging

PFE 514 **3(2+1)**

Course Outcomes: The students will be acquainted with packaging methods, packaging materials, packaging machineries, modern packaging techniques; estimation of shelf-life of packaged food stuff; determine vapour and gas transmission rate of flexible packaging material; evaluate performance and strength properties of packaging materials.

Syllabus: Introduction of packaging - Package, functions and design, principle in the development of protective packaging, deteriorative changes in foodstuff and packaging methods of prevention.

Food containers - Rigid containers, glass, wooden boxes, crates, plywood and wire bound boxes, corrugated and fibre board boxes, textile and paper sacks, corrosion of containers (tin plate); flexible packaging materials and their properties; aluminium as packaging material; evaluation of packaging material and package performance.

Packaging materials - Food packages, bags, types of pouches, wrappers, cartoonsand other traditional package; retortable pouches.

Shelf-life of packaged foodstuff - Methods to extend shelf-life; packaging of perishables and processed foods; special problems in packaging of foodstuff. Aseptic packaging, CA and MAP, active packaging; biodegradable packaging. Package standards and regulation.

Practicals

1. Determination of thickness, substance weight, water absorption capacity of flexible packaging materials.
2. Studies on strength properties of packaging materials.
3. Determination of water vapour and gas transmission rate of flexible packaging materials.
4. Determination of chemical resistance of plastic films.
5. Studies on different packaging technologies for fruits/vegetables.
6. Estimation of shelf-life of packaged foodstuff.
7. Familiarization of types of packaging material.

Suggested Readings

- Ahvenainen R. 2001. Novel Food Packaging Techniques. CRC.
- Ahvenainen R. 2003. Noval Food Packaging Techniques. 2003. Woodhead Publication Ltd, CRC press.
- Brody AL, Strupinsky ER & Kline LR. 2002. Active Packaging for Food Application. Francis and Taylor, CRC press.
- Crosby NT. 1981. Food Packaging Materials. Applied Science Publ.
- Han JH. 2005. Innovation in Food Packaging. 2005. Elsevier.
- Holdsworth D & Simpson R. 2007. Thermal Processing of Packaged Foods. Springer
- Mahadeviah M &Gowramma RV. 1996. Food Packaging Materials. Tata McGraw-Hill.
- Palling SJ. (Ed). 1980. Developments in Food Packaging. Applied Science Publ.
- Sacharow S &Grittin RC. 1980. Principles of Food Packaging. AVI Publ. Co.

Meat Processing

PFE 515 **3(2+1)**

Course Outcomes: The students will be acquainted with processing of meat and meat products and the design features of the equipments used for their processing; estimate quality of an egg; prepare whole egg powder and dry fish.

Syllabus: Meat and poultry products - Introduction, kinds of meat animals and poultry birds, classification of meat, composition of meat.

Slaughtering - Pre slaughter operations, post slaughter operations, wholesale and retail cuts.

Preservation of poultry - Different methods, stuffed products, frozen products, poultry concentrates and flavours, synthetic poultry flavour.

Different preservation methods of meat - Smoking, curing and freezing, chilling of meat and different methods of chilling, freezing of meat and different methods of freezing of meat, physical and chemical changes during chilling and freezing, packaging of meat and meat products, quality control.

Classification, composition and nutritive value of eggs - Grading of eggs, different quality parameters of eggs, Haugh unit, processing of egg, yolk processing, egg breaking mechanisms, freezing of egg, pasteurization, de-sugarisation and dehydration of egg, different dehydration methods, quality control and specification of egg products.

Fish-Nutritional quality of fish and fish products, fillet and steaks, different preservation techniques, chilling, freezing, drying, canning, curing and smoking, quality control in fish processing.

Practicals

1. Experiments on slaughtering and dressing.
2. Studies on curing and smoking of meat.
3. Experiments on wholesale and retail cutting.
4. Studies on preservation methods of meat and meat products.
5. Estimation of quality of egg.
6. Studies on Haugh unit and de-sugarisation.
7. Preparation of whole egg powder, yolk powder, freezing of fish, drying of fish, canning of fish.
8. Visit to meat and fish processing units.

Suggested Readings

- Chooksey MK &Basu S. 2003. Practical Manual on Fish Processing and Quality Control. CIFE, Kochi.
- Chooksey MK. 2003. Fish Processing and Product Development. CIFE, Kochi.
- Hall GM. 1997. Fish Processing Technology. Blabie Academic & Professional.
- Lawrie RS. 1985. Developments in Meat Sciences, Vol. III. Applied Science Publ.
- Mead GC. 1989. Processing of Poultry. Elsevier.
- Pearson AM &Tauber FW. 1984. Processed Meats. AVI Publ. Co.
- Stadelman WJ &Cotterill OJ. 1980. Egg Science and Technology. AVI Publ. Co.

Drying and Dehydration of Foods

PFE 516 **3(2+1)**

Course Outcomes: The students will be acquainted with the latest technologies of dehydration of food products and design features of different dryers; uses of different drying models in dehydration of foods; design and application of psychrometric properties in different pressure condition, design of drying systems by considering different resistances, perform testing of different dryers.

Syllabus: Importance of drying, principles of drying, moisture determination, equilibrium moisture content, determination of EMC, methods and isotherm models, psychrometry, psychrometric terms, construction and use of psychrometric charts.

Air flow and resistance, principles and equipments for air movement and heating, drying methods and theory of drying, driers, classification and other allied equipment, thin layer drying of cereal grains, deep bed and continuous flow drying, drying models.

Heat requirements and thermal efficiency of drying system, aeration, tempering and dehydration, operation of driers and their controls, selection of driers, performance testing of grain driers, drying characteristics of cereals, pulses and oilseeds, microwave drying, radio frequency drying and tunnel drying, principles and equipment.

Drying of liquid foods, spray drying, drum drying, freeze drying, foam mat drying, heat pump drying, osmotic dehydration; Principles, methods, construction and adjustments, selection of dryers, heat utilization factor and thermal efficiency.

Practicals

1. Experiments on batch type thin layer drying.
2. Experiments on fluidized bed drier.
3. Experiments on continuous flow mixing type drier, continuous flow non mixing type drier.
4. Determination of EMC of foods.
5. Applications of phychrometric chart.
6. Experiments on sand medium drier (conduction type drying).
7. Experiments on agricultural waste fired furnace drier.
8. Experiments on spray dryer and drum dryer.
9. Studies on foam mat drying and osmotic dehydration.
10. Evaluationof the thermal efficiency and heat utilization factor of dryers.

Suggested Readings

- Brooker DB, Bakker Arkema FW & Hall CW. 1974. Drying Cereal Grains. The AVI Publ. Co.
- Chakravorty A & De DS. 1999. Post-harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH.

- Chen Xiao Dong&Majumdar AS. 2008. Drying Technologies in Food Processing. Blackwell Publication.
- Hall CW. 1970. Drying of Farm Crops. Lyall Book Depot.
- HeldmanDR & Lund DB. 2007. Handbook of Food Engineering. Francis and Taylor, CRC press.
- Mujumdar AS 1998. Advances in drying, Vol 1, Hemisphere Publishing Corp. Washington.
- Singh RP &Heldman DR. 2009. Introduction to Food Engineering. Elsevier.
- Soares C. 2002. Process Engineering in Food Engineering. McGraw Hill Publication.Bala BK. 1998. Drying and Storage of Cereal Grains. Oxford & IBH.
- TadenszKudra&Majumdar AS. 2002. Advanced Drying Technologies. Marcel Dekker.

Transport Phenomena in Food Processing

PFE 522 **3(2+1)**

Course Outcomes: The students will be acquainted with the principles of heat and mass transfer,fundamental understanding of the laws of mass and energy balance, molecular diffusion and their application to food engineering; practical problems related to convective heat transfer process and its applications in food processing.

Syllabus: Introduction to heat and mass transfer and their analogous behaviour, steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems.

Convective heat transfer in food processing systems involving laminar and turbulent flow, Convective heat transfer – flow over flat plate - forced & natural convection, flow over cylinder - forced & natural convection; flow over spheres - forced & natural convection, laminar vs. turbulent flow.

Radiation heat transfer and its governing laws, its applications in food processing.

Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids, unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.

Practicals

1. Solving problems on steady and unsteady state conduction with or without heat generation.
2. Numerical analysis on steady and unsteady state problems.
3. Solving problems in natural and forced convection heat transfer.
4. Solving problems on radiation heat transfer.
5. Design of heat exchangers.
6. Experiments onconduction, convection and radiation heat transfer.

Suggested Readings

- Earle RL. 1985. Unit Operations in Food Processing. Pergamon Press.
- Geankoplis J Christie 1999. Transport Process and Unit Operations. Allyn& Bacon.
- Holman JP. 1992. Heat Transfer. McGraw-Hill.
- McCabe WL & Smith JC. 1999. Unit Operations of Chemical Engineering. McGraw Hill.
- Pitts DR& Sisson LE. 1988. Theory and Problems of Heat Transfer. Ms Graw Hill.
- Yanniotis S. 2007. Solving Problems in Food Engineering. Springer.

Food Processing Equipment Design

PFE 523 **3(2+1)**

Course Outcomes: The students will get acquainted with the types of material available for fabrication of equipments and their selection; types of pipe lines, their layout, insulation and installation; types of pressure vessel, their design for storage of liquids and gas; types of heat exchangers and design of PHE and shell and tube heat exchanger.

Syllabus: Material of construction - Choice of materials, physical and economical factors, generalized properties and fields of application of different metals such as ferrous metals and non ferrous metals; Steel and their uses; alloy steel; non ferrous metal and their alloys; generalized properties and field of application of non metals.

Design of pipe line - Cast iron and wrought iron pipes and tubing; light wall pipe; tubing, pipe connections and fittings; pipes and tube design data, design of steam piping.Sizing process lines; piping specifications; piping layout and arrangement; pipe insulation and installation.

Design of vessels and storage tanks - Vessel fabrication; welding processes; brazing and soldering; shell plates; heads; theory of pressure vessel design; working formula stress and design considerations.

Design and Selection of Heat Exchangers - Heat exchanger types; heat exchanger design-design procedure; short cut method of design.

Practicals

1. Calculation of insulation and installation.
2. Design of heat exchangers- plate heat exchanger and shell and tube heat exchanger.
3. Design of pressure vessels.
4. Design of storage tanks.
5. Design of process line and steam line.
6. Design of water piping system.
7. Design of steam piping for liquid foods.
8. Design of shell and tube heat exchanger.

Suggested Readings

- Joshi MV. 1981. Process Equipment Design. Macmillan India Ltd., New Delhi
- Rase HF& Barrow MH. 1967. Project Engineering of Processing Plants. John Wiley & Sons Inc., New York. Ch. 2, 3, 5, 12, 13, 14, 18, 20 and 21.

- Foust AS & others 2001. Principle of Unit Operations, John Willey and Sons INC., New York.
- Sinnott RK. 1983. Chemical Engineering and Introduction to Chemical Engineering Design Vol VI, Pergamon Press, Oxford.
- Soares C. 2002. Process Engineering Equipment Handbook. McGraw Hills.

Farm Structures and Environmental Control

PFE 524 **3(2+1)**

Course Outcomes: The students will be acquainted with the low cost farm structure, their ventilations and heating system; deigning of air conditioning system for farm and storage structures; exposure of various types of instrumentations used in air conditioning system in control and proper operation.

Syllabus: Thermodynamic properties of moist air, psychrometric chart and computer programmes for thermodynamic properties.

Farm structures and their design - Constructional details and design of low cost structures, heating, ventilating and exhaust systems, air distribution and air cleaning.

Drying and dehumidification system, air-water contact operations and evaporation, process and product air conditioning.

Instruments and measurements; codes and standards.

Practicals

1. Calculation of heating and cooling load.
2. Design calculation of moisture condensation in farm buildings.
3. Study of moisture migration behaviour in storage bins.
4. Study of design aspect of cold storage.
5. Determination of thermodynamic properties of air using psychrometric chart.

Suggested Readings

- Albright LD. 1990. Environmental Control for Animals and Plants. ASAE Textbooks.
- Esmay ML & Dixon JE. 1986. Environmental Control for Agricultural Buildings. The AVI Corp.
- Gaudy AF & Gaudy ET. 1988. Elements of Bioenvironmental Engineering. Engineering Press.
- Moore FF. 1994. Environmental Control Systems: Heating, Cooling, Lighting. Chapman & Hall.
- Threlkeld JL. 1970. Thermal Environmental Engineering. Prentice Hall.

Storage and Handling of Agricultural Products

PFE 525 **3(2+1)**

Course Outcomes: The students will be able to design different grain storage structure for the safe storage of grains from various destructive agents; acquaintance and design of grain conveying systems.

Syllabus: Storage of grains, biochemical changes during storage, production, storage factors affecting losses, storage requirements.

Storage of grain - destructive agents to the stored grains; living and nonliving environment in grain ecosystem; consumers like insects and rodents and decomposers like bacteria and fungi in the stored grains and their control, respiration of grain, indices of quality and conditioning of grain; functional requirement and conditioning of moist grains.

Effect of temperature and moisture content on the deterioration of stored grains; temperature in grain bin and its measurements; moisture migration.

Bag and bulk storage, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and aeration system.Rankine and Jansen's theory, side wall load, approx. Lateral pressure, increased pressure due to moisture, design of circular bins, rectangular bins, construction details; ventilation in the storage bin, aeration and cooling.

Principles of crop and food preservation and storage - Economic and health aspects, deterioration of food stuff; micro organisms and enzymes, behaviour of food stuff in storage; physiological diseases; preservation methods.

Cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen and carbon dioxide on storage of durable and perishable commodities, storage of dehydrated products, food spoilage and preservation, BIS standards.

Physical factors influencing material handling, material handling equipments for grain handling, design criteria for belt conveyors, bucket elevators, pneumatic conveying systems, importance of rural transport systems.

Practicals

1. Quality evaluation of stored products.
2. Design of storage structures i.e. cold storage.
3. Cooling load estimation of cold storage.
4. Studies on construction and maintenance ofstorage structures.
5. Studies on static pressure drop inside storage structures.
6. Experiment on controlled and modified atmosphere storage system.
7. Estimation of storage loss and quality of stored products.
8. Studies on material handling equipments.

Suggested Readings

- Chakravorty A, Majumdar AS &Raghavan GSV. 2003. Handbook of Post Harvest Technology. 2003. Marcel Dekker Inc.
- Hall CW. 1970. Handling and Storage of Food Grains in Tropical and Sub-tropical Areas. FAO Publication. Oxford & IBH.
- Henderson S & Perry SM. 1976. Agricultural Process Engineering, 5th Ed. AVI Publ. Co.
- McFarlane Ian. 1983. Automatic Control of Food Manufacturing Processes. Applied Science Publ.
- Multon JL. (Ed). 1989. Preservation and Storage of Grains, Seeds and their By-products. CBS.
- Rahman MS. 2007. Handbook of Food Preservation. Francis and Taylor, CRC press.
- Ripp BE. 1984. Controlled Atmosphere and Fumigation in Grain Storage. Elsevier.
- Shefelt RL &Prussi SE. 1992. Post Harvest Handling – A System Approach. Academic Press.
- Shejbal J. (Ed). 1980. Controlled Atmosphere Storage of Grains. Elsevier.
- Tewari G &Juneja VK. 2007. Advances in Thermal and Non-thermal Food Processing. Blackwell publication.
- Vijayaraghavan S. 1993. Grain Storage Engineering and Technology. Batra Book Service.

Post Harvest Processing of Grains

PFE 535 **3(2+1)**

Course Outcomes: The students will be acquainted with fundamental understanding of principles of grainsprocessing and management; concept of various unit operations of grainsprocessing and design features of the equipments used for their processing.

Syllabus: Processing of different grains and their engineering properties, principles and importance of grain processing.

Performance characteristics of different unit operations such as pre-cleaning, grading, conveying, elevating, drying, treating, blending, packaging and storage, seed processing machines like scalper, huller, spiral separator, cleaner-cum-grader, specific gravity separator, indent cylinder, disc separator and colour sorter; weighing and bagging machines, their operation and maintenance, installation and determination of their capacity, seed quality maintenance during processing, plant design and layout, economy and safety consideration in plant design.

Grain drying principles and methods, theory of grain drying, introduction to different types of heated air dryers, significance of moisture equilibrium, method of maintaining safe grain moisture, thumb rule and its relevance, importance of scientific grain storage, types of storage structures to reduce temperature and humidity; management and operation/cleanliness of grain stores, packaging-principles, practices, materials and hermetic packaging, grain treatment methods and machines used, method of stacking and their impact, design features of medium and long term grain storage building.

Practicals

1. Determination of engineering properties of grains.
2. Studies of various grain processing equipments such as pre-cleaners, scalpers, air screen cleaners, graders, spiral and pneumatic separators.
3. Studies of grain treating equipments and their performance evaluation.
4. Design and layout of grain processing plant and its economics.
5. Analysis of cost of operation and unit cost of processed product.
6. Effect of drying temperature and duration on seed germination and storability.

Suggested Readings

- Chakravorty A, Majumdar AS &Raghavan GSV. 2003. Handbook of Post Harvest Technology. 2003. Marcel Dekker Inc.
- Henderson S & Perry SM. 1976. Agricultural Process Engineering, 5th Ed. AVI Publ. Co.
- Rahman MS. 2007. Handbook of Food Preservation. Francis and Taylor, CRC press.
- Sahay KM & Singh KK. 1994. Unit Operation of Agricultural Processing, Vikas Publ. House.

Food Chemistry and Microbiology

PFE 536 **3(2+1)**

Course Outcomes: The students will be acquainted with food chemistry, food microbiology and its application in food plant sanitation.

Syllabus: Moisture in foods, fats and other lipids, their occurrence in foods and composition, edible fats and oils, fatty acids; physical and chemical properties; rancidity and test for rancidity; technology of edible fats and oils; carbohydrates; changes in carbohydrates on cooking. Protein in foods and their properties and determination procedures.

Introduction to micro organisms related to food and their general characteristics; contamination of foods by micro organisms; principles of food preservation; spoilage and preservation of different kinds of foods; microbiology in food plant sanitation.

Practicals

1. Chemical analysis of foods with regard to moisture, carbohydrates, fat, protein, crude fibre and mineral.
2. Estimation of rancidity in foods.
3. Estimation of carbohydrates in foods.
4. Preparations of agar medium and related growth of micro-organisms.
5. Studies on preservation methods of foods.
6. Studies on food plant sanitation processes.

Suggested Readings

- Dutta R. 2008. Fundamentals of Biochemical Engineering. Springer.
- Frazier WC, and Westhoff DC. 1983. Food Microbiology, Tata McGraw Hill Publishing Company Ltd., New Delhi.
- Meyer LH. 1960. Food Chemistry, Reinhold Publishing Corporation, New York.

Biochemical and Process Engineering

PFE 537 **3(2+1)**

Course Outcomes: The students will be acquainted and equipped with the basic principles of biochemical, instrumentation and transport phenomenon in food processing such as laws of mass and energy balance, growth kinetics in food processing, aerobic and agitated rheology of fermentative fluids; principles of recovery of fermented products.

Syllabus: Applications of engineering principles; mass and energy balance, fluid flow principles, unit operations of process engineering.

Fundamentals of growth kinetics, maintenance energy and yield concepts, principles of media sterilization, media formulations of industrial fermentation.

Aerobic and agitated rheology of fermentative fluids, design and scale-up of bioreactors, enzyme reactors.

Principles of recovery of fermented products in bio-processing, instrumentation, transport phenomenon.

Practicals

1. Solving problems on mass and energy balance.
2. Calculation of kinetics of reactions.
3. Determination of kinetics of growth in batch cultures.
4. Design consideration for bioreactors.
5. Media preparation and sterilization.
6. Studies on recovery of fermented products in bio-processing.

Suggested Readings

- Coulson JM &Richadson JF. 1999. Chemical Engineering. Vols. II, IV. The Pergamon Press.
- Dutta R. 2008. Fundamentals of Biochemical Engineering. Springer
- Treybal RE. 1981. Mass Transfer Operations. 3rd Ed. Harper & Row.
- Brennan JG, Butters JR, Cavell ND &Lilly AEI. 1990. Food Engineering Operations. Elsevier.
- Geankoplis J Christie. 1999. Transport Process and Unit Operation. Allyn& Bacon.

Advances in Food Processing

PFE 611 **3(2+1)**

Course Outcomes: The students will learn various advanced methods of food preservation technologies for inactivation of microorganisms and enzymes.

Syllabus

Preservation of foods – Physical and chemical methods-microbiological aspects, thermo bacteriology, process calculation and selection.

Low temperature preservation - Cooling and cold storage - freeze concentration and membrane separation process - hurdle technology - principles and applications - food irradiation - advantages and applications, microwave processing - interaction with food materials- microwave equipment - hydrostatic pressure treatment of food - equipment, processing and effect on microorganisms.

Application of heat energy and ultrasound - Inactivation of microorganisms and enzymes -electrical resistance heating of food - heat generation, ohmic heater, heating models - pulsed electric field preservation- principles and application - influence on microorganisms and food ingredients - decontamination of microorganisms by surface treatment.

Extrusion cooking - Recent developments, methods, equipment, design criteria of extruders.

Practicals

1. Experiments to assess the food spoilage by microorganisms and enzymes.
2. Experiments on freeze concentration.
3. Experiments on membrane separation process.
4. Studies on noval processing technologies like food irradiation, high pressure preservation, pulsed electric field.
5. Experiments on microwave processing.
6. Experiments onohmic heating of liquid foods.
7. Determination of water sorption index and expansion ratio of extruded foods.

Suggested Readings

- Brennan JG. 2006. Food Processing Handbook. Wiley-VCH Publication.
- GoldblithSA. I.Rey& Rothmayr WW. 1975. Freeze Drying and Advanced Food Technology. Academic Press, London.
- GouldGW. (Ed).1996. New Methods of Food Preservation. First Edition. Blackie Academic & Professional, London.
- HeldmanDR & Lund DB. 2007. Handbook of Food Engineering. Francis and Taylor, CRC press.
- Heldman DR& Lund DB.1992. Hand Book of Food Engineering. Marcel Dekker Inc. New York.
- LenigerHA &BeverlooWA. 1975. Food Process Engineering. First Edition. D.Reidel Publishing Company, Dordrecht, Holland.
- Riaz MN. 2000. Extruders in Food Applications. Francis and Taylor, CRC press.
- Singh RP &Heldman DR. 2009. Introduction to Food Engineering. Elsevier.
- Soares C. 2002. Process Engineering in Food Engineering. McGraw Hill Publication.
- Sun Da Wen. 2005. Emerging Technologies for Food processing. 2005. Elsevier.

Post Harvest Engineering

PFE 621 **3(2+1)**

Course Outcomes: The students will learn about the post-harvest technologies of cereals, pulses and oil seeds and related various operations; different types of cleaners and graders; concept of grain quality deterioration; chemical and biochemical methods for quality evaluation.

Syllabus: Weather characteristics and post harvestoperations– Weather characteristics including air temperature; rainfall/ RH throughout the year and corresponding EMC of different crops, safe storage of food grain.

Harvest studies on different crops– Evaluation of post harvest losses, transportation, threshing; storage and handling losses and their measurement.

Cleaning and sorting of grains– Definitions; effect of crop and machine variables; different types of cleaners and graders, vibrating screen cleaner; sieve screen method; rotary grain pre cleaner; vertical rotation, screen separator; specific gravity separator.

Grain quality deterioration due to insect and pests – Grain quality storage; different fungus; moulds and bacterial insects and their species, mites and rodents; their control and loss measurement.

Chemical control ofstored insects and mites– Principle; chemicals used to control insects and mites in stored grain; fumigants in dried and liquid form.

Various biochemical methods for quality evaluation of the farm produce – Methods for determination of protein, carbohydrate; total oil; ash; volatile oil and fibre content of various cereals; pulses; oilseeds and agricultural waste.

Size Reduction – Principles of commutation; energy and power requirements; Kick's law; Rittinger's and Bond's law; size reduction equipment.

Utilization of by-products for energy; food and feed – Utilization of rice bran and other agricultural waste and methods of their utilization.

Practicals

1. Estimation of storage and handling losses of grains.
2. Determination of EMC of food.
3. Grain size analysis.
4. Estimation of protein content in pulses.
5. Estimation of fat content.
6. Estimation of crude fibre, ash and carbohydrate.
7. Experiments on estimation of power requirement for size reduction.

Suggested Readings

- Chakravorty A, Majumdar AS &Raghavan GSV. 2003. Handbook of Post Harvest Technology. 2003. Marcel Dekker Inc.
- Chakravorty A. & De, DE. 1988. Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publ. Co., New Delhi, Ch. 14, 15 and 17.
- Muir WE. & Sinha RN. 1973. Grain Storage Part of a system. AVI Publishing Company Inc., Westport. Ch.6.
- Rahman MS. 2007. Handbook of food preservation. Francis and Taylor, CRC press.
- Tewari G &Juneja VK. 2007. Advances in Thermal and Non-thermal Food Processing. Blackwell publication.

Advances in Drying of Food Materials

PFE 612 **3(2+1)**

Course Outcome: The students will beacquaintedwith mechanism for moisture removal during drying of low, medium and high moisture materials; concept of heat and mass transfer in granular porous media; latest technologies of dehydration of food products.

Syllabus: Mechanism of moisture removal from food, feed and seed materials. Parameters of drying for various commodities and drying systems.Drying of low, medium and high moisture materials such as grains, seeds, fruits and vegetables etc. Mathematical modelling and stimulation of drying, Luikov's set differential equations and solution for single kernel, thin layer and deep bed drying. Semi-empirical and empirical equations, Thompson and MSU models. Types of dryers and their applications, batch and continuous dryers, concurrent, counter flow and cross flow dryers. Sources of heat for drying, solar, biomass, electricity and fuels.Testing of grain dryers.Special drying techniques and dryers for specific commodities; spray, drum, rotary, fluid bed and freeze dryers, their application, design and management.

Theoretical foundation of drying technology, heat and mass transfer in granular porous media, mathematical methods and kinetics of heat and mass transfer with phase change in porous media, drying theories, their bases and limitations as applied to food and grains, review on recent development on drying of food material, mass transfer in convective drying.

Practicals

1. Experiments on drying of grains in thin layer and deep bed.
2. Development of drying equations& verification of various drying models.
3. Design of dryers.
4. Testing of grain dryers.
5. Numerical problems on heat and mass transfer.
6. Experiments on drying of different type of food products.

Suggested Readings

- Chen Xiao Dong&Majumdar AS. 2008. Drying Technologies in Food Processing. Blackwell Publication.
- Mujumdar AS. 1998. Advances in drying, Vol 1, Hemisphere Publishing Corp. Washington.
- HeldmanDR& Lund DB. 2007. Handbook of Food Engineering. Francis and Taylor, CRC press.
- Singh RP &Heldman DR. 2009. Introduction to Food Engineering. Elsevier.
- Soares C. 2002. Process Engineering in Food Engineering. McGraw Hill Publication.

Mathematical Models in Food Processing

PFE 613 **3(3+0)**

Course Outcome: The students will be acquainted with the various mathematical modeling techniques, concept of mathematical models of food processing; applications of mathematical modeling in food processing.

Syllabus

An overview of the modeling process.Introduction to mathematical, correlative and explanatory models.Formulation, idealization and simplification of the problems.

Probability models, series and linear mathematical approximation, dynamic and interacting dynamic processes.

Applications of mathematical modelling techniques to food processing operations like parboiling, convective drying, pasteurization, dehydration, shelf-life prediction, fermentation, aseptic processing, moisture diffusion, deep fat drying, microwave processing, infrared heating and ohmic heating. Stochastic finite element analysis of thermal food processes. Neural networks approach to modelling food processing operations.

Suggested Readings

- Fischer M, Scholten HJ &Unwin D. 1996. Spatial Analytical Perspectives on GIS. Taylor & Francis.
- Fish NM &Fox RI. 1989. Computer Application in Fermentation Technology: Modelling and Control of Biotechnological Processes. Elsevier.
- Getz WM.1979. Mathematical Modeling in Biology Processes. Elsevier.
- Hunt DR.1986. Enginering Models for Agricultural Production. The AVI Publ.
- Jun S &Irudayaraj JM. 2006. Food Processing Operations Modeling – Design and analysis. Francis and Taylor, CRC press.
- Kapur JN.1989. Mathematical Modeling. Wiley Eastern.
- Meyer JW. 2004. Concepts of MathematicalModeling. McGraw Hill.
- Peart RM &Curry RB.1998. Agricultural Systems, Modelling and Simulation. Marcel Dekker.
- Tijms HC. 1984. Modelling & Analysis. A Congrtational Approach. Wiley Publ.

Advanced Process and Food Engineering

PFE 614 **3(2+1)**

Course Outcome: The students will be acquainted with various concepts of commercial sterility, practical thermal processing problems, freezing of foods and problems for predicting freezing time.

Syllabus: Introduction; thermodynamics applied to food engineering; fundamentals of heat and mass transfer analogy in food Processing.

Kinetics of reaction occurring in processed foods, reaction velocity constant; order of reaction; quality changes during storage of foods; application of Arrhenius equation to the biological reactions.

Commercial sterility; chilling, pasteurization and sterilization methods based on slowest heating region; determination of the process time based on region of greatest temperature lag; the process equivalence in terms of minutes at 121.1°C, calculation of process time for fluids in streamline and

turbulent flowin heat exchangers; general introduction to aseptic canning process, hydrostatic sterilizer and aseptic packaging practices and design problems.

Properties of frozen foods; freezing point depression, general introduction to enthalpy change during freezing, Plank's equation for predicting rates of product freezing; design of food freezing equipment such as air blast freezers; plate freezers and immersion freezers.

Modes of heat transfer; conduction; convection and radiation; overall heat transfer, thermal properties of foods such as specific heat and thermal conductivity; Fourier's law; steady state and unsteady state conduction; heat exchange equipment; energy balances; rate of heat transfer, thermal boundary layer; heat transfer by forced convections in laminar flow; heat transfer to flat plate and in non Newtonian fluids; heat transfer in turbulent flow; heating and cooling of fluids in forced convection outside tubes, natural convection.

Practicals

1. Calculation of kinetics of reaction- first order and second order.
2. Applications of Arrhenius equation.
3. Determination of process time.
4. Calculations of freezingpoint and estimation of freezing time by Planck's equation.
5. Designof freezing equipments.
6. Numerical problems on conduction, convection and radiation.

Suggested Readings

- Charm SE. 1971. Fundamentals of Food Engineering. The AVI Publishing Co. INC, Westport.
- Fellows PJ. 2000. Food Processing Technology 2nd ed. CRC Press Boca Raton, New York.
- HeldmanDR & Lund DB. 2007. Handbook of Food Engineering. Francis and Taylor, CRC press.
- Singh RP &Heldman DR. 2009. Introduction to Food Engineering. Elsevier.
- Soares C. 2002. Process Engineering in Food Engineering. McGraw Hill Publication.
- Sun Da Wen. 2006. Handbook of Frozen Food Processing and Packaging. Francis and Taylor, CRC press.
- Valentas KJ,Rotstein E &Singh RP. 1997. Handbook of Food Engineering Practices. CRC Press Boca Raton, New York.

Milling of Food Materials

PFE 615 **3(2+1)**

Course Outcome: The students will be acquainted with milling processes/methods of major cereals, pulses and oilseeds andrecent developments in milling processes; value addition of by-products and waste utilization.

Syllabus: Milling processes of major cereals, pulses and oilseeds. Design characteristics of milling equipments, their selection, and installation and performance evaluation. Milling of cereals (wheat, rice, maize and sorghum).Grain cleaning, grading, particle size, screen selection, grain structure, composition and proximate analysis. Grain conditioning. Traditional and modern methods of grain

milling. Equipments for wheat milling, milling losses and specific energy consumption; modern wheat milling, types of break/ rough/ corrugated rolls, steel rolls their selection, principles of working, flour yield, sieving and sifting, flour analysis and enrichments of flour, value addition of by-products and waste. Equipments for rice milling: Hand pounding, traditional and modern rice milling, dryers and their types, paddy dehuskers, shellers, rubber rollers, rice separator, rice polishers/whiteners. Parboiling of paddy: boilers and milling of parboiled paddy, utilization of by-products such as rice bran and husk.Storage of paddy and rice.Plant layout and management of rice mills. Equipments for pulse milling, and polishers, Recent developments in premilling treatments, enzymatic and sodium- bicarbonate treatment etc. Dry and wet milling, CFTRI method of Pulse Milling.Plant layout and management. Equipment for milling of maize and sorghum: Hand and power operated shellers and dehuskers. Screen analysis of flour: specific energy consumption. Equipment for expelling of oilseeds; Various types of oil-expellers, grain treatment, oil quality. Energy consumption.Traditional and commercial scale milling.Recent developments in oil processing such as use of enzymatic pre-treatment etc.Utilization of product waste. Plant layout and management of oil mill plants.

Practicals

1. Study on selection, installation and performance evaluation of milling equipments.
2. Study of modern wheat milling equipment.
3. Calculation of milling losses.
4. Determination of specific energy consumption of milling equipments.
5. Value addition of by-products and wastes.
6. Study of various equipments for rice milling.
7. Study on utilization of by-products such as rice bran and husk.

Suggested Readings

- Chakravorty A. & De, DE. 1988. Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Pub. Co., New Delhi, Ch. 14, 15 and 17.
- Kent NL. 1975. Technology of Cereals with Special Reference to Wheat. Pergamon Press, Oxford, New York.
- Inglett GE 1970. Corn: Culture, Processing, Products. The AVI Publishing Co. INC. Westport.
- Rahman MS. 2007. Handbook of Food Preservation. Francis and Taylor, CRC press.
- Chakravorty A, Majumdar AS &Raghavan GSV. 2003. Handbook of Post Harvest Technology. Marcel Dekker Inc.

Design of Grain Storage Structures

PFE 622 **3(2+1)**

Course Outcome: The students will be acquainted and equipped with designing of grain storage structures; moisture and heat management in storage structures.

Syllabus: Storage structures; bins, bunkers, silos and warehouses; Methods of computing static pressures due to granular materials, Janssen's method, Airy's method, Rimbert's method; Dynamic

pressures, Lvin's theory, Walter's method, comparison of various methods; flow patterns, pressure in Bunkers; Dead and Live loads, thermal effects, Loads at hoppers; Design of concrete and metal silos; flexible bins. Grain damage and its control, metabolic activities; biological agents; physical and chemical controls; aeration system Design and management; temperature profiles; stored product environment control storage, warehouses, site selection, stack arrangement, moisture and heat management, quality management, codes for construction and management.

Practicals

1. Quality evaluation of stored product
2. Design of storage structures.
3. Design of bag storage.
4. Silo design by Janssen's method.
5. Silo design by Airy's method.
6. Estimation of storage loss.
7. Estimation of quality of stored products.

Suggested Readings

- Bala BK. 1997. Drying and Storage of Cereal Grains. Oxford & IBH Publishing Co. Pvt. Ltd., New Dehi.
- Sinha RN &Muir WE. 1973. Grain Storage, Part of a System. The AVI Publishing Co. INC
- Shejbal J.1980.Controlled Atmosphere Storage of Grains. Elsevier Scientific Pub. Co. Oxford.

Design of Food Process Equipments

PFE 623 **3(2+1)**

Course Outcome: The students will be acquainted with the types of heat exchangers and design of PHE and shell and tube heat exchanger, pipe lines, their layout, insulation and installation; types of pressure vessel and storage tanks, their design for storage of liquids and gas.

Syllabus: Applications of design engineering to post-harvest equipments, design parameters, codes and materials selection, design of materials handling equipments, heat exchangers, seed processing equipments, pressure vessels, optimization of design in respect of process efficiency, energy and cost.

Piping - Cast iron and wrought iron pipes and tubing; light wall pipe; tubing, pipe connections and fittings; pipes and tube design data, design of steam piping.

Design of pipe line - Sizing process lines; piping specifications; piping layout and arrangement; pipe insulation and installation.

Design of vessels and storage tanks - Vessel fabrication; welding processes; brazing and soldering; shell plates; heads; theory of pressure vessel design; working formula stress and design considerations.

Design and Selection of Heat Exchangers - Heat exchanger types; heat exchanger design-design procedure; short cut method of design.

Practicals

1. Study of methods of fabrication process.
2. Design of plate heat exchanger.
3. Design of shell and tube heat exchanger.
4. Design of pressure vessels.
5. Design of storage tanks.
6. Design of process line and steam line.

Suggested Readings

- Bhattacharyya BC. 1991. Introduction to Chemical Equipment Design. CBS Publishers & Distributors. New Delhi
- Coulson JM, Richardson JF& Sinnot RK. 1983. Chemical Engineering Vol. 6, Pergamon Press.
- Evans FL. 1974. Equipment Design Handbook, Vol II, Gulf Publication Houston, Texas.
- Foust AS. 2001. Principle of Unit Operations, John Willey and Sons INC., New York.
- Joshi MV. 1981.Process Equipment Design. Macmillon India Ltd., New Delhi.
- Soares C. 2002. Process Engineering Equipment Handbook. McGraw Hills.

Rheology of Foods

PFE 624 **3(2+1)**

Course Outcome: The students will be acquainted with various textural, rheological and viscoelastic characteristics of foods.

Syllabus: Texture classification. Relation of food texture with structure and rheology. Principles and practices of objective texture measurements, viscosity measurements. Sensory methods of texture and viscosity measurements and their correlation.Rheological properties of foods. Mathematical models and their application along with pipe line design and pump selection for non-Newtonian fluids. Recent advances in textural, rheological and viscoelastic characteristics of foods and their associated mathematical models.

Practicals

1. Determination of viscosity of liquid foods.
2. Determination of rheological properties such as gumminess, chewiness, firmness, springiness and hardness of various fruits, vegetables and processed foods using texture profile measurement.
3. Studies on various rheological models.
4. Correlation between subjective and objective measurements of properties of foods.
5. Sensory evaluation of processed foods.

Suggested Readings

- Bourne MC. 2002. Food Texture and Viscosity: Concept and Measurement. Academic Press.
- Deman JM. 1976. Rheology and Texture in Food Quality. AVI Publ. Mohsanin NN.1989. Physical Properties of Plant and Animal Material. Vol. I, II. Gordon and Breach Science Publ.

- Rao MA, Rizvi SSH &Datta ADK. 2005. Engineering Properties of Food. Francis and Taylor, CRC press.
- Sahin S &Sumnu SG. 2006. Physical Properties of Food. Springer
- Steffe JF. 1992. Rheology and Texture in Food Quality. AVI Publ.

Agricultural Waste and By-Products Utilization

PFE 625 **3(2+1)**

Course Outcome: The students will be acquainted with the proper utilization of agricultural and industry waste and by-products; food waste treatment methods; development of value added products from wastes.

Syllabus: Food industry and agricultural waste: Introduction to waste from dairy industry, fermentation industry, fruit and vegetable industry, packaging material industry.

Food Waste treatment methods: Thermal processes, pyrolysis, gasification.

Fruit / fruit juice waste management: Introduction, treatment methods such as anaerobic digestion, composting, treatment of industrial water effluent, uses of fruits waste, various fruits processing by products.

Cereal waste management: Introduction, treatment methods such as composting, pyrolysis, gasification, biogas, uses of wheat, corn, rice, barley waste.

Vegetable waste management: Introduction, treatment methods, treatment of waste identification of different compounds in vegetable waste, anaerobic digestion of vegetable waste, comparison of waste treatment methods.

Dairy waste management: introduction, treatment methods, treatment of waste, uses of dairy waste, input and output in dairy.

Practicals

1. Exercises on utilization of agricultural wastes and their byproducts.
2. Studies on treatments and disposal of agro wastes.
3. Studies on production of alcohol from waste materials.
4. Studies on production and testing of paperboards and particleboards from agricultural wastes.

Suggested Readings

- Dutta R. 2008. Fundamentals of Biochemical Engineering. Springer
- Ioannis S Arvanitoyannis. 2008. Waste Management for the Food Industries. Elsevier Academic Press.
- Mahajan&Goswami. 2005. Food and Process Engineering.
- Ojha TP & Michael AM. 2006. Principles of Agricultural Engineering. Jain Brothers.

Note:

1. For supporting courses course description, which are offered by other departments, refer separately syllabus of that particular department.
2. For syllabus of Non-Credit Compulsory Courses, see at the end.

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DEPARTMENT OF RENEWABLE ENERGY ENGINEERING

VISION

To be a centre of excellence which integrates all facets of Renewable Energy, entrepreneurship and environmental management and be recognized as the focal point for catalyzing the growth of the energy and agriculture, renewable energy engineering and related industries; and to produce skilful and high quality post graduate engineers supported by up-to-date curriculum and scientific and industrial research to suit the industry, to enhance the energy saving potential by providing databank, testing facilities, suitable consultancy and training services.

MISSION

Impart education and updated knowledge to PG students so as to make them competent enough in the areas of renewable energy engineering, environmental management by offering the courses and training programmes of global standards with optimal mix of inputs on renewable energy engineering, energy auditing, energy conservation, energy production from alternate means, bio fuels & environment engineering; management and entrepreneurship.

Fully committed to provide need based quality education in all the major areas to the students so that they can not only contribute to their personal development and prosperity of the society, state and the nation as a whole but also build a leading and successful career in this field and can work in rural areas for the development of farmers community as well as aid in relieving the pressure of energy deficiency.

Programme Educational Objectives

1. To provide students with a sound foundation in the renewable energy engineering fundamentals. A post graduate must be able to understand renewable energy technologies and to engage in an integrated system-level design.

2. A post graduate student must have sound understanding of the energy and related fields and necessary perspective to pursue work in renewable related industries and fields so as to cover the whole spectrum of renewable energy engineering.
3. To develop the analytical and logical aptitude among students to quickly adapt to new work environments, assimilate new information, and solve new problems.
4. To provide exposure of new cutting edge technologies to the students and to motivate them to take up new challenges to solve the problems faced by society and nation through research and development.

Programme Outcome

1. Develop skill and expertise amongst post graduate scholars to design, install and commission projects on waste management and natural renewable resource utilization for energy recovery and environmental friendly disposal.
2. Generate adequate trained man power for implementing national mission and policies of government related to renewable energy harnessing in our country.
3. Prepare cadre of research scholars for achieving entrepreneurial skills and self employment opportunities in renewable energy sector.

Semester-wise Scheme for Post Graduate Programme in Renewable Energy Engineering

Details of courses offered for the award of M.Tech. (Ag.), REE

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV
Core Courses: Total 12 credits; 2 courses in first semester (6 credits) and 1 course each in second and third semester (3 credits each) to be evaluated externally.						
Solar Energy Utilization	REE 511	3(2+1)	3	-	-	-
Bio-energy Conversion & Processing of Wastes	REE 512	3(2+1)	3	-	-	-
Biogas Technology & Mechanism	REE 521	3(2+1)	-	3	-	-
Renewable Sources of Energy	REE 531	3(2+1)	-	-	3	-
Optional Courses: Total 15 credits; two courses in first & second semester each (6 credits in each semester) and one course in third semester (3 credits).						
Energy Conservation & Management	REE 513	3(2+1)	3	-	-	-
Waste Recycling and Resources Recovery Systems	REE 514	3(2+1)	3	-	-	-
Agro-Energy Audit and Management	REE 515	3(2+1)	3	-	-	-
Wind Energy Utilization	REE 516	3(3+0)	3	-	-	-
Design and Analysis of Renewable Energy Conversion Systems	REE 522	3(3+0)	-	3	-	-
Energy Management in Food Processing Industries	REE 523	3(3+0)	-	3	-	-
Alternate Fuels & Applications	REE 524	3(3+0)	-	3	-	-
Energy, Ecology & Environment	REE 525	3(3+0)	-	3	-	-
Solar Refrigeration and Air Conditioning	REE 526	3 (3+0)	-	3	-	-
Direct Energy Conversion Technologies	REE 535	3(2+1)	-	-	3	-
Energy Lab	REE 536	3(0+3)	-	-	3	-
Energy Management in Agriculture	REE 537	3(3+0)	-	-	3	-
Minor & Supporting Courses: Total 9 credits; one course in first, second and third semester each (3 credits in each semester).						
Statistical Methods	AST 510	3(2+1)	3	-	-	-
Advance Programme with C^{++}	CSE 511	3(1+2)	3	-	-	-
Engineering Properties of Food Materials	PFE 512	3(2+1)	3	-	-	-
Applied Instrumentation in Farm Machinery & Stress Analysis	FMPE 513	3(2+1)	3	-	-	-
Farm Power and Machinery Management	FMPE 514	3(2+1)	3	-	-	-
Higher Mathematics	BS 515	3(3+0)	3	-	-	-
Drying and Dehydration of Foods	PFE 516	3(2+1)	3	-	-	-
CAD/CAM	MED 518	3(1+2)	3	-	-	-
Methods of Numerical Analysis	BS 521	3(2+1)	-	3	-	-
GIS and Remote Sensing for Land and Water Resource Management	SWC 522	3(2+1)	-	3	-	-
Post Harvest Processing of Grains	PFE 535	3(2+1)	-	-	3	-
Others						
Compulsory Courses; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/ 502/...	1	NC	NC		
Seminar (0+1)	REE 532	1	-	-	1	-
Comprehensive	REE 533	NC			NC	
Research (Thesis). Thesis minimum duration 2 semesters	REE 534	20	-	-	-	20
Total credits to be offered (for Master Programme)		**57**	**15**	**12**	**10**	**20**

COURSE SUMMARY

Courses	No. of Courses					Credit Hours
	Semester					
	I	II	III	IV	Total	
Core	2	1	1	-	4	12
Optional	2	2	1	-	5	15
Minor & Supporting	1	1	1	-	3	9
Seminar	-	-	1	-	1	1
Comprehensive	-	-	-	1	1	Non Credit (graded as satisfactory/non satisfactory)
Research (Thesis)	-	-	-	1	1	20* (graded as satisfactory/ non satisfactory)
Compulsory Courses (PGS Series)	1	1	-	-	2	Non Credit
Total	**6**	**5**	**4**	**2**	**17**	**57**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

Details of courses offered for the award of Ph.D. (Ag. Engg.), REE

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV-VI
Core Courses: Total 6 credits (3 credits in each semester); one course in first semester and one course in second semester to be evaluated externally.						
Renewable Energy for Industrial Application	REE 611	3(2+1)	3		-	-
Solar Energy Utilization for Heating & Cooling	REE 621	3(3+0)	-	3	-	-
Optional Courses: Total 12 credits (6 credits in each semester); two course in first and second semester each.						
Energy Conservation & Management	REE 513	3(2+1)	3	-	-	-
Waste Recycling and Resources Recovery Systems	REE 514	3(2+1)	3	-	-	-
Agro-Energy Audit and Management	REE 515	3(2+1)	3	-	-	-
Wind Energy Utilization	REE 516	3(3+0)	3	-	-	-
Design and Analysis of Renewable Energy Conversion Systems	REE 522	3(3+0)	-	3	-	-
Energy Management in Food Processing Industries	REE 523	3(3+0)	-	3	-	-
Alternate Fuels & Applications	REE 524	3(3+0)	-	3	-	-
Energy, Ecology & Environment	REE 525	3(3+0)	-	3	-	-
Solar Refrigeration and Air Conditioning	REE 526	3(3+0)	-	3	-	-
Direct Energy Conversion Technologies	REE 535	3(2+1)	-	-	3	-
Energy Lab	REE 536	3(0+3)	-	-	3	-
Energy Management in Agriculture	REE 537	3(3+0)	-	-	3	-
Power System Analysis	REE 612	3(3+0)	3	-	-	-
Thermo chemical Conversion of Biomass	REE 613	3(2+1)	3	-	-	-
Environmental Pollution & Control	REE 614	3(3+0)	3	-	-	-
Management & Utilization of Natural Resources	REE 622	3(3+0)	-	3	-	-
Gender & Energy	REE 623	3(3+0)	-	3	-	-
Renewable Energy Techniques	REE 624	3(2+1)	-	3		
Wind & Human Environment	REE 625	3(3+0)	-	3	-	-
Minor & Supporting Courses: Total 9 credits; two courses in first semester (6 credits) and one course in second semester (3 credits).						
Statistical Methods	AST 510	3(2+1)	3	-	-	-
Advance Programme with C^{++}	CSE 511	3(1+2)	3	-	-	-
Engineering Properties of Food Materials	PFE 512	3(2+1)	3	-	-	-
Applied Instrumentation in Farm Machinery & Stress Analysis	FMPE 513	3(2+1)	3	-	-	-
Farm Power and Machinery Management	FMPE 514	3(2+1)	3	-	-	-
Higher Mathematics	BS 515	3(3+0)	3	-	-	-
Drying and Dehydration of Foods	PFE 516	3(2+1)	3	-	-	-
CAD/CAM	MED 518	3(1+2)	3	-	-	-
Methods of Numerical Analysis	BS 521	3(2+1)	-	3	-	-
GIS and Remote Sensing for Land and Water Resource Management	SWC 522	3(2+1)	-	3	-	-

Post Harvest Processing of Grains	PFE 535	3(2+1)	-	-	3	-
Finite Element Analysis	MED 612	3(3+0)	3	-	-	-
Advances in Drying of Food Materials	PFE 612	3(2+1)	3	-	-	-
Agricultural Waste and By-Products Utilization	PFE 625	3(2+1)	-	3	-	-
System Engineering and Productivity	SWCE 526	3(2+1)	-	3	-	-
Others						
Compulsory Courses+; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/ 502/...	1	NC	NC		
Seminar	REE 691/ 692	1(0+1)	1	1	-	-
Preliminary	REE 633	NC			NC	
Research (Thesis). Thesis minimum duration 4 semesters	REE 634	45	-	-	-	45
Total credits to be offered		**74**	**16**	**13**	**-**	**45**

Note: A Ph.D. student must take two 600 series core courses. A student may choose optional/minor & supporting courses of 500 series courses if not studied during Masters Programme as per ICAR guidelines.

\+ Exempted for those who have cleared these in Master's Programme (permission to be sought from the Dean, CTAE).

COURSE SUMMARY

Courses	No. of Courses							Credit Hours
	Semester							
	I	II	III	IV	V	VI	Total	
Core	1	1					2	6
Optional	2	2					4	12
Minor & Supporting	2	1					3	9
Seminar	1	1					2	2
Preliminary			1				1	Non Credit (graded as satisfactory/non satisfactory)
Research (Thesis)						1	1	45* (graded as satisfactory/non satisfactory)
Compulsory Courses** (PGS Series)	1	1					2	Non Credit
Total	**7**	**6**	**1**			**1**	**15**	**74**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

**Exempted for those who have cleared these in Master's Programme.

SYLLABUS
RENEWABLE ENERGY ENGINEERING

CORE COURSES

Solar Energy Utilisation

REE 511 **Credit 3(2+1)**

Course Outcome: The main objective of this course is to provide detail knowledge about working and design of various solar thermal devices like solar cooker, solar dryer, solar water heater, solar still and solar ponds. This course will explore the fundamentals of solar photovoltaic system for power generation. Student will able to design different solar thermal devices and solar photovoltaic system for power generation.

Syllabus

Solar Radiation: The sun and its characteristics, Structure of the Sun, Extraterrestrial solar radiation, the solar constant. Solar radiation at earth's surface, beam and scattered radiation and air mass, variation in extraterrestrial radiation, diffuse radiation, attenuation of beam and diffused radiation at the ground, Basic Sun Earth Angles, solar time and the equation of time, Day length.

Solar Radiation Measurement and Estimation: Solar energy measuring instruments, pyranometer, pyrheliometer, sunshine recorder, Estimation of average solar radiation, ratio of beam and total radiation on tilted surface of that on horizontal surface.

Solar Collectors: Flat plate collector, Materials for flat plate collector and their properties, Thermal Analysis of Flat-plate Collector and Useful Heat Gained by the fluid, fin efficiency, collector efficiency factor, Heat Removal Factor. Focusing collectors, types and applications of focusing collectors.

Solar Energy Applications: Introduction and principle of operation of solar cooker, solar air heater, solar water heater, solar distillation, solar pond, solar thermal power generation, Greenhouse, Solar PV system.

Storage of Solar Energy: Types of Energy Storage, Thermal Storage, Electrical Storage, Chemical Storage, Hydro-storage.

Practicals

1. Study of flat plate collector.
2. Study of a box type solar cooker and calculation of its thermal efficiency.
3. Study of a solar distillation system.
4. Study of natural convection type solar water heater.
5. Study of natural convection type solar Dryer.
6. Study of forced convection type solar Dryer.
7. Study of Solar Pond.
8. Study of solar animal feed cooker.
9. Study of Solar Greenhouse.
10. Study of Solar Tunnel Dryer.

Suggested Readings

1. Meinel, A.B and Meinel, M.P.; Applied Solar Energy, Addision Wesley Publishing Company, New York.
2. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, New York.
3. Sayigh, A. A. M., Solar Energy Engineering Academic Press, New York.
4. Rai, G.D., Solar Energy Utilization, Khanna Publishers, Delhi.
5. Garg, H.P.,Treatise on Solar Energy, Jhon Willey & Sons.
6. Sukhatme S.P., Solar Energy, Tata McGraw Hills P Co.

Bio-Energy Conversion and Processing of Wastes

REE 512 **Credit 3(2+1)**

Course Outcome: The main objective of this course is to provide fundamentals of utilization of crop residues and agro industrial waste for energy production through different conversion routes and to understanding the biofuels system, renewable feedstock and their production so that following the completion of this course, students will have the expertise to solve agro industrial, social, and environmental problems with appropriate techniques and tools.

Syllabus

Biomass Production: Introduction, Wastelands, classification and their use through energy plantation, selection of species, methods of field preparation and transplanting. Harvesting of biomass and coppicing characteristics.

Biomass Characterizations: Physio-chemical characteristics of biomass, calorific values of solid, liquid and Gaseous fuels.

Biomass Conversion: Different routes of conversion of biomass such as

Physical: cutting, sizing, drying and storage of wood, twigs and other biomass.

Biochemical: Conversion of biomass, sugar, starch and cellulose into alcohol, biodiesel.

Thermo chemical: Direct combustion, design of biomass gasifier and improved cookstoves, Briquetting of biomass, pyrolysis, gasification.Dendro thermal

Practicals

1. Identification of different plant species for energy plantation.
2. Determination of biomass properties such as bulk density, moisture content, volatilesolids, ash content, calorific value.
3. Measurement of calorific value of solid, liquid and gaseous fuels.
4. Study of biomass cutter.
5. Study of briquetting machines.
6. Performance evaluation of improved cookstoves.
7. Study on alcohol production from sugar, starch and cellulose.

Suggested Readings

1. Vimal, O.P. Energy from Biomass, AgricolePublishingAcademy, New Delhi.
2. Vimal, O. P. and Bhatt, M.S., Wood Energy System, Agricole, Pub. New Delhi.
3. Rathore N. S., Panwar N. L, Kothari S., Biomass Production and Utilization Technology. Himanshu Production, 2007.

Energy Conservation and Management

REE 513 **Credit 3(2+1)**

Course Outcome: The main objective of this course is to help students to acquaint and equip with the sources of energy, conservation of energy and its management. Also study of energy efficiency, energy planning, forecasting and energy economics will help students to prepare energy audits of various industries or sectors.This course also introduces student with fuel conversion, utility techniques, instrumentation in energy conservation and co-generation with waste utilization.

Syllabus

Energy Conservation: Status and significance with respect to developing and developed countries, concept and thermo dynamics and energy conservation, second law of thermo dynamics and efficiency analysis of system, thermal insulation.

Energy Audit: Type of energy auditing, walk through, minimum and maximum- (a) Energy accounting and analysis; input, output and impact variance, (b) Energy auditing of different sectors; Industrial tools, agriculture fields and electrical auditing.

Fuel and Process modification, Control and Instruments in Energy Conservation: Energy conservation in water pumping and other agricultural operations/machinery, food process industries and domestic appliances.

Co-generation: Waste heat recovery, co-generation with alternate energy system, Dual cycle, steam economy.

Practicals

1. Study of different energy audit techniques.
2. Study of instrumentation required for energy audit.
3. Energy audit of selected industry.
4. Scope of renewable energy techniques in industries.

Suggested Readings

1 Vogt, F; Energy Conservation and use of Renewable Energies in the Bio-Industries.

2 Pratap Singh et. al Sustainable Development through Renewable Energy Sources Yash Publications, Bikaner, 2004

3 Shinkey, F.J. Energy Conservation through control.

Waste Recycling and Resources Recovery Systems

REE 514 **Credit 3(2+1)**

Course Outcome: The main objective of this course is to help students to acquaint and equip about the sources of waste, conversion of waste into energy and its management. Due to heavy urbanization it is very important to recycle waste. This course covers bio-methanation, gasification, alcoholic fermentation, hydrogen reduction, agrochemical fuel extraction, etc. suitable for organic by products & wastes, their management approach, application and acceptability.

Syllabus

Introduction: Sources of different wastes, their nature and characteristics; quantum of industrial, agricultural, municipal, bio-medical and other organic wastes/by products and its management needs.

Waste to Energy Conversion Technologies: viz. biomethanation, gasification, alcoholic fermentation, hydrogen reduction, agrochemical fuel extraction, etc. suitable for organic by products & wastes, their management approach, application and acceptability.

Economics of Waste disposal to energy conversion, advantages & disadvantages.

Design of a suitable waste disposal plant based on local needs/village case study.

Practicals

1. Identification of industrial, bio-medical and agricultural wastes/by-products under local conditions causing environmental hazards.
2. Study of existing practices for waste disposal.
3. Study of advanced organic/carbonic waste management technologies.
4. Development of a suitable waste management process for an identified organic waste / by-product suitable under local conditions.
5. To evaluate economics of waste disposal/handling process via advanced technique vis-à-vis conventional method.

Suggested Readings

1. Pratap Singh et. al., Sustainable Development through Renewable Energy Sources, Yash Publications, Bikaner, 2004.
2. RathoreN.S., Kurchania A.K. Biomethanation Technology, Apex Publications, Udaipur, 2006.

Agro-Energy Audit and Management

REE 515 **Credit 3(2+1)**

Course Outcome: The main objective of this course is to help students to acquaint and equip with the sources of energy, conservation of energy and its management. This course also covers energy use scenario in agricultural production system, agro-based industry which is helpful in understanding energy scenarios in agriculture and allied industry. Also study of energy efficiency, energy planning, forecasting and energy economics will help students to prepare energy audits of various industries or sectors.

Syllabus

Objective

To acquaint and equip about the sources of energy, conservation of energy and its management. Energy use scenario in agricultural production system, agro-based industry. Study of energy efficiency, energy planning, forecasting and energy economics.

Theory

Energy resources on the farm: conventional and non-conventional forms of energy and their use. Heat equivalents and energy coefficients for different agricultural inputs and products. Pattern of energy consumption and their constraints in production of agriculture. Direct and indirect energy. Energy audit of production agriculture, and rural living and scope of conservation. Identification of energy efficient machinery systems, energy losses and their management. Energy analysis techniques and methods: energy balance, output and input ratio, resource utilization, conservation of energy sources. Energy conservation planning and practices. Energy forecasting, Energy economics, Energy pricing and incentives for energy conservation, factors effecting energy economics.

Practicals

1. Study of energy audit techniques.
2. Study of energy use pattern and management strategies in various Agro-industries.
3. Assessment of overall energy consumption, production and its cost in selected agro industries.
4. Visit to related Agro-industry.

Suggested Readings

1. Kennedy WJ Jr. & Wayne C Turner.1984. Energy Management. Prentice Hall.
2. Pimental D. 1980. Handbook of Energy Utilization in Agriculture. CRC.
3. Fluck RC & Baird CD.1984. Agricultural Energetics. AVI Publ.
4. Rai GD. 1998. Non-conventional Sources of Energy. Khanna Publ.
5. Twindal JW & Anthony D Wier 1986. Renewable Energy Sources. E & F.N. Spon Ltd.
6. Verma SR, Mittal JP &Surendra Singh 1994. Energy Management and Conservation in Agricultural Production and Food Processing. USG Publ. &Distr., Ludhiana.

Wind Energy Utilization

REE 516 **Credit 3(3+0)**

Course Outcome: The students will acquire knowledge regarding mechanism of wind energy and different types of wind machines available to harness wind power. The students will able to learn basics required to design wind turbine for irrigation as well as for power generation.

Syllabus

Wind Energy- Introduction, history of development, applications of wind energy, wind velocity, wind mapping minimum, maximum and averaging.

Wind Power- Power produced due to wind current, effect of height, obstacle and valley- Criterion for selection of site for wind power harnessing. Wind power equipment such as pumps, generator storage of wind energy, wind power plant and supply of wind power to consumer/grid.

Wind Measuring Instruments and Controls-Different systems of measuring and recording wind velocity, wind tower, controls used in wind machines.

Wind Machines- Types of wind mills, systems of wind machine, different parts such as rotor, structure, plunger, rod and their design, Different power transmission systems and design, Wind blade and its configurations, forces on wind blade, drag and lift, load matching, speed range selection, Selection of material for different parts.

Suggested Readings

1. More and Maheshwari; Wind Energy Utilization in India

2. Lysen, E.H. Inrtroduction to Wind Energy

3. Dunn, P.D. Renewable Energy Sources, Conversion and Application

4. Veziroglue, Najat, T., Alternate Energy Sources, Vol. IV Indirect Solar Energy.

Biogas Technology and Mechanism

REE 521 **Credit 3(2+1)**

Course Outcome: The students will able to learn about biogas production technology, different types of biogas plants, its design and utilization of produced biogas for domestic as well as for commercial purpose. Slurry mechanism, handling of solid as well as liquid fertilizers, its importance and future scope will also be covered in the course.

Syllabus

Biogas Technology: Introduction, potential of Biogas in the Energy Scenario of India Biogas in Relation to Environment, Ecology, Agriculture, Health and Sanitation. Digestion process, factors enhancing/inhibiting biogas production.

Bio-chemical and Microbial Aspects: Biogas mechanism, enhancement of Biogas production by different additives (Chemicals, organic substances, enzymes) pretreatment process, etc. Scrubbing process, bottling, need for bottling of biogas, liquefaction of biogas. Various Uses of Biogas and its Merits and Demerits.

Biogas Plant: Systems, Types of biogas plants, classification, design of a biogas plant (cow dung and organic waste) and structural strength, selection of site and size, construction technique material requirement, recent advances in high rate bio-methanation reactors design and material, night soil linked biogas plant. Cold Condition Biogas Plant Design Concept Cost and Financial Viablity.

Biogas Distribution and Utilization: Properties of biogas, different uses, design of biogas distribution system, pressure and flow measuring devices, safety devices, biogas fittings, principles of dual fuel biogas engines, its limitations, biogas appliances including thermal and cooking efficiency test.

Effluent: Handling of effluent of biogas plant (cow dung based, sanitary latrine attached and agro industrial wastes), effluent treatment and management effect of slurry on crop and fish production. Integrated recycling of organic wastes.

Alternate Feed Material: Study of biogas plant for distillery and sugar mills effluent, willow dust, agro-wastes, agro and processing industry wastes.

Repair and Maintenance: Repair and maintenance of biogas plants.

Practicals

1. Study of different Equipments in lab
2. Study on different models of biogas plants.
3. Determination of N, P and K contents of the fresh and digested slurry by chemical analysis.
4. Analysis of biogas to determine its constituents (gas chromatography, Orsate gas Analyzer)
5. Study on constructional details of different designs of biogas plants.
6. Testing of biogas burner for heat transfer, thermal and cooking efficiency.
7. Testing of biogas lamp
8. Determination of BOD/COD
9. Determination of calorific value of biogas.
10. Visit to industrial biogas plants.
11. BIS code for efficiency testing of biogas appliances.

Suggested Readings

1. Khandelwal, K.C. and S.S Mahdi.; Biogas Technology: A Practical Hand Book, Tata McGraw Hill Pvt. Co.
2. Chawla, O.P., Advances in Biogas Technology, I.C.A.R., New Delhi
3. RathoreN.S., Kurchania A.K., Biomethanation Technology, Apex Publications, Udaipur, 2006
4. Mathur, A.N. and N.S Rathore; Biogas production management and utilization-Himanshu Publication.

Design and Analysis of Renewable Energy Conversion Systems

REE 522 **Credit 3(3+0)**

Course Outcome: The students will able to design different renewable energy systems.

Thermodynamics of energy conversion systems will also be learned. Students also get acquainted with techniques of biogas utilization, biofuel production techniques, gasification systems, alcohols and plant oils.

Syllabus

Energy cycle of the earth; water flow and storage; ocean currents and tides. Energy heat flow and energy storage; photosynthesis and biomass; renewable energy sources.

Thermodynamics of energy conversion; conversion of solar energy, wind energy, water flows, heat, biomass, etc.; other conversion processes.

Development and use of biogas, alcohols and plant oils, plant oil esters in I.C. engines. Study of various parameters for measuring the performance of the output.

Design of bio-fuel production units: design of gasifiers, gas flow rates, biogas plants. Establishment of esterification plant, fuel blending.

Suggested Readings

1. Boyle Godfrey. 1996. Renewable Energy: Power for Sustainable Future. OxfordUniv. Press.
2. Culp AW. 1991. Principles of Energy Conservation. Tata McGraw Hill. Duffle JA & Beckman WA. 1991. Solar Engineering of ThermalProcesses. John Wiley.
3. Garg HP & Prakash J.1997. Solar Energy - Fundamental and Application. Tata McGraw Hill.
4. GrewalNS, Ahluwalia S, Singh S & Singh G. 1997. Hand Book of Biogas Technology. Solar Energy Fundamentals and Applications. TMH New Delhi.
5. Mittal KM. 1985. Biomass Systems: Principles & Applications. New Age International.
6. Odum HT &Odum EC. 1976. Energy Basis for Man and Nature. Tata McGraw Hill.
7. Rao SS &Parulekar BB.1999. Non-conventional, Renewable and Conventional . Khanna Publ.
8. Sukhatme SP.1997. Solar Energy - Principles of Thermal Collection and Storage. 2nd Ed. Tata McGraw Hill.

Energy Management in Food Processing Industries

REE 523 **Credit 3(3+0)**

Course Outcome: The main objective of this course is to help students to acquaint and equip with different energy management techniques including energy auditing of food industries. This course also covers energy use scenario in agro-based industry which is helpful in understanding energy scenarios in agriculture and food industry. Also study of energy efficiency, energy planning, forecasting and energy economics will help students to prepare energy audits of food processing industries or sectors.

Syllabus

Energy forms and units, energy perspective, norms and scenario; energy auditing, data collection and analysis for energy conservation in food processing industries.

Sources of energy, its audit and management in various operational units of the agro-processing units; passive heating, passive cooling, sun drying and use of solar energy, biomass energy and other non-conventional energy sources in agro-processing industries. Reuse and calculation of used steam, hot water, chimney gases and cascading of energy sources. Energy accounting methods, measurement of energy, economics of energy use.

Suggested Readings

1. Pimental D. 1980. Handbook of Energy Utilization in Agriculture. CRC Press.
2. Rai GD. 1998. Non-conventional Sources of Energy. Khanna Publ.
3. Twindal JW & Anthony D Wier 1986. Renewable Energy Sources. E & F.N. Spon Ltd.
4. Verma SR, Mittal JP &Surendra Singh. 1994. Energy Management and Conservation in Agricultural Production and Food Processing.USG Publ. & Distr., Ludhiana.

Alternate Fuels and Applications

REE 524 **Credit 3(3+0)**

Course Outcome: The students will able to learn about alternate fuels, its utilization, environmental aspects and economics. Production processes of different alternate fuels its composition, properties and combustion characteristics will be studied under this course. Environment impact by utilization of these alternate fuels as compare to conventional fuels will also be studied.

Syllabus

Introduction to alternate fuels, synthetic fuels, production, composition and properties, combustion characteristics, bio-fuels (alcohol, methanol, ethanol, biogas, producer gas hydrogen) and fuel cell.

Composition and properties of alternate fuels, comparison with conventional fuels, potential, possibilities and problems.

Production of biogas, producer gas, ethanol, methanol, alcohol and hydrogen.

Utilization: Thermal and mechanical applications, utilization in SI and CI engines, modifications needed to convert existing SI and CI engines to run on alternate fuels, utilization for miscellaneous applications.

Environmental aspects of alternate fuels: Environmental impact and safety factors, efficiency of different alternate fuels.

Economics and commercial considerations.

Suggested Readings

1. Edger J. D.; Biogas Fuel of Future.
2. Robertson E.; Gaseous Fuels.
3. Das R. S. et al; Biogas as a Replacement Fuel to Diesel.
4. Ratnakar G. L.; Utilization of Biogas in IC Engines.
5. Mathur H. B.; Synthetic Fuels.

Energy, Ecology and Environment

REE 525 **Credit 3(3+0)**

Course Outcome: The students will become an expert in energy, environmental economics, policy and ecology. They will develop an interdisciplinary knowledge base that will enable them to understand and solve contemporary environmental problems.

Syllabus

Origin of the earth, Earth's temperature and atmosphere, Sun as a source of energy, biological processes, photosynthesis, food chain, energy, fuel and power.

Energy sources, quality and concentration of energy sources, characteristics, temperature, classification of energy sources, renewable energy and non-renewable energy sources, scientific principles of renewable energy, technical and social implications.

Scope and history of ecology, nature of environmental responses, community ecology, eco-system, theory, population ecology, evolutionary and geographical ecology.

Environment and its relationship with earth, forest, dams, atmosphere, habitats, health, energy, living resources, agents of change. Environmental degradation, primary and secondary pollutants. Environmental Impact Assessment.

Micro climatic effects of pollution, pollution from stationary and mobile sources, ground water pollution, biological effect of radiation, heat and radio activity disposal, Pollution abatement methods, Greenhouse Effect.

Suggested Readings

1. Twidell John W. and A. D. Weir; Renewable Energy Sources.
2. Dune, P. D.; Renewable Energies: Sources, Conversion and Applications.
3. Hopes G. Puppy; Energy and Environment, Mankind and Energy Needs, Elsevir Pub. Co., New York.
4. Rao C. S.; Environmental Pollution Control Engineering.
5. RathoreN.S., Kurchania A.K., Climatic Changes & Their Remedial Measures, Shubhi Publications, Gurgaon, 2001.
6. Mathur A. N., Rathore N. S. and V. K. Vijay; Environmental Awareness.

Solar Refrigeration and Air-Conditioning

REE 526 **Credit 3(3+0)**

Course outcomes: The main objective of this course is to impart knowledge about principles of producing low temperatures using solar energy. The concepts about designing, installation and servicing of solar refrigeration and air-conditioning systems in residential, commercial and industrial buildings will enable the students to articulate the non-conventional solar cooling systems.

Syllabus

Potential and scope of solar cooling, Types of solar cooling systems, Solar collectors and storage systems for solar refrigeration and air-conditioning, Solar operation of vapour absorption and vapour compression refrigeration cycles and their thermodynamic assessment, Rankine cycle, sterling cycle based solar cooling systems, Jet ejector solar cooling systems, Fuel assisted solar cooling systems, Solar desiccant cooling systems, Open cycle absorption / desorption solar cooling alternatives, Advanced solar cooling systems, Thermal modeling and computer simulation for continuous and intermittent solar refrigeration and air-conditioning systems, Refrigerant storage for solar absorption cooling systems, Solar thermoelectric refrigeration and air-conditioning, Solar thermo acoustic cooling and hybrid air-conditioning, Solar economics of cooling systems

Suggested Readings

1. Kaushik S.C. Solar Refrigeration and Air Conditioning.
2. Arora C.P. Refrigeration and Air Conditioning.
3. Dincer I, Mehmet K. Refrigeration Systems and Applications.

Renewable Sources of Energy

REE 531 **Credit 3(2+1)**

Course Outcome: This course is undertaken to introduce basic aspects of renewable energy supply presenting fundamental characteristics of the resource base (solar radiation, wind energy, bio energy, etc.) and principles of related technical systems (photovoltaic, wind, biomass power generation, etc.). In a further step an economic analysis of supply technologies will be undertaken. Students will learn to acquire a basic understanding of issues related to renewable energy supply systems.

Syllabus

Solar Energy: Sources, its advantages, availability. Heat transfer processes applicable to solar energy, solar radiation and its analysis, Instruments for measurement of solar energy (Pyranometer / pyrheliometer), Introduction to basic flat plate and focusing collectors. Solar thermal energy technology application: Solar Cooker and Water Heater, Solar Dryers, Solar Green House, Active/passive Heating, Stills, Solar photovoltaic technology.

Biogas: its applications and importance, Biogas plant (types, size their features, merits and demerits) Utilization of biogas-spent slurry.

Biomass: Introduction to biomass as source of energy and its advantages, Biomass Classification, Characteristics of biomass (proximate analysis and ultimate analysis).

Harvesting of biomass (coppicing, pollarding, lopping, pruning, thinning)

Biomass conversion technologies (thermo-chemical, bio-chemical and agro-chemical) technology, Briquetting, Biomass gasification technology.

Improved Cookstoves: Fundamental & types, techno-economic analysis of renewable energy sources and comparison with conventional energy sources.

Wind Energy: Basic principles of wind energy conversion, site selection consideration, Basic components of wind energy conversion system, Type of wind machine.

Practicals

1. Study of a box type solar cooker,
2. Study of a solar distillation plant.
3. Study of biomass briquetting machine
4. Study of direct and indirect solar dryer
5. Study of a KVIC biogas plant.
6. Study of a Deenbandhu biogas plant.
7. Study of a biomass gasifier.
8. Study and testing of biogas appliances
9. Study and testing of improved cookstoves.

10. Study of Wind Energy Conversion Devices
11. Design of solar water heater.
12. Design of solar dryer.
13. Study on Clean energy Trainer

Suggested Readings

1. Garg H.P. Advances in Solar Energy Technology. D. Publishing Company, Tokyo, 1990.
2. Alan L: Farredbruch& R.H. Buse. Fundamentals of solar Academic Press, Lundon, 1983.
3. Bansal N.K., Kleemann M. & Michael, Meliss, Rene, energy Sources & Conversion Technology. Tata Megras publishing Company, New Delhi, 1990.
4. Mathur, A.N.&RathoreN.S.,Biogas Production Management & Utilization. Himanshu Publications, Udaipur. 1992.
5. Khandelwal, K.C. &Mandi, S.S. Practical hand boo Biogas Technology, 1990.
6. Rai, G.D. Non-Conventional Energy Sources, Khanna Publishers, New Delhi.
7. Mathur A.N. &RathoreN.S. Renewable Energy Sources Bohra Ganesh Publications, Udaipur.

Direct Energy Conversion Technologies

REE 535 **Credit 3(2+1)**

Course Outcome: The main objective of this course is to acquaint students with the basic fundamentals of different energy conversion technologies. Direct power generation from waste heat i.e by thermo electric generator, power from magneto hydro dynamic generator and fuel cell. Students will able to learn design of on-grid as well as off-grid solar photovoltaic system, selection of components, and selection of site.

Syllabus

Basic Science of Energy Conversion, Physics of semi-conductor junctions for photo-voltaic conversion of solar energy, solar cell, types of solar cell modules, components of SPV system, details of blocking diode, charge controller, inverter and batteries used, application of solar cell in photo-voltaic power generation system, power output and conversion efficiency, advantages and disadvantages of photo-voltaic solar energy conversion, design of photo-voltaic systems.

Technologies and physics of thermo-electric generators, thermo-electric materials and optimization studies.

Basic concepts and design consideration of MHD generators, cycle analysis of MHD system, thermo ionic power conversion and plasma, thermo-dynamics and performance of fuel cells and their applications.

Practicals

1. To demonstrate the I-V and p-V characteristics of PV module with varying tradition and temperature level.
2. To demonstrate the I-V and p-V characteristics of series and parallel combinations of PV Module.
3. To show the effect of variation in tilt angle on PV module power.
4. To demonstrate the effect of shading on module output power.
5. To demonstrate the working diode as Bypass diode and blocking diode.
6. Workout power flow calculations of standalone PV system of DC system of DC load with battery.
7. Workout power flow calculations of standalone PV system of AC load with battery.
8. Workout power flow calculations of standalone PV system of DC and AC load with battery.
9. To draw the charging and discharging characteristics of battery.

Suggested Readings

1. Meinel & Meinel, Applied Solar Energy.
2. Derrick, Francis and Bokalders, Solar Photo-voltaic Products.
3. M. P. Agrawal, Solar Energy.
4. R. H. Taylor Alternate Energy Sources.
5. G. D. Rai, Non-conventionalEnergy Sources.
6. Pratap Singh et al., Sustainable Development through Renewable Energy Sources, Yash Publications, Bikaner, 2004.

Energy Lab

REE 536 **Credit 3(0+3)**

Course Outcome: The students would be able to carry out lab analysis and can operate different analytical equipment independently. They also get acquainted with solar PV systems, solar cell characteristics, solar still and solar refrigeration systems. Students can able to work on GC (gas chromatograph) to determine composition of biogas, producer gas and other flue gases. Testing of dual fuel engine, improved cook stoves and biodiesel operated engine will also be carried out.

Syllabus

1. Study of Solar cell characteristic.
2. Study of Solar P. V. System.
3. Study of Plank's constant by radiation law.

4. Study of Solar Still and calculation of its efficiency.
5. Study of agricultural wastes fired gasifier for power generation.
6. Study of Solar Powered Refrigeration system.
7. Study of Gas Chromatograph and determination of composition of biogas, producer gas and flue gases.
8. Development of solid and liquid fuel from biomass.
9. Study and testing of dual fuel engine running on biogas and diesel.
10. Development of biodiesel from Jatropha oil.
11. Study of Bomb Calorimeter and measurement of calorific value of different biomass.
12. Study of Proximate and Ultimate analysis of biomass.
13. Testing of portable type of Improved Cook stoves.
14. Study the harnessing the power from wind.
15. Study of Integrated Energy System.

Suggested Readings

1. Rathore N.S., Kurchania A.K., Panwar N.L., Renewable Energy: Theory & Practice, Himanshu Publications, 2006
2. Khandelwal, K.C. & Mahdi, S.S. Biogas Technology, 1990.
3. Rai, G.D. Non-Conventional Energy Sources, Khanna Publishers, New Delhi.

Energy Management in Agriculture

REE 537 **Credit3 (3+0)**

Course Outcome: The objective of this course is to introduce students to the significance of energy management in agriculture to the total national economy.The student will incline towards conservation of energy through application of efficient devices and practices.

Syllabus

General aspects of Energy, Energy Economics, Principles of Energy Conservation, Global Environmental Concerns, Measurement of Energy & Power, Power & Energy Measuring Devices, Rural Energy Action Planning, Rural Project Management, Rural Energy Modeling.

Energy efficiency in Thermal Utilities of Agro-industries/Processing Plants, Cogeneration, Power Production from Conventional &Non-Conventional Energy Sources, Energy Efficiency in Electrical Utilities of Agro-industries/Processing Plants, Waste & Heat Recovery, Application of Non-conventional & Renewable Energy Sources, Waste Minimization & Resource Conservation, Energy Performance Assessment for Equipment & Utility Systems, Energy Conversion Act.

Suggested Readings

1. Donald L. Klass & George M. Emert. 1985. Fuels from Biomass & Wastes. Ann Arbor Science Publishing Inc. Michigan.
2. Colin Parket& Tim Robers. 1983. Energy from Waste – An Evaluation of Conversion Technologies – Elsevier-Applied Science Publishers, London.
3. Murphy W.R. &Mc Kay G. 1982. Energy Management.
4. Rathore N.S., Mathur A.N.&Solanki A.S. 1993. Integrated Rural Energy Planning.
5. Murgai M.P. & Ram Chandra. 1990. Progress in Energy Auditing & Conservation.
6. Victor B. Ottaviano.1993. Energy Management.
7. Craig B. Smith. 1081. Energy Management, Principles, Applications, Benefits and Savings.
8. Richard Porter & Tim Roberts. 1985. Energy Savings by Waste Recycling.
9. Szues. 1980. Similitude & Modeling.

Renewable Energy for Industrial Application

REE 611 **Credit 3(2+1)**

Course Outcome: This course provides an outline and brief description, including fundamentals, of the different renewable energy technologies, wind, solar, bio-energy, hydro and fuel cells. It provides a general overview of the technologies and their applications. This course provides an ability to understand their strengths and weaknesses and hence to have a better grasp of the benefits available from, and the barriers faced by, these technologies.

Syllabus

Solar: Solar Power Generation, Solar water heating, steam solar cooking system, Industrial solar dryer & solar process heat. Solar cooling system (refrigeration, air conditioning and solar architecture technology), solar furnace & solar green house technology for high-tech cultivation.

Bio Energy Sources: Power generation through bio-methanation, gasification &dendro thermal power plant.

Wind Energy: aero generator of new era and national and international state of art in wind power generation.

Other renewable energy sources: Magneto Hydro Dynamics, solar photo- voltaic technology, Ocean thermal energy conversion technology, fuel cells technology & micro-hydro energy technology.

Practicals

1. Design of solar dryers.
2. Design of solar Photovoltaic system.
3. Design of gasifiers.

4. Design of combuster (gasifier stove).
5. Study of solar greenhouse.
6. Study of biogas engine generator set.
7. Field visit to NRSE power generation site.

Suggested Readings

1. Pratap Singh et al., Sustainable Development through Renewable Energy Sources, Yash Publications, Bikaner, 2004
2. Rathore N. S., Kurchania A. K., Panwar N. L., Non Conventional Energy Sources, Himanshu Publications, 2007
3. Duffie, J.A., and Beakman, W.A. Solar Energy Thermal Process, John Wiley and Sons, New York.
4. Sayigh, A. A. M., Solar Energy Engineering Academic Press, New York.

Solar Energy Utilization for Heating and Cooling

REE 621 **Credit 3(3+0)**

Course outcome: The main objective of this course is to provide detail knowledge about solar architecture, green building, solar passive heating and cooling, solar active heating and cooling. The course will help the student to design solar refrigeration system, solar air conditioning system for residential, commercial building and different type of storage system for refrigeration and air conditioning.

Syllabus

Solar Architecture- Thermal comfort, building orientation and design, passive heating concept, passive cooling concepts, heat transfer in buildings, evaporative cooling, Tromb wall.

Solar Refrigeration and Air- conditioning- Potential and scope of solar cooling, types of solar cooling systems, solar collectors and storage system for solar refrigeration and air conditioning, solar operation of vapour absorption and compression, refrigeration cycle and their assessment, solar desiccant cooling systems; open cycle solar absorption/adsorption, solar cooling alternatives.

New Development on the area; some case studies**.**

Suggested Readings

1. Bansal, N.K., Solar Passive building, Science and Design.
2. Kaushik, S.C., Solar Refrigeration and Space conditioning**.**
3. Pratap Singh et al., Sustainable Development through Renewable Energy Sources, Yash Publications, Bikaner, 2004.

Power System Analysis

REE 612 **Credit 3(3+0)**

Course outcome: The objective of this course is to provide students with an overview of power system operation. The student will learn about power flow analysis and its role in economic dispatch and generation control. The students will learn basic principles for formulation and application of optimal power flow. In addition, this course deals with the voltage control techniques used for renewable rich distribution feeders.

Syllabus

Load forecasting load characteristics and probability of loss of load.Load flow studies; Fault level analysis; Fundamentals of power system stability; Physical concepts; Synchronous machine power angle relations; swing equation; Stability of small and large disturbances; Numerical techniques for solution of swing equations; Digital computer solution of transient stability; Method of improving transient stability, Microprocessor applications in power systems.

Suggested Readings

1. Culp AW. 1991. Principles of Energy Conservation. Tata McGraw Hill. Duffle JA & Beckman WA. 1991. Solar Engineering of ThermalProcesses. John Wiley.
2. Garg HP &Prakash J.1997. Solar Energy - Fundamental and Application. Tata McGraw Hill.
3. Rao SS &Parulekar BB.1999. Non-conventional, Renewable and Conventional . Khanna Publ.

Thermo Chemical Conversion of Biomass

REE 613 **Credit 3(2+1)**

Course outcomes: The main objective of this course is to help students to understand the biofuels system, types of biomass derived fuels and energy, thermochemical conversion of biomass to heat, power and fuel, value adding of biofuel residues. After completion of this course students will enable to extract the energy from biomass and know how to choose the suitable biomass fuels for different industrial applications.

Syllabus: Introduction – Thermochemical degradation. History of small gas producer Engine system. Chemistry of gasification. Gas producer – type, operating principle. Gasifier fuels, properties, preparation, conditioning of producer gas. Application, shaft power generation, thermal application, economics.

Combustors- construction, operation, wood burning stoves.

Pyrolysis – plant, operation, product recovery, incineration and plant lay out.

Co-generation plant – type, layout, energy recovery.

Instruments related to thermochemical conversion.

Practical

1. Study of producer gas generators such as open core, throat type for shaft power production and thermal application.
2. To study design and drawing of gasifier.
3. To study wood burning stoves.
4. Estimation of pollutant caused by gasification process.
5. Study of pyrolysis plant.
6. Study of charcoal making unit.
7. Study of incinerator and co-generators for power production.
8. Study of instrumentation requiredfor thermal degradation.

Suggested Readings

1. Kauppa, A., 1984. Gasification of Rice hulls – Theory and Practice. Publication of GATE. Gmbh, Germany.
2. Rathore, N. S., Panwar, N. L. and Kothari S. 2007, Biomass Production and Utilization Technology, Himanshu Publication, Udaipur.
3. Vimal O. P. and Tyagi, P. D., 1985 Fuel wood from waste land. AgricolePublishingAcademy, New Delhi.

Environmental Pollution and Control

REE 614 **Credit 3(3+0)**

Course Outcome: The students will able to distinguish between various methods of air pollution analysis, water sample analysis and measurement of soil contamination. They will understand air pollution sampling and measurement. Various water treatment methods will also be learned.

Pollution – Sources of pollution, consequences of pollution growth, energy problems, air pollution, water pollution, ozone depletion.

Air Pollution – Definition, classification, sources of air pollution, effect of air pollution on health, vegetation, material, air pollution measurement, air pollution laws and standards.

Air pollution analysis – For sulphurdio-oxide, nitrogen oxide, carbon mono-oxide, oxidants and ozone, hydrocarbons, particulate matters

Water Pollution – Types of water pollution, effect on air temperature, effect on water temperature

Control – Air pollution control methods, source correction method, cleaning of gaseous effluents, particulate emission control, control of gaseous emission.

Water Treatment – Basic process of water treatment, primary treatment, secondary (biological) treatment, advanced waste water treatment, recovery of material from process effluents.

Suggested Readings

1. Jhadav, H &Bhosale, V. M.: Environmental Protection & Laws, Himalaya Pub. House, Delhi
2. Rao, M. N. and A. K. Datta, Waste Water Treatment. Oxford & IBH Publ. Co. Pvt. Ltd.
3. Rathore N.S, Kurchania A.K., Biomethanation Technology, Apex Publications, Udaipur, 2006
4. Sharma, B. K., Environmental Chemistry. Goel Publishing House, Meerut

Management and Utilisation of Natural Resources

REE 622 **Credit 3(3+0)**

Course Outcome: This course covers and helps student to understand Water Resources, Energy resources, conventional and non-conventional energy sources, and Mineral resources, Forest Resources, potential & state of art of technology of utilization. This will help in understanding resources on earth and their exploitation, use and effects of them on human.

Syllabus

Natural Resources and it's classification. Renewable and Non Renewable resources.

Water Resources, status of use and problems associated with over utilization. Surface and ground water potential and future scenario. Problems related to water resources i.e. floods, draughts, and disturbance in natural water cycle, water logging & salinity.

Energy resources, conventional and non-conventional energy sources, potential & state of art of technology of utilization. Use of Renewable Energy sources, case studies.

Mineral resources, use and exploitation, environmental effect of extracting & using Mineral. Open cast and underground mining, various mineral resources & potential.

Land resources- National status of land as a resource, land degradation, landslides, soil erosion, desertification & sand dunes.

Forest Resources – Natural scenario of forest, use & over exploitation, deforestation, effect of loss of forest on won and allied field.

Food sources, Growing energy need, modern agriculture techniques, world food problems

Air resource, its quality & pollution status, causes, effect & control measures of air pollution

Management and utilization of natural resources in equitable manner for sustainable development.

Role of individuals in management of natural resources, future strategies for prevention of natural resources.

Suggested Readings

1. Colin Parket& Tim Robers. 1983. Energy from Waste – An Evaluation of Conversion Technologies – Elsevier-Applied Science Publishers, London.
2. Murphy W.R. &Mc Kay G. 1982. Energy Management.
3. Rathore N.S., Mathur A.N &Solanki A.S. 1993. Integrated Rural Energy Planning.
4. Murgai M.P. & Ram Chandra. 1990. Progress in Energy Auditing & Conservation.
5. Victor B. Ottaviano.1993. Energy Management.
6. Craig B. Smith. 1081. Energy Management, Principles, Applications, Benefits and Savings.

Gender & Energy

REE 623 **Credit 3 (3+0)**

Course Outcome: This course covers goals, framework for gender analytical tool, Engineering Energy Policy, Gender tools for energy projects, gender mainstreaming v/s the women-only approach, MDG goals & targets related to gender & energy. This course is helpful to address gender based energy and will help understanding gender discourse and energy side by side.

Syllabus

Gender concepts, overview of gender & energy planning, identifying gender needs & goals, framework for gender analytical tool, Engineering Energy Policy, Gender tools for energy projects, gender mainstreaming v/s the women-only approach, MDG goals & targets related to gender & energy. Case studies.

Suggested Readings

1. Murphy W.R. &Mc Kay G. 1982. Energy Management.
2. Odum HT &Odum EC. 1976. Energy Basis for Man and Nature. Tata McGraw Hill.

Renewable Energy Techniques

REE 624 **Credit 3(2+1)**

Course Outcome: The course enables the student to outline the various renewable energy sources and the possible conversion paths to useful form of energy. It describes power generation potential from various renewable energy sources and performance evaluation of these devices.

Syllabus

Energy in house Hold, Energy sources, Application & Present Energy Consumption Pattern, Energy and economical Development, Use of New & Renewable Energy Sources in House Hold.

Biogas

Biogas Technology and Mechanism, Factors Affecting Biogas Production, Properties of Biogas, Uses, Types of Biogas Plants, Classification Selection of Site, Selection of Size Night Soil based Biogas Plants, Alternative feed material and slurry utilization.

Socio-Economic aspects, Role of women in Propagation Technology, Effect of Environment and Health User's Education / Motivation.

Solar Energy

Solar Radiation and Measuring Instrument**,** Solar Collectors**,** Solar Cooking, Solar drying, Solar Distillation, Solar water Heating**,** Solar Photovoltaic Power Generation**,** Quality of Solar Processed Food/Grain.

Improved Cook-Stove

Various Cooking Options, Traditional Cookstoves and their constraints, Wood combustion Techniques of Biomass, Improved Cook Stoves, Materials for Construction of Improved Cook stoves.

Practical

1. Study of Solar Cooker.
2. Study of Solar Dryers.
3. Study of Deenbandhu Biogas Plant.
4. Study of Pragati Biogas Plant.
5. Construction of Fixed type Improved Cook Stoves
6. Testing of Fixed type Improved Cook Stoves.
7. Testing of Portable cook Stoves.

Suggested Readings

1. Rathore N. S., Kurchania A. K., Panwar N. L., Non Conventional Energy Sources, Himanshu Publications, 2007
2. Mathur, A.N. &RathoreN.S., Biogas Production Management & Utilization. Himanshu Publications, Udaipur. 1992.
3. Khandelwal, K.C. &Mandi, S.S. Biogas Technology, 1990.
4. Rai, G.D. Non-Conventional Energy Sources, Kh Publishers, New Delhi.
5. Rathore N. S., Kurchania A. K., Panwar N. L., Renewable Energy Sources: Theory and Practice, Himanshu Publication, 2007
6. Rathore N. S., Kurchania A. K., Panwar N. L., Non Conventional Energy Sources, Himanshu Publications, 2007

Wind and Human Environment

REE 625 **Credit 3(3+0)**

Course Outcome: The students will be able to learn about the wind and its effect on human environment. They will also be able to understand theory of aerodynamic wind forces and its effect. The effect of wind in natural environment will be learned in the course.

Syllabus

Wind Energy- Symbolism and Mythology' concept and historical progress in the wind energy harnessing techniques.

Wind and it's Effects- Origin of wind, atmospheric circulation, gradient wind geostrophic winds, Hurricanes, Tornado Ratings, tornadoes in various countries, measurements forward velocity, Tangential velocity, Horizontal component of Extricates on maximum pressure differential, rate of pressure change.

Aerodynamic wind forces- Wind loads, velocity pressure, static velocity pressure, wind forces, pressure coefficient, Aerodynamics, airflow Streamlines, Energy flow and Dissipation, Wind loads on buildings. Wind loads on Rigid Frames, Wind load factors and Form response to wind.

Wind in the Natural Environment- Wind over land, Evaporation wind fire interaction, wind effect on climate, wind and nature of wind over water and shores.

Wind in the Urban and Regional Environment- Heat losses by wind, wind effect on sound propagation, wind as recreational resource.

Wind Power- History, Wind conversion (Theoretical values), Power Augmentation, Turbines, Design of Wind Rotor and other accessories, Wind Intermittence and storage systems and its design, wind machine design for maximum efficiency; Wind wave energy; ocean waves energy conversion techniques, present state of art for wind energy utilization; Future development.

Suggested Readings

1. Wind in Architectural and Environmental Design- Michele Melarango Publication, Van NostrandRinchold Company.
2. Rathore N.S., Kurchania A.K., Panwar N.L., Renewable Energy: Theory & Practice, Himanshu Publications, 2006.
3. Man and the winds- De la Rue E.A., Philosophical Library.

Note:

1. For supporting courses course description, which are offered by other departments, refer separately syllabus of that particular department.
2. For syllabus of Non-Credit Compulsory Courses, see at the end.

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DEPARTMENT OF SOIL AND WATER ENGINEERING

SOIL AND WATER CONSERVATION ENGINEERING

VISION

To create a centre of excellence, foster high standards and orient teaching, research and extension program of Soil and Water Engineering towards future needs and opportunities through involvement of various stake holders.

MISSION

Impart education and knowledge to the students to make them competent enough in the areas of soil and water conservation, hydrology, irrigation management, groundwater development and water resource management. Further, enable them entrepreneurship oriented by offering the courses and training programs of global standards with optimal mix of inputs on electrical, mechanical and computer science engineering. The course is fully devoted to provide need based quality education in all the major areas for perspective engineers. So the skill developed by the course will not only contribute in their personal development, prosperity of the society, state and the nation as a whole but also build a leading and successful career in this direction and work in rural areas for the development of farmer's community.

Program Educational Objectives

1. To provide the student with a sound foundation in the Soil and Water Conservation Engineering fundamentals. A post graduate student must be able to understand new emerging technologies and to engage implementation of soil and water conservation practices in watershed management.

2. A post graduate students must have sound understanding of the soil and water conservation and related fields and necessary perspective to pursue work in watershed and command area. So as to cover the whole common understanding of soil and water conservation engineering research.
3. To develop analytical and logical aptitude among the students to quickly adapt to new work, new challenges, assimilate new information about the hydrological modellings, and solve new problems.
4. To provide exposure of new cutting edge technologies to the students and to motivate them to take up new challenges to solve the problems faced by society and nation through research

Program outcome

1. To develop the competency of managing the soil and water resources under dynamic environmental process and improving environmental management by incorporating elements of social systems in watershed management. Also enhanced the effective and efficient use of scare natural resources focusing on improved land productivity.
2. Able to work with regional as well as the national governmental and nongovernmental organizations in the process of environmental protection and natural resources development. Use of real-time hydrological information systems in mitigating flooding and drainage with help of new emerging techniques such as Remote sensing and GIS.
3. To develop the competency of phenomenon such as surface and ground water for conjunctive use planning in the command area for maximizing the net employment, production, labor in the command area.
4. To develop the proficiency for estimating the potential rate of recharge and discharge of wells for managing the demand and supply with ascertain the water quality.
5. To develop the competency about the design and installation of pressurized irrigation system for increasing water use efficiency, uniformly distribution of water and decreasing the fertilizer used in the field for accommodating the maximum crop yield.
6. Ripeness of improved agricultural drainage by less cost and more effective techniques for removing excess water used in the field.

Semester-wise Scheme for Post Graduate Programme in Soil and Water Conservation Engineering

Details of courses offered for the award of M.Tech. (Ag.), SWCE

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV
Core Courses: Total 12 credits; 2 courses in first semester (6 credits) and 1 course each in second and third semester (3 credits each) to be evaluated externally.						
Watershed Hydrology	SWC 511	3 (2+1)	3			
Ground water Engineering	SWC 512	3 (2+1)	3			
Design of Farm Irrigation Systems	SWC 521	3 (2+1)		3		
Agricultural Drainage Systems	SWC 531	3 (2+1)			3	
Optional Courses: Total 15 credits; two courses in first & second semester each (6 credits in each semester) and one course in third semester (3 credits).						
Flow through porous media	SWC 513	3 (2+1)	3			
Advanced Soil and Water Conservation Engineering	SWC 514	3 (2+1)	3			
Open Channel Flow	SWC515	3 (2+1)	3			
Soil and Water Conservation Structures	SWC 516	3 (2+1)	3			
Soil-Water-Plant Relationship	SWC 517	3 (2+1)	3			
GIS and Remote Sensing for Resources Management	SWC 522	3 (2+1)		3		
Watershed Management & Modelling	SWC 523	3 (2+1)		3		
Land Development and Earth Moving Machinery	SWC 524	3 (2+1)		3		
Water Resources Systems Engineering	SWC 525	3 (2+1)		3		
System Engg.& Productivity	SWC 526	3 (2+1)		3		
Social Aspects of Watershed Management	SWC 527	3 (2+1)		3		
Crop Environmental Engineering	SWC 535	3 (2+1)			3	
Design of Pumps for Irrigation & Drainage	SWC 536	3 (2+1)			3	
Dryland Technology	SWC 537	3 (2+1)			3	
Minor & Supporting Courses: Total 9 credits; one course in first, second and third semester each (3 credits in each semester).						
Statistical Methods	AST 510	3 (2+1)	3			
Advanced programming with "C++"	CSE 511	3 (1+2)	3			
Command area Development	IWM 514	3 (2+1)	3			
Higher Mathematics	BS 515	3 (3+0)	3			
Reclamation of Irrigated lands	IWM 521	3 (2+1)		3		
Irrigation Economics Planning and Management	IWM 522	3 (2+1)		3		
Water Conveyance and Distribution	IWM 523	3 (2+1)		3		
Design of Drip & Sprinkler Irrigation System	IWM 524	3 (2+1)		3		
Minor Irrigation	IWM 535	3 (2+1)			3	
Farm irrigation structures	IWM 536	3 (2+1)			3	
Others						
Compulsory Courses; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/ 502/...	1	NC	NC		
Seminar (0+1)	SWC532	1	-	-	1	-
Comprehensive	SWC 533	NC			NC	
Research (Thesis). Thesis minimum duration 2 semesters	SWC 534	20	-	-	-	20
Total credits to be offered (for Master Programme)		**57**	**15**	**12**	**10**	**20**

COURSE SUMMARY

Courses	No. of Courses					Credit Hours
	Semester					
	I	II	III	IV	Total	
Core	2	1	1	-	4	12
Optional	2	2	1	-	5	15
Minor & Supporting	1	1	1	-	3	9
Seminar	-	-	1	-	1	1
Comprehensive	-	-	-	1	1	Non Credit (graded as satisfactory/ non satisfactory)
Research (Thesis)	-	-	-	1	1	20* (graded as satisfactory/ non satisfactory)
Compulsory Courses (PGS Series)	1	1	-	-	2	Non Credit
Total	**6**	**5**	**4**	**2**	**17**	**57**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

Details of courses offered for the award of Ph.D. (Ag. Engg.) SWCE

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV-VI
Core Courses: Total 6 credits (3 credits in each semester); one course in first semester and one course in second semester to be evaluated externally.						
Advanced Hydrology	SWC 611	3 (2+1)	3			
Soil and Water Systems Simulation & Modelling	SWC 621	3 (2+1)		3		
Optional Courses: Total 12 credits (6 credits in each semester); two course in first and second semester each.						
Flow through porous media	SWC 513	3 (2+1)	3			
Advanced Soil and Water Conservation Engineering	SWC 514	3 (2+1)	3			
Open Channel Flow	SWC515	3 (2+1)	3			
Soil and Water Conservation Structures	SWC 516	3 (2+1)	3			
Soil-Water-Plant Relationship	SWC 517	3 (2+1)	3			
GIS and Remote Sensing for Resources Management	SWC 522	3 (2+1)		3		
Watershed Management & Modelling	SWC 523	3 (2+1)		3		
Land Development and Earth Moving Machinery	SWC 524	3 (2+1)		3		
Water Resources Systems Engineering	SWC 525	3 (2+1)		3		
System Engg.& Productivity	SWC 526	3 (2+1)		3		
Social Aspects of Watershed Management	SWC 527	3 (2+1)		3		
Crop Environmental Engineering	SWC 535	3 (2+1)			3	
Design of Pumps for Irrigation & Drainage	SWC 536	3 (2+1)			3	
Dryland Technology	SWC 537	3 (2+1)			3	
Water Resources Pollution and Control	SWC 612	3 (2+1)	3			
Mechanics of soil erosion & sedimentation	SWC 613	3 (2+1)	3			
Unsaturated Flow Through Porous Media	SWC 614	3 (2+1)	3			
Hydro-Chemical Modelling and Pollutant Management	SWC 622	3(2+1)		3		
Plant Growth Modelling & Simulation	SWC 623	3 (2+1)		3		
Advances in Irrigation & Drainage	SWC 624	3 (2+1)		3		
Minor & Supporting Courses: Total 9 credits; two courses in first semester (6 credits) and one course in second semester (3 credits).						
Statistical Methods	AST 510	3 (2+1)	3			
Advanced programming with “C++”	CSE 511	3 (1+2)	3			
Command area Development	IWM 514	3 (2+1)	3			
Higher Mathematics	BS 515	3 (3+0)	3			
Reclamation of Irrigated lands	IWM 521	3 (2+1)		3		
Irrigation Economics Planning and Management	IWM 522	3 (2+1)		3		
Water Conveyance and Distribution	IWM 523	3 (2+1)		3		
Design of Drip & Sprinkler Irrigation System	IWM 524	3 (2+1)		3		
Finite Element Analysis	ME 610	3 (2+1)	3			
Design, Operation & Evaluation of Pressurised Irrigation System	IWM 611	3 (2+1)	3			
Soil Water Plant Atmospheric System Modelling	IWM 613	3 (2+1)	3			

Data Structures & Algorithms	CSE 621	3 (2+1)	3			
Minor Irrigation	IWM 535	3 (2+1)			3	
Farm irrigation structures	IWM 536	3 (2+1)			3	
Others						
Compulsory Courses; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/502/...	1	NC	NC		
Seminar	SWC 691/ 692	1 (0+1)	1	1	-	-
Preliminary	SWC 633	NC			NC	
Research (Thesis). Thesis minimum duration 4 semesters	SWC 634	45	-	-	-	45
Total credits to be offered		**74**	**16**	**13**	**-**	**45**

Note: A Ph.D. student must take two 600 series core courses. A student may choose optional/minor & supporting courses of 500 series courses if not studied during Masters Programme as per ICAR guidelines.

\+ Exempted for those who have cleared these in Master's Programme (permission to be sought from the Dean, CTAE).

COURSE SUMMARY

Courses	No. of Courses							Credit Hours
	Semester							
	I	II	III	IV	V	VI	Total	
Core	1	1					2	6
Optional	2	2					4	12
Minor & Supporting	2	1					3	9
Seminar	1	1					2	2
Preliminary			1				1	Non Credit (graded as satisfactory/ non satisfactory)
Research (Thesis)						1	1	45* (graded as satisfactory/ non satisfactory)
Compulsory Courses** (PGS Series)	1	1					2	Non Credit
Total	**7**	**6**	**1**			**1**	**15**	**74**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

**Exempted for those who have cleared these in Master's Programme.

SYLLABUS

SOIL AND WATER CONSERVATION ENGINEERING

Watershed Hydrology

SWC 511 **3 (2+1)**

Course Outcome

- Able to understand and analyze the process and the effect of various climatic parameters.
- Able to develop the competency of hydrological parameter analysis.
- Able to develop the competency data transformation, calibration and evaluation of hydrologic models and computer simulation.

Theory

Hydrology in water resources planning rainfall, surface runoff and sub-surface runoff as components of hydrologic cycle, Runoff phenomena relationship between precipitation and runoff, Methods of runoff estimation from small watersheds, synthetic unit hydrograph, recent advances in analysis of hydrologic data and flow from small watersheds, use of IUH and various methods of estimation, Micro climate estimation methods of evaporation, Advances and improvements in rational approach, SCS approach criticism and improvements, Hydrological Hazard function. Methods of estimation of hydrologic parameters, Data transformation, Calibration and evaluation of hydrologic models, Computer simulation of hydrological process in small watersheds.

Practicals

Based on theory

Suggested Readings

1. Singh V.P., (2010),Rainfall-Runoff Modelling (Vol. I) – Prantice Hall, New York.
2. Singh V.P., (2010), Environmental Hydrology. Springer, New York.

Ground Water Engineering

SWC 512 **3 (2+1)**

Course Outcome

- After completion of course student will be able to analyze storage, movement and flow characteristics of different aquifers.
- Able to model ground water and plan for ground water recharge.

Theory

Properties affecting groundwater storage and movement, groundwater balance studies.

Well hydraulics, two dimensional flow, steady and unsteady state flow in confined, unconfined and semi-confined aquifers, steady flow in sloping aquifers, partial penetrating wells. Analysis of multi-aquifers.

Flow analysis in interfering wells. Pumping tests and determination of aquifer parameters.

Groundwater modelling for water resources planning.

Techniques for groundwater recharge.

Practicals

Water table contour maps and determination of groundwater flow, estimation of aquifer characteristics, problems on non leaky and leaky aquifers, analysis of pumping test data, computation of interference of wells; groundwater computer simulation models.

Suggested Readings

1. Boonstra J & de Ridder NA.1981. Numerical Modelling of Groundwater Basins. ILRI.
2. Demenico PA 1972. Concept and Models in Groundwater Hydrology. Mc Graw Hill.
3. Jat, M.L. and SR Bhakar 2008. Ground Water Hydrology. Agrotech Publishing Academy, Udaipur.
4. Huisman L.1972. GroundWater Recovery, Mac Millan.
5. Polubarinova Kochina P Ya 1962. Theory of Ground Water Movement. Princeton Univ. Press.
6. Raghunath HM. 1992. Ground Water.Wiley Eastern.
7. Todd DK 1997. Ground Water Hydrology. Wiley Eastern.

Design of Farm Irrigation Systems

SWC 521 **3(2 +1)**

Course outcome

- Able to identify principle losses and develop water budgeting for farms.
- Develop understanding of hydraulics of water advance and recession of irrigation stream.
- Design surface irrigation system, sub irrigation system and pressurized irrigation system.

Theory

Concepts of Irrigation; Irrigation principles, losses, conveyance, distribution; Application, scheduling parameters, water budgeting.

Surface irrigation, hydraulics of water advance and recession, hydraulic resistance to flow, gravity irrigation.

Design of Border irrigation, furrow irrigation, check basin irrigation; Sub Irrigation methods and concepts.

Preliminary design criteria of sprinkler and micro irrigation systems, hydraulics of sprinkler and micro irrigation systems. Design of lateral, sub main and main line ofsprinkler and micro irrigation. Fertigation aspects.

Underground water conveyance system; Evaluation of irrigation systems and practices.

Practicals

Design and evaluation of border, furrow, check basin, sprinkler and micro irrigation, computation of frictional losses, Design of underground water conveyance systems, economics of irrigation methods, visit to mechanized farms.

Suggested Readings

1. Finkel HJ 1983. Handbook of Irrigation Technology. Vols. I-II. CRC Press.
2. Karmeli D, Peri G & Todes M. 1985. Irrigation Systems: Design and Operation. Oxford Univ. Press.
3. Pillsbury AF.1972. Sprinkler Irrigation. FAO Agricultural Development Paper No. 88, FAO.
4. Rydzewski 1987. Irrigation Development Planning. John Wiley & Sons.
5. Sivanappan RK, Padmakumari O & Kumar V. 1987. Drip Irrigation, Keerthy Publ, House.
6. Sivanappan RK.1987. Sprinkler Irrigation. Oxford & IBH.
7. Michael, A.M.,2008, Irrigation Theory & Practices, Vikas Publishing House Pvt. Ltd., New Delhi.
8. Schwab, G.O.,D.D. Fangmeier, W.J.,Elliot & R.K. Frevert, 1993. Soil & Water Conservation Engineering. Fourth Edition, John Wiley & Sons, Inc.New York.
9. Varshney. R.S.,S.C. Gupta & R.L. Gupta, 1979. Theory & Design of Irrigation Structures, Vol.II, Nem Chand & Bros. Roorkee.
10. Walker, Wynn R. & Skogerboe, Gaylord V.,1987, Surface Irrigation,Theory and Practice, Prentice-Hall, Inc. Englewood Cliff, New Jersey, USA.
11. ASABE, Design & operation of farm irrigation system, 2nd edition.

Agricultural Drainage Systems

SWC 531 **3(2 +1)**

Course Outcome

- After completion of course student will be able to analyze theories and application of Drainage by measuring hydraulic conductivity of aquifer.
- Able to design drainage system and waste disposal system.

Theory

Theories and applications of surface and sub-surface drainage, steady state, unsteady state drainage equations for layered and non-layered soils, horizontal sub-surface drainage.

Principle and applications of Ernst, Glover Dumm, Kraijenhoff-van –deleur equations.

Salt balance, leaching requirement and management practices under drained conditions.

Design of different components of sub-surface drainage systems, theories of vertical drainage and multiple well point system.

Disposal of drainage effluents, Management of drainage projects of water-logged land saline soils, case studies.

Practicals

Measurement of *in-situ* hydraulic conductivity, estimation of drainage coefficient and leaching requirements, Delineation of waterlogged areas through isobar, isobath and topographic maps. Design of surface and subsurface drainage systems, design of filter and envelop materials.

Suggested Readings

1. Bhattacharaya AK & Michael AM.2003. Land Drainage..Vikas Publ.
2. Clande Ayres & Daniel Scoates A.E. 1989. Level Drainage and Reclamation. Mc.Graw Hill.
3. Luthin JN 1978. Drainage Engineering. Wiley Eastern.
4. Ritzema HP.(Ed.) 1994. Drainage Principles and Applications. ILRI
5. Roe CE 1966. Engineering for Agricultural Drainage. Mc Graw Hill.
6. Schillgaardo Jan Van (Editor 1974) Drainage for Agriculture. Monograph No. 17. American Society of Agronomy Madison, Wisconsin, USA.

Advanced Hydrology

SWC 611 **3 (2+1)**

Course outcome

- Able to develop the hydrologic modelling and find out their trend as well as periodic component.
- To develop the stochastic and deterministic model for forecasting the precipitation for prediction the flood and drought.

Theory

Hydrological models, processes and systems. Uncertainty in hydrological event. Statistical homogeneity.

Probabilistic concept. Frequency analysis. Correlation and regression analysis. Probability distribution of hydrological variables.

Time series analysis. Markov processes.

Formulation of various steps of statistical models and their application in hydrology.

Practicals

Based on theory and recent advances in the field.

Suggested Readings

1. Garg SK.1987. Hydrology and Water Resources Engineering. Khanna Publications.
2. Hann CT. Advanced Hydrology. Oxford Publications House.
3. Linseley RK Jr., Kohler MA & Paulhus JLH.1975. Applied Hydrology. McGraw Hill.
4. Mutreja KN.1986. Applied Hydrology. Tata McGraw Hill.
5. Singh V.P.(2010), Hydrological Modelling, Springer, New York.

Soil and Water Systems Simulation and Modelling

SWC 621 **3 (2+1)**

Course outcome

- Able to develop the model for reservoir monitoring which can be contributed to watershed management and planning.
- Able to simulate the ground water and surface water by developing the ground water model and runoff model respectively.

Theory

Systems engineering for water management: complexity of resources management process, systems analysis.

Rainfall- runoff models, Infiltration models, Simulation methods, structure of a water balance model.

Channel flow simulation- parameters and calibration-Streamflow statistics, surface water storage requirements.

Flood control storage capacity; total reservoir capacity–surface water allocations. Ground water models.

Design of nodal network, General systems frame work-Description of the model; Irregular boundaries, General-Numerical approaches.

Practicals

Rainfall- Runoff models- Infiltration models-Stanford watershed model (SWM) –channel flow simulation problems- stream flow statistics –model parameters and input data requirements of various softwares of surface hydrology and groundwater-Hydrologic Modelling System- Soil Water Management Model- Soil Water Assessment Tool- Catchments, Simulation Hydrology Model – Stream flow model and use of dimensionless unit hydrograph-Generalized groundwater models.

Suggested Readings

1. Biswas AK. 1976. Systems Approach to Water Management.Mc Graw Hill.
2. Cox DR & Mille HD.1965. The Teory of Stochastic Processes. John Wiley & Sons.
3. Eagleson PS 1970. Dynamic Hydrology. Mc Graw Hill.
4. Himmel Blau DM & Bischoff KB.1968. Process Analysis and Simulation Deterministic Systems. John Wiley & Sons.
5. Linsley RK,Kohler MA & Paulhus JLH. 1949. Applied Hydrology. Mc Graw Hill.
6. Schwar RS & Friedland B. 1965. Linear Systems. Mc Graw Hill.
7. Ven Te Chow, David R Maidment & Mays LW. 1998. Applied Hydrology. Mc Graaw Hill.

Flow through Porous Media

SWC 513 **3(2+1)**

Course outcome

- Understanding of physical properties of flow through porous media.
- Competence on various laws governing dynamics of flow through porous media.
- Understanding of hydrodynamics in porous media, governing laws and boundary conditions.

Theory

Physical properties of water occurrence of water, physico-chemical nature of water, its structure and its three phases. Energy required for transformation of water from one state of another. Properties of fluid systems in porous media, concept of Continumm, forces on fluid elements, Newtonian viscous fluids, concept of potential, fluid acceleration. Static water in soil, structure of water, forces and energy in water, Van der Walls-London (V-L) forces, dispersion of soil colloids surface tension.

The state of water in the soil, energy state of soil water. Quantitative expression of soil water potential, soil moisture characteristics curve, Hysteresis.

Dynamics of fluids in porous media, Darcy's law, Poiseuille's law, Flow in films and small tubes, Homogenity and Isotropy, Factors affecting permeability, Fundamentals of Groundwater flow, General hydrodynamic equations: velocity potential. Two-dimensional flow, Stream function, Streamlines and equipotential lines, Boundary conditions, the flow net. The basic seepage equation. The continuity equation. Non-uniform seepage of an Incompressible fluid. Axisymmetric confined seepage of an Incmpressible fluid, General Hydrodynamic Equations, velocity potential. Fundamentals of seepage analysis, Richard's equation, cylindrical coordinates. Application of the Dupuit theory of unconfined flow.

Hydrodynamics in porous media; and the limitations of the governing laws, initial and boundary conditions, Dupuit and Boussinesque approximations and linearization techniques, use of flow net in subsurface flow quantification, simulation of soil moisture dynamics, Analysis of seepage (lateral & upward) from earthen dams and canals. Conformal mapping & hodograph transformation, Laplace, its derivation & solution in various forms.

Practicals

Based on theory

Suggested Readings

1. Soil Physics, Helmut Kohnke, pp. 7-79.
2. A.T. Core, Flow in Porous Media
3. Collins, R.E., Flow of Fluids Through Porous Materials; Reinhold publishing cooperation, New York, 1961, chapter 1.
4. Zemansky, M.W. 1943, Heat and Thermodynamics, McGraw Hill, New York, Second edition, chapter III, section 32.
5. Daniel Hillel, 1971. Soil and Water : Physical Principles and Processes (Physiological Ecology, A series of monographs, texts and treatises, academic press, New York, San Francisco, London, pp. 288. J:1(D2)L1, 174739
6. Daniel Hillel, 1980. Fundamentals of Soil Physics, Academic press, New York, pp. 413. J:1(C) MO, 174741
7. De Wiest Roger J.M., 1969. Flow Through porous media, academic press, New York, pp. 530. D28, K9:1, 47814

Advanced Soil and Water Conservation Engineering

SWC 514 **3 (2+1)**

Course outcome

- Able to estimate the erosivity index of rainfall in particular watershed area.
- Able to estimate the sedimentation and its losses.
- Able to design specifically the gully control structure and earthen dam.

Theory

Concepts of soil and water conservation, relevance of soil and water conservation in agriculture and in the river valley projects, productivity loss due to soil erosion, water stress and water excess, Types and mechanics of soil erosion, Theories of sediment transport, Control of runoff and runoff and sediment loss, Design of soil and water conservation structures-check dams, gully plugs, gabions, earth dams, silt detention dams, farm ponds, energy dissipation structures, etc., and the alternate use of the stored water for agriculture.

Practicals

Assessment of erosive status of a watershed through field measurement or analysis of morphometric properties, Estimation of erosivity index of rainfall, Determination of soil physical properties-texture, grain size distribution, Atterberg's limits, Various moisture percentages, Locating best possible sites of soil and water conservation structures on the basis of map features and erosivity status, Estimation of costs of soil and water conservation measures.

Suggested Readings

1. Suresh, R. (1993). Soil and Water Conservation Engineering. Standard Publishers and Distributors, New Delhi.
2. Garg, S.K. (1987). Irrigation Engineering and Hydraulic Structures. Khanna Publishers, New Delhi
3. Kirkby, M.J. and Morgan, P.P.C. (Eds). (1980). Soil Erosion. John Wiley and Sons. New York, USA
4. Thorn, R.B. (1966). River Engineering and Water Conservation Works. Butterworths, London.
5. Hundson and Norman. (1985). Soil Conservation. (2nd edition). Cornell Univ. Press, Ithaca, New York.

Open Channel Flow

SWC 515 **3 (2+1)**

Course outcome

- To develop the common understanding of open channel flow and their properties as well as its application.
- To develop the common understanding that how hydraulic jump formed in open channel and how much dissipated kinetic energy.
- To impart the knowledge of various type of flow occur during flowing in channel and their characteristics.

Theory

Open channel and their properties, energy and momentum, critical flow computation and application.

Uniform flow: gradually varied flow theory and analysis, methods of computation.

Practical problems such as design of transitions, flow passing Islands etc. spatially varied flow, rapidly varied flow.

Hydraulic jump ad its use as energy dissipater, flow through channel of non-linear alignment and flow through non-prismatic channel sections.

Unsteady flow, gradually varied unsteady flow and rapidly varied unsteady flow.

Practicals

Based on theory

Suggested Readings

1. Chaudhry MH.1993. Open channel Flow. Prentice Hall.
2. Chow VT. 1959. Open Channel Hydraulic. Mc-Graw Hill.
3. Henederson FM.1996. Open Channel Flow. MacMillian.
4. Srivastava Rajesh, (2008), Flow through open channel. Oxford University Press.

Soil and Water Conservation Structures

SWC 516 **3(2+1)**

Course outcome

- Able to design the soil and water conservation measures as well as permanent gully control structure.
- Design and test analysis of water harvesting structures.
- To develop the common understanding of mechanized construction of soil and water conservation structures.

Theory

Probability concepts in the design of structures. Design planning and layout of soil and water conservation structures. Design and construction of earthen dam, stability analysis of land slopes and soil mass including landslides. Hydrological design and structural design including stress analysis flow net and determination of uplift pressure in drop structures, design of energy dissipater. Mechanized construction techniques for soil and water conservation structures. Water harvesting structures design, construction, maintenance and utilization of stored water.

Practicals

Based on theory

Suggested readings

1. V.V.N. Murty, 1988. Land and Water Management Engineering, Second Edition Kalyani Publishers, New Delhi.
2. Michael A.M. and T.P. Ojha, 1999, Principles of Agricultural Engineering, Vol. II, Third Edition, Jain Brothers, New Delhi.
3. Singh Gurmel, C. Venkataraman, G. Sastri and B.P. Joshi, 1991. Manual of Soil & Water conservation Practices, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Schwab, G.O., Frangmier DD, Elliot M.J., and Frevert R.K., 1995, Soil and Water Conservation and Engineering, Fourth edition, John Villey & Sons Inc.
5. Singh P.K., 2000, Watershed Management (Design and Practice), e-media publications, Udaipur.
6. Suresh, R. (2002). Soil and Water Conservation Engineering, Fourth Edition Standard Publishers and Distributors, Delhi.
7. Singh, Raj. Vir. 2003. Watershed Management, Second Edition, Yash Publishing, Bikaner

Soil–Water-Plant Relationship

SWC 517 **3 (2+1)**

Course outcome

- After completion of course student will be able to analyze factors responsible for water movement in soil, plant and evaporative demand of plant.
- Student will be able to estimate the evapotranspiration using meteorological data.

Theory

Aerial and edaphic environment for plant growth, Energy and Mass transfer in and above crop canopies, Plant response to environmental stresses, Evapo-transpiration models, Instrumentation techniques for monitoring plant environment, Processes and aspects of growth and development, Soil root interface, Root sink functions, Water movement in soil-plant-atmosphere continuum, Artificial environment and plant behavior, Design and operation of controlled environment facilities and their instrumentation.

Practicals

Measurement and interpretation of environmental parameters relevant to crop growth, Establishment of soil moisture characteristic curves and their interpretation, Design of polyhouse and other controlled environment chambers, Estimation of evapotranspiration by different methods and their comparison, Estimation of crop water requirement, Estimation of irrigation requirement.

Suggested Readings

1. Ghildyal, B.P. and Tripathy, R.P. (1987). Fundamentals of Soil Physics. Wiley Eastern Ltd, New Delhi.
2. Slatyer, O.P. (1967). Plant-Water Relationship. Academic Press. London.
3. Hillel, Deniel (1982). Introduction to Soil Physics. Academic Press. San Diego, CA, USA.
4. Kozlowski, T.T. (Editor). 1968. Water Deficits and Plant Growth. Vols I and II. Academic Press. London.
5. Wild, Alan (Editor). (1988). Russell's Soil Condition and Plant Growth, Longman Group UK.

GISand Remote Sensing for Resource Management

SWC 522 **3 (2+1)**

Course outcome

- Understanding of aerial photography and interpretation.
- Able to use satellite remote sensing to perform image analysis and classification for developing thematic maps.
- Able to integrate satellite data with GIS to undertake recourse mapping and planning studies.

Theory

Basic principles of remote sensing and sensors, Elements of photogrametry, Electromagnetic spectrum, Energy interaction with surface features, Aerial photo and satellite imagery, Photo and image interpretation, Principles of Geographical Information System tools, their varieties and capabilities, Advantages of GIS over conventional methods, Importance of ground truth establishment, GIS and remote sensing for land and water resources data collection, analysis and interpretation, Application of GIS in water and land resource development and management. Digital Image Processing.

Practicals

Familiarization with remote sensing and GIS hardware and their principle of working, Methods of establishing ground truth, Comparison between truth and remotely sensed data, Application of GIS packages. Practical based on digital image processing

Suggested Readings

1. Sabins, J.R. (1987). Remote Sensing Principles and Interpretations, W.H. Freeman & Co.
2. Burrough, P.A. (1986). Principles of GIS for Land Resource Assessment
3. Heywood, Ian., Cornelius Sarah and Carver Steve. (1989). An Introduction to Geographic Information Systems. Addison-Wesley-Longman.
4. Chrisman Nicholas. (1987). Exploring Geographic Information Systems. John Wiley and Sons.
5. Shultz, G.A. and Engman, E.T. (2000). Remote Sensing in Hydrology and Water Management. Springer, New York.

Watershed Management &Modelling

SWC 523 **3 (2+1)**

Course outcome

- Able to estimate the geomorphologic parameter of particular watershed and suggest their limitation.
- Able to design the plot for small erosion study by using different types of rainfall simulators (Tubing Tip type, Hypodermic needle type and spray type).
- To develop the common understanding of different conservation practices and their effect on watershed behavior.

Theory

Soil erosion models, Rainfall simulators and scope of their use in soil erosion studies. IUH estimation using geomorphological methods. Artificial groundwater recharge, Use of GIS and remote sensing tools in watershed management, Watershed based water management, Economics of water management, Participatory mode of water management.

Delineation and codification of small watersheds. Characteristics of small watershed as related to hydrologic processes infiltration, channel flow and storage. Different conservation practices biological, mechanical and structural and their effects on watershed behaviour. Effect of land use changes. Physiography of small watersheds and hydrologic measurement. Space time characteristic of precipitation and design application models to field problems. Environmental impact assessment of watersheds. Quantitative evaluation of management techniques.

Practicals

Watershed delineation; Watershed discretisation; Assessment of inflow and outflow; Measurement, calculation and interpretation of geomorphologic parameters, Design of soil and water conservation structures; Land and water use planning of watershed

Suggested Readings

1. Tideman, E.M. (1999). Watershed Management (Guidelines for Indian Conditions), Omega Scientific Publishers, New Delhi.
2. Dhruvanarayana, V.V. Sastry, G., Patnaik, U.S. Watershed Management.Publ. and Inf.D.v, ICAR, Krishi Anusandhan Bhavan, New Delhi.
3. Singh, Raj Vir. (2000). Watershed Planning and Management. Second Edition Yash Publishing House, Bikaner.
4. Lal, R. (1996). Methods and Guidelines for Assessing Sustainable use of Soil and Water Resources in the Tropics. Jagmander Book, Karol Bagh, New Delhi.
5. Dhaliwal, G.S., Hansra, B.S. and Ladhar, S.S. (1993). Wetlands, their Conservation and Management. Punjab Agicultural University, Ludhiana.
6. USDA. (1969). A manual on Conservation of Soil and Water. Oxford and IBH Publishing Co. New Delhi.

Land Development & Earth Moving Machinery

SWC 524 **3(2+1)**

Course outcome

- Able to classify the land use and make them into use for planning and management of watershed.
- To develop the common understanding of earth moving machineries which is used for earth work excavation and their selection criteria's.

Theory

Land as the primary resource base for agriculture, Basic engineering considerations for planning and development of land for efficient water resource management, methods of land development and their sustainability, Importance of land development for sustainable agriculture, Land development criteria and methods, Macro leveling and grading, Machinery for land development, Estimation of earth work, land development costs and benefits. Design principles of small drainage machinery, Principles of laser controlled earth moving machinery.

Practicals

Survey for land leveling and grading calculations, Land leveling index calculation, Calculation of irrigation efficiencies in lands with varying land leveling index, Bunding and terracing computations, Selection of topographic map scale for land development planning, Interpretation of topographic maps, Use of remote sensing imagery for identification of land features, Use of GIS for planning land development, Surveys and preparation of integrated land development plans, Earth work and cost estimation. Calculation of volume, time and cost of earthwork for construction of open drains/channels using different machines and its comparison with manual execution.

Suggested Readings

1. Murty, V.V.N. (1988). Land and Water Management, Kalyani Publisher, Ludihana.
2. Murty, V.V.N. and Takeuchi, D.K. (1997). Land and Water Development for Agriculture in Asia-pacific Region. Oxford and IBH Publishing Co. New Delhi.
3. Schwab, G.O. Frevert, R.K. Edminister, T.W. and Barns K.K. (1981). Soil and Water Conservation Engineering. Wiley and Sons, New Yor.
4. SCS. (1959). National Engineering Handbook, Chapter 12. Soil Conservation Service, U.S. Department of Agriculture. Washington DC, USA.
5. Mal, B.C. (1995). Soil and Water Conservation Engineering. Kalyani Publisher, Ludhiana.

Water Resources Systems Engineering

SWC 525 **3 (2+1)**

Course outcome

- Able to identify objective function and components in water resource planning problems.
- Able to formulate and solve various mathematical programming models of water resource system.
- Able to develop conjunctive use and crop production function optimization models.

Theory

Concepts of significance of optimization in water resources, objective function, deterministic and stochastic inputs.

Mathematical programming technique , linear programming and its extension: gradient method, simplex method, non-linear programming classical optimization.

Geometric programming and dynamic programming, application of optimization techniques for water resources.

Development and management including conjunctive use, crop production functions and irrigation optimization.

Practicals

Based on theory and recent advances in the field.

Suggested Reading

1. Larry WM.(1996) Water Resources Handbook. Mc-Graw-Hill.
2. Loucks DP et al.(1981).Water Resources System Planning and Analysis Prentice Hall.
3. Rao SS.(1978) Optimization Theory and Application. Wiley Eastern.
4. Wallander WW, BOS M (1990) Water resource system Planning & Management.

System Engineering & Productivity

SWC 526 **3 (2+1)**

Course outcome

- Understanding system engineering concepts and system analysis tools.
- Apply project management techniques for real life engineering problems.
- Able to develop and solve optimization models for agricultural engineering systems.

Theory

System definition and concept. System engineering function, management and problems. Classification of system analysis models. Economic analysis techniques : Interest land interest estimation of single and multiple alternatives, break even analysis.

Mathematical modelling and analysis : Application of linear programming, Network theory –CPM and PERT, Queuing theory and its application, assignment & transportation models land job scheduling/allocation for the synthesis of agriculture machine systems.

Dynamic programming, Markov chains, application of forecasting in agricultural engineering systems and products. Concept utilization and mathematical formulation of the labor, equipment and material factors affecting productivity .

Computer use in solving problems of optimization, writing of algorithms for problem solutions land decision making.

Practical

Extensive practice on the packages mentioned on theory.

Suggested Readings

1. Danovan SS.2000 System Programming. Tata McGraw.
2. Gillett G. 2001. Introduction to Operations Research. Tata McGraw Hill.
3. Grawham WJ & Vincent TL. 1993. Modern Control System Analysis and Design. John Wiley & Sons.
4. Lewis FL & Syrmos VL. 1995. Optimum Control. 2nd Ed. John Wiley & Sons.
5. Loomba D. 2000. Linear Programming. Tata McGraw.
6. Puttaswamaiah K. 2001. Cost Benefits Anaysis . Oxford & IBH.

Social Aspects of Watershed Management

SWC 527 **3(2+1)**

Course outcome

- To develop the common understanding of participatory approach in watershed development program and know its tools.
- Have been chance to visit particular watershed and able to discussed problems of villagers.
- Able to make the solutions of villagers problem and identifying it by using participatory tools. Specially the loan problems and marketing.

Theory

Participatory Rural Appraisal (PRA) Techniques & its uses in Watershed Management – Rapid Rural Appraisal, Participatory Learning Approach, Focus Group Discussion & various PRA tools for identification of problems of the area.

Post Project Management Strategies in Watershed Projects.

Socio–economic survey:- Data set and data point. Statistics main division and nature of statistics, planning of socio-economic survey.

Collection of data:- Primary and secondary data, questionnaires & schedules sampling, editing and scurting of secondary data, classification and tabulation and analysis of data.

Credit- Source of credit, need, importance and role of credit in watershed management, classification of credit, credit institutions, principles of credit. Agriculture marketing, role and importance, market, classification of markets, marketable and marketed surplus, function of marketing, agencies, channels and instification in watershed areas. Cooperation, principles, role of cooperation in marketing and finance in watershed areas.

Practicals

1. Exercise on Various principles of Farm management.
2. Study on collection of data and tabulation in socio-economic survey of Irrigation Management.
3. Study on sampling various methods commonly used for survey of Irrigation management.

4. Study on preparation of questionnaire and schedules for socio-economic survey in irrigated areas.
5. Find out marketable and marketed surplus in the irrigated areas.
6. Exercise on various repayment plans of agricultural credit in the irrigated areas.

Suggested Readings

1. Reddy, A.A.(1987), Extension Education. Sree Laxmi Press, Bapatta(AP).
2. Acharya, S.S. and N.L.Agrawal(1996).Agricultural Marketing in India, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
3. ReddySubba S. and P.Raghu ram,(1996), Agricultural Finance and Management, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
4. Johl, S.S.and T.R.Kapoor,(2001), Fundamentals of Farm Business management. Kalyani Publishers, Ludhiana.

Crop Environmental Engineering

SWC 535 **3(2 + 1)**

Course outcome

- To develop the common understanding aerial and edaphic environments for plant growth, energy and mass transfer which help to maximizing the crop yield.
- To understanding the basic interface of soil and root and its characteristics.
- Able to identify climatic changes on plant and how plan are response to environmental stresses, evapotranspiration.

Theory

Aerial and edaphic environments for plant growth, energy and mass transfer in and above crop canopies.

Climatic changes and plant response to environmental stresses, evapotranspiration models. Instrumentation and techniques for monitoring plant environments.

Processes and aspects of growth and development, soil-root interface, root sink functions.

Water movement in soil-plant atmosphere continuum, artificial environments and plant behavior. Water requirement of crops in controlled environment.

Design and operation of controlled environment facilities and their instrumentation. Crop growth and yield modelling. Remote sensing based modelling.

Practical

Base on theory and recent advances in the field.

Suggested Readings

1. Ghildyal BP and Tripathy RP. 1987. Fundamental of Soil Physics. Wiley Eastern.
2. Slatyor OP. 1967. Plant Water relationship. Academic Press.
3. Gomtia N.K. & Tiwari K.N. 2008. Irrigation Scheduling & Crop water Stress using Remote sensing & GIS, Lamber Publication

Design of Pumps for Irrigation and Drainage

SWC 536 **3 (2+1)**

Course outcome

- Able to select the pump for desired discharge to be pumped from particular water source by developing pump characteristics curve.
- Able to analyze the flow in different types of pump.
- Able to design the pumping station for managing the irrigation and drainage system.

Theory

Design principles of the common types of pumps and well lifts, Influence of design parameters on the pump performance, Matching of pumps with prime movers, Matching of pumps and prime movers with water source, Non-conventional energy sources for pumping, Assessment of wind energy and design of wind mill, Assessment of solar insolation and selection of photovoltaic pump, Hydraulic ram and its design, Energy loss in pressurized conveyance of pumped water, Design of pumping plant for irrigation and drainage.

Practicals

Performance evaluation of pumps and prime movers, Selection of suitable pump and prime mover with appropriate technical specifications to satisfy irrigation and drainage requirement of a given area, Estimating irrigation command for wind mill and solar photovoltaic pump for a known water sources,

Suggested Readings

1. Church, A. H. and Jagdish Lal. (1973). Centrifugal Pumps and Blowers, Metropolitan Book Co. Pvt. Ltd. Delhi.
2. Bansal, R. K. (1990). A Text Book of Fluid Mechanics and Hydraulic Machines. Laxmi Publications, New Delhi.
3. Luthine, J N. (1966). Drainage Engineering, Wiley and Sons. New York, USA.
4. Michael, A. M. and Khepar, S. D. (1989). Water Wells and Pump Engineering. Tata McGraw Hill Publishing Co., New Delhi.

Dry Land Technology

SWC 537 **3 (2+1)**

Course outcome

- To develop the common understanding of land development and land shaping for its use specially for agricultural purpose, also for developing the soil for *in-situ* moisture conservation.
- Able to estimate the runoff from the particular watershed and reuse of harvested water for the irrigation and allied purpose.
- Understanding planning and design soil and water conservation measures and water shed planning using RS and GIS.

Theory

Land shaping and land development for soil moisture conservation. Improvement of tillage and soil management by implements and engineering practices.

Soil and moisture conservation for rainfed lands through improved implements and engineering practices.

Water harvesting-microcatchments, their types and design; recycling of runoff water for better utilization.

Crops and cropping practices related to soil and moisture conservation. Fertility management in dry land farming.

Planning and development of watersheds from engineering view point-case studies.

Application of aerial photography in surveys and planning of watersheds for rainfed agriculture.

Use of Remote Sensing in soil moisture estimation.

Practicals

1. Study and demonstration of various implements used for land shaping for soil moisture conservation.
2. Study of various implements used for land development for soil moisture conservation.
3. To evaluate the effect of various vegetative and non-vegetative mulches on soil moisture conservation.
4. Demonstration and study of micro and macro catchment for conservation of moisture.
5. Design of water storage structures such as ponds and Khadin.
6. Visit to water harvesting site at SWC demonstration farm.
7. A complete project on water harvesting. (a) Field survey of the given area for site selection. (b) Planning of water harvesting system (c) Design of the water harvesting system.

Suggested Readings

1. Singh, R.V. 2003. Watershed Planning and Management. Second Edition. Yash Publishing House, Bikaner
2. Murty, V .V. N. 1998. Land and Water Management Engineering. 2nd Ed. Kalyani Publishers Ludhiana.
3. Singh, Gurmel. Manual of Soil Water Conservation Practices in India.
4. Somani, L. L. (2004). Dryland Agriculture in India. Agrotech Publisher, Udaipur

Water Resources Pollution and Control

SWC 612 **3 (2+1)**

Course outcome

- Able to determine the water quality parameter which is recommended for agriculture, domestic and industrial purpose.
- To develop the common understanding of water treatment or sewage treatment plants.
- Able to understand modelling studies in water pollution, Pollution control laws and their enforcement mechanism.

Theory

Impurities in water, physical, chemical and bacteriological analysis of water, Indices of water quality domestic, agricultural and industrial uses, Water quality standards, Monitoring of water quality, Sources of water pollution and their control measures, Modelling studies in water pollution, Pollution control laws and their enforcement mechanism, Unit operations and waste water treatment kinetics, Pollutant uptake by plants.

Practicals

Determination of dissolved in suspended impurities, Bacteriological test of water, Testing for fitness in irrigation of the water source, Estimation of consequent changes in soil quality due to irrigation by varying water quality, Estimation of leaching requirement of cropped land, Physical filtration of impure water in pressurized irrigation system, Analysis of industrial effluent water quality and interpreting suitability for its use in irrigation.

Suggested Readings

1. Eckenfelder, W. Wesley (Jr.) (1970). Water Quality Engineering for Practicing Engineers, Barnes & Nobel Inc., New York.
2. Snoeyink Vernon, J. and Jenkins, David, (1980). Water Chemistry. John Wiley & Sons. New York
3. Weber Walter, J (Jr.) (1972). Physico-Chemical Processes for Water Quality Control. Wiley Interscience, New York.
4. Pepper, L.L., Gerba, C.P. and Brusseau, M.L. (Eds) (1996). Pollution Science, Academic Press. San Diego.

Mechanics of Soil Erosion & Transportation

SWC 613 **3(2+1)**

Course outcome

- Able to estimate the sediment from the particular watershed by using various instruments.
- To develop the common understanding of mechanics of sediment transportation process and remedies to reduce this.
- Able to design and install the sediment observation post at the outlet of any watershed for analyzing the efficacy of installed structures.

Theory

The processes, factors responsible for and consequences of soil erosion, kinetic energy of rainfall, Overland flow process and sediment transport, Sediment transport in stream flow, Sediment deposition process and reduction in live storage of reservoirs, Universal soil loss equation, its applicability and its refinements, Instantaneous unit sediment graph, its

development and use, Measurement of sediment flow and sediment deposition, Erosion control and silt detention structures and their design, Conceptual physical process based and empirical models for quantifying sedimentation, used of Geographical information system for modelling erosion and sedimentation.

Incipient motion of sediment particles, Bed load transportation mechanism and models, Total load Transport, macroscopic and microscopic methods, Suspended and bed load sampling, sediment samplers, control of suspended and bed load.

Practicals

Computation of soil erosion index and estimation of soil erodibility factors, Water sampling in natural streams or in hydraulic flumes for finding sediment concentration, Analysis of recorded information on runoff and sediment flow and developing relation between them, Analysis of watershed map for calculation of hysometric integral and other geomorphological parameters for assessing the watershed erosion status and watershed prioritizing for soil conservation treatment.

Suggested Readings

1. Morgan, R.P.C. (Ed. D.A. Davidson). Soil Erosion and Conservation, ELBS-Longman, UK.
2. Dhruvananrayna, V.V. et al. Soil Conservation Research in India. Publ. And Inf, Div, ICAR, Krishi Anusandhan Bhavan, New Delhi.
3. Garde, R.J. and Ranga Raju, K.G. (1977). Mechanics of Sediment Transportation and Alluvial Stream Problems. Wiley Eastern Ltd., New Delhi.
4. USDA. (1969). A Manual on Conservation of Soil and Water. Oxford and IBH Publishing Co. New Delhi.
5. Zachar, Dusan. (1982). Soil Erosion. Elsevier Scientific Publishing Co. Amsterdam, The Netherlands.
6. Schab, G.O. Fangeir, D.D. Elliot, W.S. and Frevert, R.K. (1993). Soil and Water Conservation Engineering (4th edition). John Wiley and Sons. New York.
7. Garde, R. J. and RangaRaju, K. G. (1995). Mechanics of Sediment Transportation and Alluvial Stream Problems. 2nd Ed. Willey Eastern Ltd. New Delhi.
8. River Behaviour Management and Training (1989). CBIP Publication No. 204, CBIP, New Delhi.

Unsaturated Flow through Porous Media

SWC 614 **3(2+1)**

Course outcome

- Able to analyze movement of water in unsaturated soils conditions.
- Able to estimate unsaturated flow in porous media through partial difference equations.
- Understanding different infiltration theories and models. Temperature and pressure aspects of soil and water transport.

Theory

Fundamental concepts of soil and water relationship. Unsaturated flow of water in soils, Liquid phase transport. Hysteresis. Basic characteristics of suction head, conductivity and diffusivity, their estimation for unsaturated flow through porous media. Partial differential equations and their solutions. Theory of infiltration, infiltration model. Temperature and pressure aspects of soil water transport. Miscellaneous problems in unsaturated flow.

Suggested Readings

1. DeWiest, R.J.M. 1969. Flow Through Porous Media. Academic press, New York, USA.
2. Hillel, D. 1983. Fundamentals of Soil Physics. Academic press inc. Harcourt Brace Jovanovich Publishers, SanDiego, USA.
3. Haan, C.T., Johanson. H.P., Brakensick, D.C. 1982. Hydrologic Modelling of Small Watersheds. ASAE monographs no. 5, ASAE, Michigan, USA.
4. Fredlund, D.G., Rahardio, H., 1993. Soil Mechanics for Unsaturated Soils. John Wiley & Sons, inc. New York. USA.
5. Kirkhan, D., Powers, W.L. Lane. Advanced Soil Physics. John Wiley & Sons, inc. New York. USA.

Hydro-Chemical Modellingand Pollutant Management

SWC 622 **3(3+0)**

Course outcome

- Demonstrate understanding of hydrodynamics of fluid and pollutant transport through modelling.
- Capable to do water quality analysis of lakes and reservoir based physical and chemical characteristics.
- Develop water reclamation and water reuse plans for irrigation and industries.

Theory

Hydrodynamics in flow through porous media, Hydrodynamic dispersion, diffusion, convection equation.

Analytical and numerical models of contaminant transport in unsaturated soil profile and ground water.

Water quality management in lakes and reservoirs; physical characteristics; hydrologic and chemical budgets; bio geochemical processes of pollutants, assessment methods.

Classical wastewater problems; water reclamation, reuse, water quality constraints and considerations for reuse in irrigation and industry; Biological wastewater treatment.

Modern stream pollution problem. Quality of groundwater and sources of contaminants. Cost economics-environment impact assessment.

Suggested Readings

1. Larry W Mays 1996. Water Resources Handbook. Mc Graw Hill.
2. Metcalf and Eddey 1994. Wastewater Treatment Engineering and Reuse. John Wiley.
3. Soli J Arceivala 1998. Wastewater Treatment for Pollution Control. Tata Mc Graw-Hill.

Plant Growth Modelling & Simulation

SWC 623 **3 (2+1)**

Course Outcome

- After completion of course student will be able to know various plant growth models and their application based on input environmental parameters.
- Student will acquainted with generalized agricultural simulator.

Theory

Introduction to plant growth modelling, Simulation and simulation language, Types of models and modelling approaches, Relational diagram of principle process, Structure of a generalized agricultural simulator, Input environment and techniques for monitoring plant environment, Process and aspects of growth and development, Input yield models, Quantitative analysis of photosynthesis, respiration, growth, water and nutrient uptake, Yield functions. Remote sensing based modelling.

Practical

Identification of growth parameters, familiarization and use of different instruments used for investigation of various plant and crop parameters and their uses in respective measurements, usefulness of modelling and simulation studies, Field variability of growth influencing factors, Controlled environment experiments and their use, undertaking of the functioning of DSSAT, CERES, CROPWAT, SWACROP or other model, Model testing, calibration and validation.

Suggested Readings

1. Nobel, P.S. (1991). Physicochemical and Environment Plant Phsiology. Academic Press Inc. San Diego, CA, USA.
2. Goudriaan, J and Van Laar, H.H. (1994). Modelling Potential Crop Growth Process. Kluweer Academic Publisher, Dordrecht, Netherlands.
3. Levitt, J. (1972). Responses of Plants to Environment Stress. Academic Press, New York. USA.
4. Evans, L.T. (1963). Environmental Control of Plant Growth. Academic Press, New Yor, USA.
5. Charls-Edwards, D.A. (1981). The Mathematics of Photosysnthesis and Productivity Academic Press, London
6. Thorwey, J.H.M. and Johnson, I.R. (1990). Plant and Crop Modelling: A Mathematical Approach to Plant and Crop Physiology. Clarendon Press, Oxford
7. Jones, J.W. and Ritchie, J.T. (1990). Crop Growth Models. In: ASAE Monograph on Management of Farm Irrigation Systems, Editted by:G.J. Hoffman, T.A. Howell and K.H. Solomon, ASAE, St. Joseph, Michigan, USA

Advances in Irrigation and Drainage

SWC 624 **3 (2+1)**

Course Outcome

- After completion of course student will be familiar about Advance methods of Irrigation and Drainage, drainage material and various sources of agricultural pollution.
- Able to develop and apply simulation model for management of drainage system for particular area.

Theory

Advances in surface irrigation systems-surge irrigation : effect of surging on surface flow hydraulics, cablegation: water supply management.

Atomization in sprinkler and micro irrigation systems; multipurpose and special uses of micro irrigation.

Synthetic materials for drainage systems. Environmental issues related to drainage. Socio-economic impacts of drainage systems.

Controlled drainage for reducing agricultural non point pollution . Application of simulation models for drainage systems.

Practical

Based on theory and recent advances in the field.

Suggested Readings

1. FAO. 1082. Mechanized Sprinkler Irrigation. FAO Irrigation and Drainage Paper 35.
2. FAO. 1989. Guidelines for Designing and Evaluating Surface Irrigation System.FAO Irrigation and Drainage paper 45.
3. Keller J and Bliesner RD. 1990. Sprinkler land Trickle Irrigation. Chapman & Hall.
4. Ritzema HP. (Ed.) 1994. Drainage Principles and Applications. ILRI. Walker WR & Skogerboe GV. 1987. Surface Irrigation: Theory and Practice, Prentice Hall.

Command Area Development

IWM 514 **3 (2+1)**

Course outcome

- Able to understand the concept of command area and its development.
- Able to analyze problem diagnostics and remedies of command area.
- Able to understand the performance evaluation procedure if command area.

Theory

Concept of command area development as an integrated approach, Command area project formulation, Major, medium and minor projects, Various clearances involved for project approval, Command areas in India, Command area activities and their prioritization, Source of budget for

CAD works, Structure of command area development organization, legal aspects of natural resource development, Partnership among developers, managers and users of natural resources in a command area, Diagnostic analysis and perform appraisal of command area projects.

Practicals

Study of canal, tank and tube well in a command area, Study of design and operational parameters of a command area, Study of water balance in a command, Study the impact of command area project on crop yield and environment, Conflict resolution through PRA exercise, Diagnostic analysis of the problems of command area through PRA and field observations, Analysis of equity in water distribution, Considerations for preparation of rostering schedules, Study of the functioning of irrigation cooperatives/water user's associations, Preparation of command area development plan.

Suggested Readings

1. Kumar, P. (1977). Economics of Water Management. Heritage Publishers, New Delhi.
2. Garg, S.K. (1987). Hydraology and water resources engineering, Khanna Publishers, Delhi.
3. Michael, A.M. (2006). Irrigation theory and practice. Vikas Publications, New Delhi.
4. Sharma, R.K. (1987). Hydrology and water resources engineering, Dhanpat Rai & Sons, New Delhi.
5. Subramanya, K. (1993). Engineering hydrology, Tata Mc-Graw-Hill Co. Ltd. New Delhi.

Reclamation of Irrigated Lands

IWM 521 **3 (2+1)**

Course outcome

- Able to identify the various types of problematic soils.
- Develop competency for reclamation of problematic and water logged soils.
- Understanding of leaching requirement, Hydraulic conductivity and design of drainage system.

Theory

Causes of waterlogging and soil salinity in irrigated lands, Extent of waterlogging and soil salinity in arid and semi-arid lands, Field investigations of soil and water salinity components, Movement of water and salts, Control for seepage and leakage from canal network, Groundwater geology considerations, Quality of canal and ground water, Water balance, Salt balance, Use of amendments for reclamation or irrigated lands, Leaching of salts, Disposal of drainage water, Reuse of drainage water. Sensor based drainage system.

Practicals

1. Diagnosis of salinity and waterlogged area in a minor
2. Soil investigation of a watershed area pH, EC, SAR, etc.Hydraulic conductivity
3. Soil investigation of a saline areapH, EC, SAR, etc. Hydraulic conductivity
4. Determination of quality ofCanal andGroundwater

5. Calculation of amendments for reclamation of a saline area
6. Estimation of leaching requirement
7. Design of drainage system in a salt affected area

Suggested Readings

1. Ritzema, H.P. (Ed) (1994). Drainage Principles and Applications, Second Edition, International Institute for land Reclamation and Improvement; Wageningen. The Netherlands.
2. Singh, R.V. (Ed) (1991), Drainage and Salinity Control, Himanshu Publication, Udaipur.
3. Rao KVGK, Agrawal MC & Singh OP (1993), Reclamation and Management of Waterlogged Saline soils. CSSRI Karnal.

Irrigation Economics Planning and Management

IWM 522 **3(2+1)**

Course Outcome

- Able to estimate the cost benefit analysis, pricing and investment criteria on irrigation project evaluation and finding their problems.
- To impart the knowledge of various public and government policy on regulation and allocation of irrigation water.

Theory

Criteria for investment in irrigation projects. Economics analysis of irrigation projects, cost benefit analysis, pricing and investment criteria on irrigation project evaluation, social benefits, problems and causes of under-utilization.

Impact of public policies on regulation and allocation of irrigation water. Relative economic efficiency of alternative irrigation water management models irrigation system improvement by simulation and optimization.

Economic and social benefits of irrigation projects after institutional and legal aspects in the use of irrigation water. Technological changes and irrigation water use efficiency.Methods and approaches to water pricing.

Indian agriculture, main problems, population, government policies, systems, organizing agriculture production, socio-economic survey, importance of such survey in planning, implementation and evaluation of project performance.

Farm Management- definition, Importance, scope, relation with other sciences and its characteristics. Role of farm management principles in decision making for irrigated agriculture.

Socio–economic survey:- Data set and data point. Statistics main division and nature of statistics, planning of socio-economic survey.

Collection of data:- Primary and secondary data, questionnaires & schedules sampling, editing and scurting of secondary data, classification and tabulation and analysis of data.

Practicals

1. Exercise on cost benefit analysis.
2. Working out net present value anb BC ratio of irrigation project nearby Udaipur.
3. Exercise on par back period and internal rate of returns.
4. Exercise on interpretation of social benefits.
5. Field exercise on socio-economic survey schedule and interlink the respondents and collection of data.
6. Exercise on analysis of data and interpretation.
7. Field exercise on economic of irrigation crops and farms.

Suggested Readings

1. James, Douglas and Lee. Rober R-Economics of Water Resource Planning. Tata Mcgraw-Hill Publication Company Ltd., Bombay, New Delhi.
2. Sharma, V.K. (1985) Water Resource Planning and management. Himalaya Publication House, New Delhi.
3. Management of Water Project-Decision making and investment appraisal. Oxford Publication Co.
4. Heady, Early O.R. Hexem, Rogrew Water Production Functions for irrigated Agriculture.
5. Agarwal, A. N. Indian Economic Problens of Development and Planning.
6. Guidelines for project appraisal (1678). United Nations Publication.
7. Joshi, S.S. and T.R. Kapoor,(2001), Fundamentals of Farm Business management. Kalyani Publishers, Ludhiyana.

Water Conveyance and Distribution

IWM 523 **3 (2+1)**

Course outcome

- To develop the common understanding of different conveyance structure in canal irrigation network.
- Able to infuse the knowledge about different types of channel flow and their behavior.
- Able to gain the knowledge of appraisal of flow control and distribution structures.

Theory

Channel characteristics, Prismatic and non-prismatic channel, Steady, unsteady, uniform and non-uniform flow, Dimension-less representative parameters of flow behavior, Energy and momentum in open channel flow, Critical uniform, gradually varied rapidly varied and spatially varied flows and their computations, Energy dissipation, Flow control structures, Flow measurement, Theories and

methods of open channel design. Water conveyance through pipes – Design & evaluation. Methods of Seepage estimation and control measures – Lining Material.

Practicals

Computation and use of geometrical and hydraulic elements of open channel, Use of flow measuring devices and methods and their limitations, Examination of velocity distribution and calculation of energy and momentum coefficients, Solution of channel design problems, Appraisal of flow control and distribution structures, Analysis and computation of flow profiles.

Suggested Readings

1. Chaudhry M.H. (1993). Open channel Flow. Prentice-Hall, NJ.
2. Chow, Ven T. 1959. Open Channel Hydraulic, Mc-Graw Hill Book Co. New York.
3. Kinori, B.Z. (1970). Manual of Surface Drainage Engineering. Elsevier Publ. Co. Amsterdam.
4. Henderson, F.M. (1966). Open Channel Flow. Macmillan Co. New York.
5. USBR. (1977). Water Measurement Manual. United States Bureau of Reclamation.

Design of Sprinkler and Micro Irrigation Systems

IWM 524 **3 (2+1)**

Course outcome

- Able to hydraulic design of drip as well as sprinkler irrigation system for particular area and crop based on water requirement.
- Able to calculate uniform distribution of water and pressure distribution through entire system.
- Able to compute the size of pipe for conveying the flow of water in drip as well as sprinkler irrigation system.

Theory

Suitability of sprinkler and micro irrigation systems under Indian conditions. Basic hydraulics of sprinkler and micro irrigation system. Pipe flow analysis . Friction losses and pressure variation. Flow in nozzles and emitters. Design & evaluation of sprinkler and micro irrigation systems in relation to source, soil , climate and topographical conditions. Selection of pipe size, pumps and power units, layout distribution, efficiency and economics, Fertigation through sprinkler and micro irrigation systems.

Practicals

Based on theory and recent advances in the field.

Suggested Readings

1. Michael, A.M. 2006. Irrigation Theory and Practice. Vikas Publ. New Delhi.
2. Jensen, M.E. (Editor). (1983). Design and Operation of Farm Irrigation Systems, ASAE, Monograph No. 3. USA

3. James. L.G. (1988). Principles of Farm Irrigation System Design. John Wiley and Sons, New York, USA.
4. Withers, Bruce and Vipond, Stanley. (1974). Irrigation : Design and Practice. B.T. Batsford Ltd., London.
5. Sivanappan, R.K. (1987). Sprinkler Irrigation. Oxford and IBH Publishing Co. New Delhi.
6. Sivanappn,R.K. Padmakumari,O. and Kumar V.(1987). Drip Irrigation. Keeerthy Publishing House Coimbature.
7. Keller, J. and Karmeli, D. (1975). Trickle Irrigation Design. Rainbird Sprinkler Manufacturing Corporation. Glendora, California, USA
8. Karmeli, D., Peri, G. and Todes, M. (1985). Irrigation Systems: Design and Operation. Oxford University Press. Captown.

Design, Operation & Evaluation of Pressurized Irrigation System

IWM 611 **3(2+1)**

Course outcome

- Developing competency for hydraulic design of drip as well as sprinkler irrigation system for particular area and crop based on site situation.
- To develop the common understanding of filtration unit in drip and sprinkler irrigation and able to estimate the fertilizer requirement for particular crop.
- Able to assess the cost effective drip and sprinkler irrigation system for particular area and crop.

Theory

Filtration units, drip fertigation, Distribution uniformity of water, Pressure distribution in the system, Cost economics of different systems, Evaluation of micro and sprinkler irrigation system.

Basic hydraulics of sprinkler and drip system, Pipe flow analysis, Friction losses and pressure variation, Flow in nozzles and emitters, Design of sprinkler drip and micro irrigation system in relation to source, soil, climate and topographical conditions, Selection of pipe sizes, pumps and power units, layout distribution, efficiency and economics, Fertilizing through sprinkler and drip system. Pressurized irrigation networks system (PINs).

Practicals

Evaluation of various uniformities, Evaluation of pressure distribution, Efficiencies of filtration, Fertigation efficiency, and also based on theory and recent advances in the field.

Suggested Readings

1. Sivanappan, R.K. (1987). Sprinkler Irrigation. Oxford and IBH Publishing Co. New Delhi.
2. Finkel, H.J. (1983). Handbook of Irrigation Technology Vol. I CRC Press, Florida, USA.
3. Karmeli, D., Peri, G. and Todes, M. (1985). Irrigation Systems: Design and Operation. Oxford University Press. Captown.

4. ICID. (1988). Sprinkler Irrigation in India. Indian National Committee on Irrigation and Drainage, New Delhi.
5. Sivanappn, R.K. Padmakumari, O. and Kumar V. (1987). Drip Irrigation. Keerthy Publishing House Coimbature.
6. Keller, J. and Karmeli, D. (1975). Trickle Irrigation Design. Rainbird Sprinkler Manufacturing Corporation. Glendora, California, USA.
7. Pillsbury, A.F. (1972). Sprinkler Irrigation, FAO Agricultural Development Paper No. 88, FAO, Rome.
8. Mane & B. L. Ayare, Design Operation of Drip Irrigation, Jain Publications.
9. Mane & B. L. Ayare, Design Operation of Sprinkler Irrigation, Jain Publications.
10. ASABE, Design & Operation of Farm Irrigation System, 2nd edition.

Soil-Water-Plant Atmospheric System Modelling

IWM 613 **3(2+1)**

Course outcome

- After completion of course student will be able to make energy balance and water balance in soil and plant.
- Student will know about various theories for movement of water from soil to plants and from plants to atmosphere.

Theory

Radiation balance of earth's surface, Turbulent transport of heat and momentum, Radiation exchange and heat transfer in a low plant cover, Measurement of radiation, leaf and air temperature, humidity and wind profiles within plant cover, Predicting potential evapotranspiration, Thermodynamics of flow through plant cells, Dynamics of water movement through soil plant atmosphere system, Stomatal aperture, photosynthesis and actual evapotranspiration relationship, Production functions of evapotranspiration. Evaportranspiration in mathematical modelling and optimization of design and regulation of irrigation systems and for utilization of limited water resources in agriculture. Crop water requirement under protected cultivation & remote sensing based modelling.

Practicals

Based on theory and recent advances in the field.

Suggested readings

1. Deniel Hillel, Advances in Irrigation, All Volumes.
2. Gomtia N.K. and Tiwari K.N. 2008, Irrigation Scheduling and Crop water Stress using Remote sensing & GIS, Lamber Publication.

Minor Irrigation

IWM 535 **3 (2+1)**

Course Outcome

- Able to assess surface water resources and design surface water storage structures.
- Understanding of ground water development and assess safe yield of wells.
- Able to design groundwater development by selecting appropriate methods for drilling well design and pump.
- Able to perform groundwater development legislation, recharge and utilization practices.

Theory

Definition, scope, historical background and progress in minor irrigation works in India, Assessment of surface water resource, Design and operation of surface water storage structures, Evaporation and seepage control, Groundwater development methods and their scope, Groundwater extraction devices and methods, Aquifer characteristic and their evaluation, Wells in alluvial and rocky aquifers, Well interference, spacing and multiple well point system for controlled groundwater pumping, Safe yield from wells, Augmentation of well yield through pumping and recovery time management, Well design, drilling and construction, Tube well strainers, gravel packing and resistance to flow, Pumps and prime movers for groundwater lifting, Diagnosis of sick and failed wells and tube wells and their remediation, Conjunctive use of surface and groundwater, Legislation for groundwater development and management. Groundwater recharge & its use.

Practical

Measurement of seepage loss from reservoirs, Estimation of inflow to surface reservoir, Measurement of evaporation loss from surface reservoirs, Pumping test and determination of aquifer parameters, Establishment of draw down-discharge characteristic, Well log analysis and deciding on length and placement of strainers, Computation of well interference and deciding on well spacing, Estimation of irrigation for given discharge from well, Estimating pumping cost for irrigation, Analysis of ground water quality, Problems on well design.

Suggested Readings

1. Garg, S.K. (1987). Irrigation Engineering and Hydraulic Structures, Khanna Publisher, Delhi.
2. Garg, S.K. (1987). Hydrology and Water Resource Engineering, Khanna Publishers, Delhi.
3. Michael, A.M. (2006). Irrigation Theory and Practice. Vikas Publications, New Delhi.
4. Sharma, R.K. (1987). Hydrology and Water Resources Engineering, Dhanpat Rai & Sons, New Delhi.
5. Subramanya, K. (1993). Engineering Hydrology, Tata Mc-Graw-Hill Co. New Delhi.

Farm Irrigation Structures

IWM 536 **3(2+1)**

Course Outcome

- Able to handle the different water measurement instruments and calculate the flow rate from the channel.

- To gain the knowledge of different water control and diversion structure and their suitability and adoption under varying condition.
- Able to design the dugout farm pond, on and off stream farm pond and selecting essential site for constructing it.
- To develop the common understanding of material, testing, spacing and capacity of different pipe size.

Theory

Water measurement methods and devices; trapezoidal and cutthroat flumes, broad crested flume, tracer method of measurement.

Water control and diversion structures, their suitability and adoption under varying condition.

Structures for safe conveyance of Irrigation Water.

Farm water delivery and distribution system; Material for lining of water courses and field channels and their economics, earthen embankments and farm ponds

a) Types of earthen embankments, foundation requirements, design to suit available materials, seepage through the embankment, foundation treatments, compaction and settlement, Mechanical and emergency spillway. Design for stability; construction, protection and maintenance, cost estimates.

b) Types of ponds and reservoir; dug out ponds, on-stream ponds and off-stream ponds, essential requirements for ponds, site selection, design and cost estimates.

Irrigation with saline water, Environmental impact of Irrigation.

Underground pipe line irrigation distribution system, types of pipe materials, testing of pipes, spacing and capacity of pipe line, installation, structures for the evaluation of different irrigation system.

Practicals

- Water measurements by trapezoidal, cut throat flume etc. in a farm irrigation channel.
- Design and cost estimation of drop spillway and drop inlet spillway for a specific location.
- Test against sliding, overturning and rupture for drop spillway and drop inlet spillway.
- Study of seepage losses in a farm channel.
- Design and cost estimates of farm pond.

Suggested Readings

- Michael, A. M. 2006. Irrigation Theory and Practices, Vikas Publishing House Pvt. Ltd., New Delhi.
- Sally, H. L. 1965. Lining of Earthen Irrigation Channel. Asia Publishing House, Bombay.
- Schwab, G. O., D. D. Fangmeier, W. J., Elliot and R. K. Frevert 1993. Soil and Water Conservation Engineering. Fourth Edition, John Wiley and Sons, Inc. New York.
- Varshney, R. S. S. C. Gupta and R. L. Gupta 1979. Theory and Design of Irrigation Structures Vol. II, Nem Chand & Bros. Roorkee.

Note:

1. For supporting courses course description, which are offered by other departments, refer separately syllabus of that particular department.
2. For syllabus of Non-Credit Compulsory Courses, see at the end.

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IRRIGATION WATER MANAGEMENT ENGINEERING

VISION

To create a centre of excellence, foster high standards and orient teaching, research and extension program of Soil and Water Engineering towards future needs and opportunities through involvement of various stake holders.

MISSION

Impart education and knowledge to the students to make them competent enough in the areas of soil and water conservation, hydrology, irrigation management, groundwater development and water resource management. Further, enable them entrepreneurship oriented by offering the courses and training programs of global standards with optimal mix of inputs on electrical, mechanical and computer science engineering. The course is fully devoted to provide need based quality education in all the major areas for perspective engineers. So the skill developed by the course will not only contribute in their personal development, prosperity of the society, state and the nation as a whole but also build a leading and successful career in this direction and work in rural areas for the development of farmer's community.

Program Educational Objectives

1. To provide the student with a sound foundation in the irrigation and drainage engineering fundamentals. A post graduate students must be able to understand new emerging technologies and to engage in an irrigation and drainage system design and installation.
2. A post graduate students must have sound understanding of the irrigation and related fields and necessary perspective to pursue work in irrigation related industries and fields so as to cover the whole common understanding of irrigation engineering research.
3. To develop analytical and logical aptitude among the students to quickly adapt to new work, new challenges, assimilate new information, and solve new problems.
4. To provide exposure of new cutting edge technologies to the students and to motivate them to take up new challenges to solve the problems faced by society and nation through research and development.

Program outcome

1. To develop the competency of managing the irrigation and drainage engineering under dynamic process and improving irrigation water management by incorporating elements of soil systems in command area development. Also enhanced the effective and efficient use of scare water resources focusing on improved crop productivity with minimum water use.

2. Able to work with regional as well as the national governmental and nongovernmental organizations in the irrigation projects and natural water resources development. Use of real-time irrigation scheduling for the crop in mitigating crop water requirement with help of new emerging techniques such as drip irrigation and sprinkler irrigation.
3. To develop the competency of phenomenon such as surface and ground water for conjunctive use planning in the command area for maximizing the net employment, production, labor in the command area.
4. To develop the proficiency for estimating the potential rate of discharge of channels for managing the demand and supply with ascertain the water quality.
5. To develop the competency about the design and installation of pressurized irrigation system for increasing water use efficiency, uniformly distribution of water and decreasing the fertilizer used in the field for accommodating the maximum crop yield.
6. Ripeness of improved agricultural drainage by less cost and more effective techniques for removing excess water used in the field.

Semester-wise Scheme for Post Graduate Programme in Irrigation Water Management Engineering

Details of courses offered for the award of M.Tech. (Ag.), IWME

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV
Core Courses: Total 12 credits; 2 courses in first semester (6 credits) and 1 course each in second and third semester (3 credits each) to be evaluated externally.						
Irrigation Planning and Management	IWM511	3 (2+1)	3			
Design of Surface Irrigation Systems	IWM 512	3 (2+1)	3			
Reclamation of Irrigated Lands	IWM 521	3 (2+1)		3		
Design of Agricultural Drainage System	IWM 531	3 (2+1)			3	
Optional Courses: Total 15 credits; two courses in first & second semester each (6 credits in each semester) and one course in third semester (3 credits).						
Social Aspects of Irrigation Management	IWM 513	3 (2+1)	3			
Command Area Development	IWM 514	3 (2+1)	3			
Aquaculture Engineering	IWM 515	3 (2+1)	3			
Irrigation Economics Planning and Management	IWM 522	3 (2+1)		3		
Water Conveyance and Distribution	IWM 523	3 (2+1)		3		
Design of Drip & Sprinkler Irrigation System	IWM 524	3 (2+1)		3		
Minor Irrigation	IWM 535	3 (2+1)			3	
Farm irrigation structures	IWM 536	3 (2+1)			3	
Minor & Supporting Courses: Total 9 credits; one course in first, second and third semester each (3 credits in each semester).						
Watershed Hydrology	SWC 511	3 (2+1)	3			
Ground Water Engineering	SWC 512	3 (2+1)	3			
Open Channel Flow	SWC515	3 (2+1)	3			
Soil-Water-Plant Relationship	SWC 517	3 (2+1)	3			
GIS & Remote Sensing for Resources Management	SWC 522	3 (2+1)		3		
Water Resources Systems Engineering	SWC 525	3 (2+1)		3		
Advanced programming with “C++”	CSE 511	3 (1+2)	3			
Higher Mathematics	BS 515	3 (3+0)	3			
Statistical Methods	AST 510	3 (2+1)	3			
Crop Environmental Engineering	SWC 535	3 (2+1)			3	
Design of Pumps for Irrigation & Drainage	SWC 536	3 (2+1)			3	
Dryland Technology	SWC 537	3 (2+1)			3	
Others						
Compulsory Courses; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/ 502/...	1	NC	NC		
Seminar (0+1)	IWM 532	1	-	-	1	-

Comprehensive	IWM 533	NC			NC	
Research (Thesis). Thesis minimum duration 2 semesters	IWM 534	20	-	-	-	20
Total credits to be offered (for Master Programme)		**57**	**15**	**12**	**10**	**20**

COURSE SUMMARY

Courses	**No. of Courses**					**Credit Hours**
	Semester					
	I	**II**	**III**	**IV**	**Total**	
Core	2	1	1	-	4	12
Optional	2	2	1	-	5	15
Minor & Supporting	1	1	1	-	3	9
Seminar	-	-	1	-	1	1
Comprehensive	-	-	-	1	1	Non Credit (graded as satisfactory/ non satisfactory)
Research (Thesis)	-	-	-	1	1	20* (graded as satisfactory/ non satisfactory)
Compulsory Courses (PGS Series)	1	1	-	-	2	Non Credit
Total	**6**	**5**	**4**	**2**	**17**	**57**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

Details of courses offered for the award of Ph.D. (Ag. Engg.) IWME

Course Title	Course No.	Credit Hours	Semester			
			I	II	III	IV-VI
Core Courses: Total 6 credits (3 credits in each semester); one course in first semester and one course in second semester to be evaluated externally.						
Design, Operation & Evaluation of Pressurized Irrigation System	IWM 611	3 (2+1)	3			
Advances in Irrigation Water Management	IWM 621	3 (2+1)		3		
Optional Courses: Total 12 credits (6 credits in each semester); two course in first and second semester each.						
Social Aspects of Irrigation Management	IWM 513	3 (2+1)	3			
Command Area Development	IWM 514	3 (2+1)	3			
Aquaculture Engineering	IWM 515	3 (2+1)	3			
Irrigation Economics Planning and Management	IWM 522	3 (2+1)		3		
Water Conveyance and Distribution	IWM 523	3 (2+1)		3		
Design of Drip & Sprinkler Irrigation System	IWM 524	3 (2+1)		3		
Minor Irrigation	IWM 535	3 (2+1)			3	
Farm irrigation structures	IWM 536	3 (2+1)			3	
Modelling of Evapotranspiration	IWM 612	3 (2+1)	3			
Soil Water Plant Atmospheric System Modelling	IWM 613	3 (2+1)	3			
Advanced drainage Engineering	IWM 614	3 (2+1)	3			
Water Resources System Analysis	IWM 622	3 (2+1)		3		
Reservoir Operation and River Basin Modelling	IWM 623	3 (2+1)		3		
Advanced Hydro-Mechanics in Soil Aquifer Systems	IWM 624	3 (3+0)		3		
Minor & Supporting Courses: Total 9 credits; two courses in first semester (6 credits) and one course in second semester (3 credits).						
Watershed Hydrology	SWC 511	3 (2+1)	3			
Ground Water Engineering	SWC 512	3 (2+1)	3			
Open Channel Flow	SWC515	3 (2+1)	3			
Soil-Water-Plant Relationship	SWC 517	3 (2+1)	3			
Advanced Hydrology	SWC 611	3 (2+1)	3			
Unsaturated Flow through Porous Media	SWC 614	3 (2+1)	3			
GIS & Remote Sensing for Resources Management	SWC 522	3 (2+1)		3		
Water Resources Systems Engineering	SWC 525	3 (2+1)		3		
Plant Growth Modelling and Simulation	SWC 623	3 (2+1)		3		
Advanced programming with “C++”	CSE 511	3 (1+2)	3			
Higher Mathematics	BS 515	3 (3+0)	3			
Statistical Methods	AST 510	3 (2+1)	3			
Finite Element Analysis	ME 610	3 (2+1)	3			
Data Structures & Algorithms	CSE 621	3 (2+1)		3		
Crop Environmental Engineering	SWC 535	3 (2+1)			3	

Design of Pumps for Irrigation & Drainage	SWC 536	3 (2+1)			3	
Dryland Technology	SWC 537	3 (2+1)			3	
Others						
Compulsory Courses; {(0+1) or (1+0)} Non Credit (NC); PGS Series	PGS501/ 502/...	1	NC	NC		
Seminar	IWM 691/ 692	1 (0+1)	1	1	-	-
Preliminary	IWM 633	NC			NC	
Research (Thesis). Thesis minimum duration 4 semesters	IWM 634	45	-	-	-	45
Total credits to be offered		**74**	**16**	**13**	**-**	**45**

Note: A Ph.D. student must take two 600 series core courses. A student may choose optional/minor & supporting courses of 500 series courses if not studied during Masters Programme as per ICAR guidelines.

\+ Exempted for those who have cleared these in Master's Programme (permission to be sought from the Dean, CTAE).

COURSE SUMMARY

Courses	No. of Courses							Credit Hours
	Semester							
	I	II	III	IV	V	VI	Total	
Core	1	1					2	6
Optional	2	2					4	12
Minor & Supporting	2	1					3	9
Seminar	1	1					2	2
Preliminary			1				1	Non Credit (graded as satisfactory/ non satisfactory)
Research (Thesis)						1	1	45* (graded as satisfactory/ non satisfactory)
Compulsory Courses** (PGS Series)	1	1					2	Non Credit
Total	**7**	**6**	**1**			**1**	**15**	**74**

*Research (Thesis) credit load is not counted in calculation of final OGPA.

**Exempted for those who have cleared these in Master's Programme.

SYLLABUS

IRRIGATION WATER MANAGEMENT ENGINEERING

Note: For courses, which are same as per the Soil and Water Conservation Engineering (M.Tech. & Ph.D.) programmes, refer syllabus of SWCE.

Irrigation Planning and Management

IWM 511 **3(2+1)**

Course outcome

- Understanding of irrigation technologies and systems.
- Able to develop irrigation schedule and canal water distribution and operation.
- Assessment and appraisal for water availability in command area.
- Able to evaluate performance of irrigation projects based on water delivery.

Theory

Basic terminology used in planning of irrigation projects, Duty of water, its determination and factors affecting it. Methods of improving duty of canal water.

Canal Scheduling, Assessment and appraisal of water availability in command areas, preliminary planning and investigation in irrigation project formulation, Socio economic aspects of irrigation management, Water management problems in command areas and their possible remedies.

Multi objective command area planning for the better management of Irrigation Water, Conjunctive use of canal and groundwater. Root zone water balance, Water allocation, Real Time Irrigation Scheduling, Performance appraisal of irrigation projects- equity, adequacy. Design of On Farm Water Distribution Network.

Practicals

1. Review of main features of some major irrigation projects.
2. Review of literature regarding evapotranspiration.
3. Problems on determination of evapotranspiration by climatological methods
4. Problems on irrigation scheduling.
5. Problems on determination of duty.
6. Review on canal operation methods.
7. Development of crop coefficient curves.

Suggested Readings

1. Doorenbos, J. and W. O. Pruitt. (1977). Guidelines for Predicting Crop Water requirement, Irrigation and Drainage Paper No. 24, FAO, UN, Rome.
2. Michael, A. M. (2006) Irrigation-Theory and Practices, Vikas Publishing House Pvt. Ltd., New Delhi. 799 pp.
3. Annonymous, (1982), Organization, Operation and Maintenance of Irrigation Schemes, Irrigation and Drainage Paper No. 40, FAO, UN, Rome. 189 pp.
4. T. B. S. Rajput and A. M. Michal, (1990). Scheduling of canal deliveries. Application of the Integrated Canal Scheduling Model, Irrigation and Power Journal 47(1): 17-39.
5. L. Kalu, G. N. Paudyal and A. Dasgupta, (1995). Equity and Efficiency issues in Irrigation Water Distribution. Journal of Agric. Water Management, 28(4): 335-348.
6. Rao P. and S.R. Bhakar (2008) Irrigation Engineering, Theory and Practice. Agrotech Publishing Academy, Udaipur.

Design of Surface Irrigation System

IWM 512 **3(2+1)**

Course outcome

- Selection of suitable method of surface irrigation based on land irritability and infiltration characteristics.
- Design and evaluation of various surface irrigation methods.
- Design optimum layout, conveyance network for efficient use water in surface irrigation system.

Theory

Historical evidence of development and progress of farm irrigation systems, Land irrigability, Theory of Infiltration and its measurement, Methods of irrigation-their selection and suitability, Surface Irrigation Systems- Water advance, wetting, depletion and recession in surface irrigation, field data and performance measures of surface irrigation systems, evaluation and design of surface irrigation methods- border, basin and furrow method, surge irrigation and adaptability and design, irrigation scheduling and equity in water distribution, optional layout of conveyance network-shortest root and minimum tree spanning tree approach.

Practicals

Infiltration test and mathematical representation of the test result, Estimation of required irrigation depth based on soil moisture analysis, Calculation of irrigation efficiencies, Design and evaluation of irrigation methods, Developing irrigation plan for a project, measurement of seepage loss, preparation of irrigation water distribution rosters for beneficiaries under different methods of water distribution.

Suggested Readings

1. Michael, A.M. (2006). Irrigation Theory and Practice. Vikas Publ. New Delhi.
2. Jensen, M.E. (Editor). (1983). Design and Operation of Farm Irrigation Systems, ASAE, Monograph No. 3. USA.
3. Walker, W.R. and G.V. Skogerboe. (1987). Surface Irrigation: Theory and Practice Prentice-Hall Inc. New Jersey, USA
4. James. L.G. (1988). Principles of Farm Irrigation System Design. John Wiley and Sons, New York, USA.
5. Withers, Bruce and Vipond, Stanley. (1974). Irrigation: Design and Practice. B.T. Batsford Ltd., London.
6. Rao, P and S.R. Bhakar (2008) Irrigation Theory and practice. Agrotech Publishing Academy, Udaipur.

Design of Agricultural Drainage System

IWM 531 **3 (2+1)**

Course outcome

- Able to develop surface as well as subsurface drainage network in the agriculture field.
- Able to install and laying the drainage pipe with fitting of all accessories at their place.
- Able to derive equation for different flow in drainage system and their approaches.

Theory

Drainage coefficient. Theories of surface and subsurface drainage, Hydrologic and hydraulic design of drainage system.

Study of application of various theories in drainage design, Concepts of vertical and bio-drainage, Water table control, Salt balance and leaching requirement.

Drainage methods and layout, Physical and conceptual models for drainage studies, Drainage materials, machinery and structures, Performance evaluation of drainage systems, Alternatives to conventional drainage. Economics implication of drainage, Case studies of drainage systems

Capillary potential, Devices to measure capillary potential. Drainage criteria, Flow equations in general and the approach, Flow problem and physical artifices.

Practicals

1. Verification of Dacry's law by the use of sand and soil and comparison of hydraulic conductivity values in laboratory model.
2. Determination of hydraulic conductivity of soil below water table by auger hole method.

3. Determination of hydraulic conductivity of soil above water table.
4. Measurement of sub-surface drain flow and verification from the drain spacing under field ponded conditions.
5. Simple solutions of drainage problems using electric analogue and teledeltos paper.
6. Use of Hele shaw model for solution of drain spacing problems.

Suggested Readings

1. Ritzema, H.M. (Editor in Chief). (1994). Drainage Principles and Applications (2nd edition), International Instt., of land Reclamation and Improvement, Post Box-45, Wageningen. The Netherlands.
2. Smedema, L.K. and Rycroft, D.W. (1988) and Drainage (Planning and design of agricultural drainage systems). B.T. Batsford Ltd., London.
3. Schilfgaarde, Jan Van. (Editor) (1974). Drainage for Agriculture Agronomy Monograph No. 17, American Society of Agronomy, USA.
4. Luthin, James N. (Editor) (1957). Drainage of Agricultural Lands, Agronomy Monograph No. 17, American Society of Agronomy, USA.
5. Rao, K.V.G.K., Agarwal, M.C. Singh, O.P. and Osterbaan, R.J. (Editor). (1995). Reclamation and Management of Waterlogged Saline Soils (National Seminar Proc.), CSSRI, Karnal and HAU, Hissar.
6. Singh, R.V. (1991). Drainage and Salinity Control, Himanshu Publications, Udaipur.
7. Kirkham D. and Powers, W.L. 1972. Advanced Soil Physics. Inter Science, New York.

Advances in Irrigation Water Management

IWM 621 **3 (2+1)**

Course outcome

- Able to exploration of water management problems and finding out their remedies.
- To develop the common understanding irrigation scheduling and able to do real time irrigation schedule for particular crop.
- Able to design on farm water distribution networks and construct the sensor network for atomizing the system network.

Theory

Multi objective command area planning for better management of irrigation water and command analysis of irrigation projects. Water management problems and their possible remedies in command area. Conjunctive use of canal and groundwater. Roozone water balance, water allocation, unit command area management, Real time irrigation scheduling, diagnostic analysis for evaluation, design of on farm water distribution networks. Sensor based automatic irrigation system. Crop water stress for irrigation management.

Practicals

Based on theory and recent advances in the field.

References

1. Daniel Hillel 1994. Advances in Irrigation Vol 1 & II CRC press.
2. R.G. Allen, L.S. Pereira, D. Raes, M. Smith 1998, Crop Evapotranspiration, FAO Irrigation & Drainage paper no. 56.
4. Gomtia N.K. and Tiwari K.N. 2008, Irrigation Scheduling and Crop water Stress using Remote sensing & GIS, Lamber Publication.

Social Aspects of Irrigation Management

IWM 513 **3(2+1)**

Course outcome

- Able to develop the sociometric ranking, wealth ranking and time diagram of particular command area for planning and management.
- Able to the take experience which will have spending time for collecting the data in command area by the help of villagers and their participation approach.

Theory

The role and importance of communication, motivation and leadership styles in irrigation water management. Rural sociology concept and their application to irrigation systems. Organizational analysis (Departmental as well as farmer groups) Water laws, institution and farmer water use organization.

Factors producing social and cultural changes under irrigated condition. SWOT analysis of irrigation projects.

Role of Agricultural leaders and change agents in communication of irrigation innovation in the context of rural social systems. Training methods,and training aids .

System analysis of socio-institutional aspects of irrigation systems and project.

Farmer,s typology in terms of adoption of irrigation technology and factors affecting its adoption.

Participatory Rural Appraisal techniques and its use in irrigation management.

Participatory irrigation management efforts and strategy for preparing PIM.

Participatory drainage management, Warabandhi, its types and advantages

Water users association – functions, problems encountered during formation of WUA and stretergy and overcome the problems.

Socio-economic issues in irrigation development and distribution.

Practicals

The student will visit villages of those Panchayat Samities where irrigation management work/projects are in operation. Besides this, they will be required to study various social aspects of irrigation management in the adopted villages of nearby Panchayat Samities. The following practical exercise will be completed:

1. Identification of leaders in the community.
2. Bench mark survey of the irrigation project.
3. Study of various sources of irrigation and their management practices.
4. Study analysis of the social constraints in the effective management of irrigation water.
5. Preparation and use of various aids for transferring irrigation technology.
6. Preparation of model irrigation system/project keeping in view the economic, physical, agricultural and environmental aspects of the area visited.

Suggested Readings

1. Reddy, A. A. (1987). Extension Education. Sree Lakshmi Press, Bapatta (AP)
2. Chitambar, J. B. Introductory Rural Society. Wilsey and Eastern Limited, New Delhi.
3. Joshi, L. K. and Hooga, Rakesh (2000). Participatory irrigation management. Parading for the 21st Century. Rewat Publication Jaipur.
4. Hooga, Rakesh, Bawer, R. C. and Mundra, S. N. (1997). Irrigation, Agriculture and Social Development. Himanshu Publication, Udaipur.

Aquaculture Engineering

IWM 515 **3 (2+1)**

Course outcome

- Able to develop and design Aqua cultural project.
- Able to design and develop water harvesting structures with special reference to particular fish species.

Theory

Aqua cultural project layout and planning, Types of pond and their design, Determination of earthwork volume, Source of water and pumping devices, Surface and subsurface flow schemes for water supply, Design of channels, Design of drainage system of aqua cultural farms, Design of monk and their construction procedure, Formulation of mathematical models for different aqua cultural operations, Design of earthen and cemented fish raceways with and without water re-circulatory system, Functional design of biological and mechanical filters, Design of fish ladders and fish lifts, Design of aeration equipment for aqua cultural ponds.

Practicals

Biochemical analysis of pond water, performance testing of aquaculture machinery, design of fish tanks for specific conditions including the earth work & costing, studies on effect of microclimatic parameters on fish and the analysis of data, development of decision support systems for different acquacultural production systems, storage and packaging of fish and fish products.

Suggested Readings

1. Yoo, K.H. and Boyd, C.E. (1993). Hydrology and Water Supply for Pond Aquaculture, Chapman and Hall. New York, USA
2. Wheaton, F.W. (1977). Aquacultural Engineering. John Wiley and Sons.
3. Lawson, Thomas, B. Fundamentals of Aquacultural Enginering. CBS Publishing and Distributors, 4596/IA, 11-Dayaganj, New Delhi.
4. Bose, A.N. Ghosh, S.N. C.T. and Mitra, A. (1991). Coastal Aquacultural Engineering. Oxford and IBH Publishing Co. New Delhi.

Modelling of Evapotranspiration

IWM 612 **3(2+1)**

Course Outcome

- Able to understand the theories of Evaporation fluctuation and profile from pan and water surface.
- Able to calculate the evapotranspiration of particular area.
- Able to gain the knowledge of water movement through soil-plant atmosphere system.
- Able to derive the empirical equation of evapotranspiration.
- Able to use the remote sensing tools for calculating the evapotranspiration and develop the model for it.

Theory

Evaporation from water areas and evaporation from pans, aerodynamics of evaporation, fluctuation and profile theory, energetics of evaporation, radiant energy, sensible and latent heat energy, bown ratio, energy balance. Combination of aerodynamics and energy balance approach. Solar radiation, definition of solar radiation, utilization of solar radiation by crops, measurements of solar radiation. Humidity, Wind profile.

Dynamics of water movement through soil plant atmosphere system (five theories). Evapotranspiration, Estimation of Evapotranspiration (different methods). Energy balance and combination methods. Empirical method. Lysimetry, classification of lysimeters. Scheduling of irrigation using meteorological data.

Use of crop water, Remote sensing based ET Models.

Practicals

1. Measurement of wet bulb and dry bulb temperatures and relative humidity.
2. Measurement of wind speed by anemometer.
3. Measurement of sunshine hour.
4. Measurement of solar radiation.
5. Estimation of solar radiation.
6. Estimation of long wave radiation and net radiation.
7. Measurement of evaporation from USWB class A pan.
8. Study of lysimeter and measurement of evapotranspiration.
9. Estimation of evapotranspiration by different methods.
10. Scheduling of irrigation of crops.

Suggested Readings

1. R. Lal. 1978. Irrigation Hydraulics. Saroj Prakasan, Allahabad.
2. Micheal, A. M. 2006. Irrigation-Theory and Practices, Vikas Publishing House Pvt. Ltd., New Delhi.
3. R. M. Hagan, H. R. Haise and T. W. Edminster (Editors). 1967. Irrigation of Agricultural Lands. Monograph No. 11, American Society of Agronomy, Madison, Wisconsin, USA.
4. M .E. Jensen (Ed.) 1983. Design and operation of Farm Irrigation Systems. ASAE Monograph No. 3, American Society of Agricultural Engineering, St. Joseph, Michigan, USA.
5. M. J. Rosenberg, B. L. Blad and S. B. Verma. 1983. Micro climate. The Biological Environment. John Wiley and Sons, New York.
6. Gontia N.K. & Tiwari K.N. 2008, Irrigation Scheduling & Crop water Stress using Remote sensing & GIS, Lamber Publication.

Advance Drainage Engineering

IWM 614 **3 (2+1)**

Course outcome

- Able to derive equation for different flow and understand their approaches in drainage channels.
- To develop the common understanding of physics of land drainage, forces and energy form in soil water and their effect on surface tension of soil and its criteria.

Theory

Physics of land drainage, forces and energy in soil water, surface tension and energy effects water, Energy of soil water, Capillary potential, Devices to measure capillary potential, Hystersis, Darcy's law .

Laplace equation its derivation and solution in various forms, Boundary value problems, Liner flow laws and Laplaces equation, Drainage criteria saturated flow theory, Steady flow, Non steady flow, Flow equations in general and the approach, Flow problem and physical boundary condition.

Practical

Based on theory and latest advances in the field.

References

1. Kirkham D land Powers, W.L. 1972. Advanced Soil Physics. Inter Science, New York.
2. Schillgaardo Jan Van (Editor 1974) Drainage for Agriculture. Monograph No. 17. American Society of Agronomy Madison, Wisconsin, USA.
3. Drainage Principles and Applications, 1974. Theories of Field Drainage and Watershed Bunoll (Vol. II) Publication No.16, International Institute of land Reclamation and Management. The Netherlands.
4. Singh R.V. 1991 Drainage and Salinity control. Himanshu Publication, Udaipur.

Water Resources Systems Analysis

IWM 622 **3 (2+1)**

Course outcome

- Able to understand the major reservoir systems with demand management.
- Able to prepare water allocation, demand and supply management programs using computer programs.

Theory

Water resources of India and competitive demands for water, Use and requirement of water for agriculture, Water resources systems, Decision variables, state variables, policy space, system parameters, Objective function, Deterministic and stochastic models, Optimization techniques, commensurate and non-commensurate objectives, Project evaluation, net present worth, benefit: cost analysis. Internal rate of return, Production function.

Practicals

Assessment of water resources, Problems related to water allocation in agriculture under single and multiple cropping system, Use of computer software for linear and dynamic programming, Introduction to the use of other programming methods, Sensitivity analysis of different alternatives of water resources development and allocation, Analysis of water demand and supply, Analysis of Competitive demands for water by various sectors of development, Benefits and cost of water resources development.

Suggesting Readings

1. Loucks, D. P. et al. (1981). Water Resources System Analysis. Prentice Hall Inc. NJ.
2. Helweg, O. J. (1985). Water Resources Planning and Management. John Wiley and Sons. New York.
3. Chaturvedi, M. C. (1987). Water Resources System Planning and Management. Tata McGraw Hill, New Delhi.

Reservoir Operation and River Basin Modelling

IWM 623 **3(2+1)**

Course outcome

- To impart the knowledge of water resource system analysis, technique, concept and their objective and application for planning of water resources.
- To develop the stochastic and deterministic model of river basin.
- Able to formulate the stream flow analysis and estimate the flow and reservoir storage.

Theory

Water resources system analysis - techniques, concept, objectives and applications. Identification and evaluation of water management plans, demand analysis, policy formulation, water resources

planning objectives, water resources planning under uncertainty. Deterministic river basin modelling - stream flow estimation, estimating reservoir storage, mass diagram analysis, sequent peak analysis, single and multi reservoir operation models, deterministic river basin planning model, model formulation and solution.

Stochastic river basin modelling - single reservoir design and operation, multisite river basin models, stochastic linear programming operation models.

Practical*

Based on theory, model formulation and solution.

Suggested Readings

1. Loucks, D. P. et al. (1980). Water Resources System Planning and Analysis. Prentice Hall, NJ.
2. Chaturvedi, M. C. (1984). System Approach to Water Resources Planning and Management.
3. Major, D. C. and Lenton, R. L. (1979). Applied Water Resources System Planning, Prentice Hall Inc. New Jersey.

Advanced Hydro-Mechanics in Soil Aquifer Systems

IWM 624 **3(3+0)**

Course outcome

- Able to understand complex mechanics movement of water in soil systems.
- Able to estimate the statistical parameters for better understanding of soil aquifer system.

Theory

Soil aquifer system. Flow of water in partially saturated soils. Partial differential equation of flow.

Determination of unsaturated hydraulic conductivity and models for its estimation.

Infiltration and ex-filtration from soils in absence and presence of water table. Movement of groundwater in fractured and swelling porous media.

Spatial variability, Theory of krigging. Statistical approaches in soil water dynamics.

Practical

Based on theory, and recent advances in the field.

Suggested Readings

1 Kirkham & Powers.1972. Advanced Soil Physics. John Wiley & Sons.

2. Muskut M.1937. The Flow of Homogeneous Fluid through Porous Media. McGraw Hill.

Note:

1. For supporting courses course description, which are offered by other departments, refer separately syllabus of that particular department.
2. For syllabus of Non-Credit Compulsory Courses, see at the end.

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COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's Programme in all disciplines; Optional for Ph.D. scholars)

CODE	COURSE TITLE	CREDITS
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
PGS 503	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE(e-Course)	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES(e-Course)	1+0
PGS 506	DISASTER MANAGEMENT(e-Course)	1+0

Note: Any Two from above listed courses as proposed by the ICAR.

SYLLABUS

Library and Information Services

PGS 501 **0+1**

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modem tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

Technical Writing and Communications Skills

PGS 502 **0+1**

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

Chicago Manual of Style. 14,h Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins.

Gordon HM & Walter J A. 1970. *Technical Writing.* 3 rd Ed. Holt, Rinehart & Winston.

Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English.* 6[1] Ed. Oxford University Press.

James HS. 1994. *Handbook for Technical Writing.* NTC Business Books.

Joseph G.2000.*MLA Handbook for Writers of Research Papers.* 5thEd. Affiliated East-West Press.

Mohan K. 2005. *Speaking English Effectively.* MacMillan India.

Richard WS. 1969. *Technical Writing.* Barnes & Noble.

Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language.* Abhishek.

Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English.* 2nd Ed. Prentice Hall of India.

Wren PC & Martin H. 2006. *High School English Grammar and Composition.* S. Chand & Co.

Intellectual Property and Its Management in Agriculture (e-Course)

PGS 503 **1+0**

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy. Theory Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural technology.* CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy.* McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer.* Vol.V. *Technology Generation and IPR Issues.* Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics.* CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies.* Daya Publ. House. *The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.*

Basic Concepts in Laboratory Techniques

PGS 504 **0+1**

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety.* CRC Press.

Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions.*Chemical Publ. Co.

Agricultural Research, Research Ethics and Rural Development Programmes (e-Course)

PGS 505 **1+0**

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group -Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co- operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. *Indian Agriculture - Four Decades of Development.* Sage Publ.

Punia MS. *Manual on International Research and Research Ethics.* CCS, Haryana Agricultural University, Hisar.

Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives.* Mittal Publ.

Singh K. 1998. *Rural Development - Principles, Policies and Management.* Sage Publ.

Disaster Management (e-Course)

PGS 506 **1+0**

Objective

To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

Theory

UNIT I

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming. Sea Level rise. Ozone Depletion

UNIT II

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community- based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

Suggested Readings

Gupta HK. 2003. *Disaster Management.* Indian National Scienc Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management.* Routledge.

Sharma VK. 2001. *Disaster Management.* National Centre for Disaster Management, India.

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