UNDER GRADUATE
COURSE CATALOGUE
2025

CHAUDHARY CHARAN SINGH HARYANA AGRICULTURAL UNIVERSITY HISAR-125004

(A+ Grade NAEAB-ICAR ACCREDITED)

Foreword

It gives me immense pleasure to present the Undergraduate Academic Catalogue of Chaudhary Charan Singh Haryana Agricultural University, Hisar, developed in adherence to the academic guidelines laid down by the Indian Council of Agricultural Research (ICAR) and the holistic vision of the National Education Policy 2020 (NEP 2020).

This catalogue encompasses a wide array of undergraduate programmes-B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Tech. (Agricultural Engineering), B.Tech. (Biotechnology), B.Sc. (Hons.) Community Science and B.F.Sc. reflecting our institution's comprehensive and forward-looking approach to agricultural education.

Rooted in academic excellence and enriched with hands-on learning, the curriculum is crafted to develop skilled, innovative and socially responsible professionals. The NEP 2020's emphasis on multidisciplinary education, flexibility and learner-centric models is well-embedded in the structure of this catalogue. It is designed to empower students with critical thinking, entrepreneurial aptitude, ethical grounding and global awareness-traits essential for addressing the challenges and opportunities of the 21st century agri-food systems.

As we move toward a future of sustainable agriculture, climate resilience and technological integration, this academic catalogue stands as a guiding document that aligns education with employability, research with relevance and tradition with transformation.

I congratulate the all contributing faculty members, Dr. S.K. Pahuja (Dean, College of Agriculture and College of Agricultural Engineering & Technology), Dr. Beena Yadav (Dean, College of Community Science), Dr. K.D. Sharma (Dean, College of Biotechnology), Dr. Rajesh Gera (Dean, College of Basic Sciences & Humanities and College of Fisheries Science), Dr. Atul Dhingra, OSD to Vice-Chancellor and Head, Business Management and Dr. Mukesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, College of Agriculture for their dedication, vision and hard work in preparing this catalogue. It will undoubtedly serve as a valuable academic compass for our students, educators and stakeholders.

Prof. B.R. Kamboj

Prof. B.R. Kamboj
Vice-Chancellor
CCSHAU, Hisar

Preface

I am delighted to present the Undergraduate Academic Catalogue of CCS Haryana Agricultural University, Hisar, meticulously prepared in alignment with the guidelines of the Indian Council of Agricultural Research (ICAR) and the National Education Policy 2020 (NEP 2020). This catalogue outlines the structure, curriculum and academic framework of our diverse undergraduate programs-B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Tech. Agricultural Engineering, B.Tech. Biotechnology, B.Sc. (Hons.) Community Science and B.F.Sc. The course catalogue and examination and evaluation system as per the recommendations of the Sixth Deans' Committee of ICAR and will be implemented from academic session 2025-26 of 4-year programme of all the colleges.

In tune with the vision of NEP 2020, this catalogue embodies a holistic and multi disciplinary approach, aiming to nurture critical thinking, practical skills, ethical grounding and entrepreneurial spirit among our students. The curriculum emphasizes experiential learning, skill development, and industry alignment, ensuring that our graduates are not only academically sound but also socially responsible and globally competent.

Each program has been thoughtfully designed to balance foundational knowledge with emerging scientific advancements, integrating local relevance with global perspectives. Special emphasis has been placed on internships, rural and industry exposure, interdisciplinary electives, and innovation-driven projects to foster creativity and real-world problem-solving abilities in our students.

This catalogue is a testament to our commitment to academic excellence, student-centric learning, and nation-building through quality education in agriculture and allied sciences. I sincerely hope it serves as a valuable guide for our students, faculty, and stakeholders, and contributes to shaping the next generation of agricultural professionals and leaders.

I acknowledge the dedicated efforts of Dr. Beena Yadav (Dean, College of Community Science), Dr. K.D. Sharma (Dean, College of Biotechnology), Dr. Rajesh Gera (Dean, College of Basic Sciences & Humanities and College of Fisheries Science), Dr. Atul Dhingra, OSD to Vice-Chancellor and Head, Business Management, Dr. Mukesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, Dr. Anil Kumar, Sr. Scientist & Head, Dept. of Nematology, Dr. Subodh Aggarwal, Assistant Professor, Dept. of Business Management, Dr. Lomash Kumar, Assistant Professor, Dept. of Entomology, Dr. Neelam M. Rose, Professor & Head, Dept. of Apparel & Textile Science , Dr. Saroj Yadav, Associate Professor, Dept. of Apparel & Textile Science, Dr. Rachna Gulati, Professor, Dept. of Aquaculture & Post harvest Technology, Dr. Anupam Anand, Assistant Professor, Dept. of Fisheries Extension, Economics & Statistics, Dr. Kavita Sharma, Assistant Professor, Dept. of Fisheries Resource Management, Dr. Rajender Kumar, Assistant Professor, Dept. of Basic Engineering, Dr. Ajeev Kumar, Assistant Professor, Dept. of Agricultural Biotechnology and Dr. Kanika Rani, Assistant Professor, Dept. of Nanobiotechnology for curriculum development, revision and compilation of under graduate course curriculum of the university.

The help extended by Registrar, Dean, PGS, Directors and Officers of the university, the Head of departments and faculty members involved in the preparation of this document is gratefully acknowledged.

Dr. S. K. Pahuja

Dr. S. K. Pahuja
Dean, College of Agriculture
&
Chairperson
Committee for finalisation
of UG Course Curriculum
CCS HAU, Hisar

ACRONYMS

AAHM	Aquatic Animal Health Management
ABM	Agricultural Business Management
ABT	Agricultural Biotechnology
AE	Agricultural Engineering
AEC	Ability Enhancement Course
AEM	Aquatic Environment Management
AGRI	Agriculture
AIA	Agro-Industrial Attachment
AM	Agribusiness Management
ANBT	Animal Biotechnology
ATS	Apparel and Textile Science
AGRON	Agronomy
AG ECON	Agricultural Economics
AGM	Agricultural Meteorology
AQC	Aquaculture
BI	Bioinformatics
BIO	Biology
BIOCHEM	Biochemistry
BIOTECH	Biotechnology
CCA	Co-curricular Activity
CE	Civil Engineering
CS	Community Science
COMP	Computer Science
EE	Electronics and Electrical Engineering
EECM	Extension Education and Communication Management
ENG	English
ENT	Entomology
EXT	Extension Education
FE	Fish Engineering
FN	Foods and Nutrition
FEES	Fisheries Extension, Economics & Statistics
FMPE	Farm Machinery & Power Engineering
FOR	Forestry
FPT	Fish Processing Technology
FRM	Fisheries Resource Management
FS	Fisheries Science
GPB	Genetics & Plant Breeding
HDFS	Human Development and Family Studies
HORT	Horticulture
IBT	Industrial Biotechnology
LPM	Livestock Production Management
MATH	Mathematics

MBB	Molecular Biology & Biotechnology
MDC	Multi-Disciplinary Course
ME	Mechanical Engineering
MEB	Microbial and Environmental Biotechnology
MICRO	Microbiology
NBT	Bio-Nanotechnology
NCC	National Cadet Corps
NEMA	Nematology
NG	Non Gradial
NSS	National Service Scheme
PBT	Plant Biotechnology
PFE	Processing and Food Engineering
PL PATH	Plant Pathology
PL PHY	Plant Physiology
RAWE	Rural Agricultural Work Experience
REE	Renewable Bio-energy Engineering
RMCS	Resource Management and Consumer Science
SEC	Skill Enhancement Course
SOC	Sociology
SOILS	Soil Science
SST	Seed Science & Technology
STAT	Statistics
SWE	Soil and Water Engineering
TUT	Tutorial
VAC	Value Added Course
VSC	Vegetable Science

CONTENTS

GENERAL INFORMATION

Chaudhary Charan Singh Haryana Agricultural University, Hisar has revised Course Curriculum for undergraduate programmes in all the colleges of the University as per the recommendations of the Sixth Deans' Committee of ICAR and implemented from academic session 2025-26.

- The B.Sc. (Hons.)/ B.F.Sc./ B.Tech. programme are of 4 years duration, covering 166-174 credits of coursework. Additionally, students engage in 16 credits of non-gradial courses and 10 credits of MOOCs/online courses. The credit distributions for the different courses have been specified for individual disciplines.

General Credit Allocation Scheme of UG Programmes

Semester	Core Courses (Major+ Minor)	Multi-Disciplinary Courses (MDC)	Value Added Courses (VAC)	Ability Enhancement Courses (AEC)	Skill Enhancement Courses (SEC)	Internship/ Project/ Student READY/ RAWE & AIA	Total Credits	Non-Gradial	Online Courses/ MOOC
I	12	3(2)	-	2(3) + 2(4)	4	-	23	3(1+1a)	10
II	10	3(5)	3(6)	2(3) + 2(7)	4	-	24	2(1a+8a)	
Post-II semester	-	-	-	-	-	10(12)	-	-	
III	16	-	-	2(8)	2	-	20	3(3+1a)	
IV	12	3(9)	3(10)	-	2	-	20	2(1a+8a)	
Post-IV semester	-	-	-	-	-	10(13)	-	-	
V	21	-	-	-	-	-	21	5(3+1a+11)	
VI	21	-	-	-	-	-	21	1(1a)	
VII	20	-	-	-	-	-	20	-	
VIII	-	-	-	-	-	20	20	-	
Total	**112**	**9**	**6**	**10**	**12**	**20**	**169**	**16**	**10**

(1) Deeksharambh (Induction-cum-Foundation Course) of 2 credits (2 weeks duration)
(1a) Tutorial
(2) Farming based Livelihood systems
(3) NCC/NSS
(4) Communication Skills
(5) Entrepreneurship Development and Business Management
(6) Environmental Studies and Disaster Management
(7) Personality Development
(8) Physical Education, First Aid, Yoga Practices and Cultural Activities
(8a) Co-curricular Activity
(9) Agriculture Marketing and Trade
(10) Agriculture Informatics and Artificial Intelligence
(11) Educational Tour (10-14 days)
(12) Only for those opting for an exit with UG-Certificate
(13) Only for those opting for an exit with UG-Diploma

One multidisciplinary course in Agricultural Engineering discipline is different from the above common courses keeping in view the discipline specific requirement.

UNDERGRADUATE PROGRAMMES COLLEGE-WISE

Programme	Core Courses (Major+ Minor)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill Enhancement Course (SEC)	Internship/ Project/ Student READY/ RAWE & AIA	Total Credits	Non-Gradial	Online Courses/ MOOC
B.Sc. (Hons.) Agriculture	112	9	6	10	12	20	169	17	10
B.Sc. (Hons.) Agribusiness Management	112	9	6	8	12	20	167	17	10
B.Tech. (Agricultural Engineering)	125	10	6	10	8	15	174	18	6
B.Tech. (Biotechnology)	112	9	6	8	12	20	167	16	10
B.Sc. (Hons.) Community Science	112	9	6	10	12	20	169	16	10
B.F.Sc.	117	9	6	8	12	20	172	16	10

- After the admission in the University, the students will register for *Deeksharambh* (0+2) (Non-gradial) the Foundation course of 2 weeks' duration in the 1st semester of the degree programme. It will include discussions on operational framework of academic process in the college and the university. There will be sessions with alumni, business leaders, University academic and research personnel on instilling social awareness, ethics and values, cultural heritage, folk art and craft, Indian Constitution etc. It will help to identify the strength and weakness of students, diverse potentialities and to enhance cultural integration of students from different backgrounds. It will also create a platform for students to learn from each other's life experiences.
- The first year of the degree programme comprises skill development courses/ modules along with other fundamental courses. After satisfactory completion of courses in two semesters of 1st year and subsequent satisfactory completion of 10 credits (10 weeks) of industry/ institute training/ internship, the student will become eligible for the award of UG-Certificate in admitted programme on exit. The students continuing the study further, would not have to attend the internship after 1st year.
- The second year has been designed with the skill development courses as well as fundamental courses related to degree programme with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of agricultural sciences. After satisfactory completion of the courses during first two years and subsequent satisfactory completion of 10 credits (10 weeks) of internship/industry/institute training, the student will become eligible for the award of UG-Diploma in the admitted programme on exit. The students continuing the further study, need not to attend the internship after 2nd year. However, the students of B.Tech (Agricultural Engineering) are being offered 4 weeks In-Plant training as partial credits

after 4th Semester during break for completing the degree requirement with splitting in two slots (4 weeks each).

- The courses in the third year have been designed to impart in-depth knowledge of the subject to the students. There will not be an exit after 3rd year. During 5th semester, the students will have an educational tour of 10-12 days duration, which will be counted as 2 credits (Non-gradial).
- The fourth year of degree programmehas been meticulously designed not only to impart specialized knowledge to the students in the selected major disciplines but also to prepare the students to take up employment or entrepreneurship as their future career.
- During the 7th semester, the students will adequately select 20 credits from a basket of elective courses, each course giving an opportunity to gain advanced knowledge in frontier areas of science. The objective is to enable the student to acquire deeper understanding in any particular field.
- In the 8th semester of the degree programme, Student READY programme: Rural Agricultural Work Experience (RAWE), Experiential Learning, Hands-on Training, In-plant Training/ Industrial Aattachment/Internship and Project Work of 20 credits will be offered.
- In B.Tech (Agricultural Engineering) final year, the student will have the liberty to choose any three elective subjects, preferably from one or related disciplines. The objective is to enable the student to acquire deeper understanding in a particular field. In the final year, the Project-I (3 credits in 7th semester) and Project-II (4 credits in 8th semester) are meant for advanced skill development for research, employment and entrepreneurship. Under these courses, the student will have the option to take up a research project (R & D based/field study based) for developing research skills in form of project or take up incubation/ experiential learning-based activity for entrepreneurship development. The Project-I and II can also be taken up in collaboration with any organization/ industry.
- The students have to take a minimum of 10 credits of online courses (6 credits for B.Tech Agricultural Engineering) during four years as a partial requirement for the B.Sc. (Hons)/ B.F.Sc./B.Tech. programme. The online courses can be from any field such as Agriculture and allied sciences, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, Mook IT, edX, Coursera, SWAYAM or any other such reputed portal accepted by the University. The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. These online courses will be non-gradial and separate certificates would be issued by institute/organization offering the courses. The student must submit the list of online courses along with the content he/she intends to undertake to the Dean/Assoc. Dean/Principal of the college for a permission and records.

Entry and Exit Options

The entry and exit options for the UG programme is shown in the figure below.

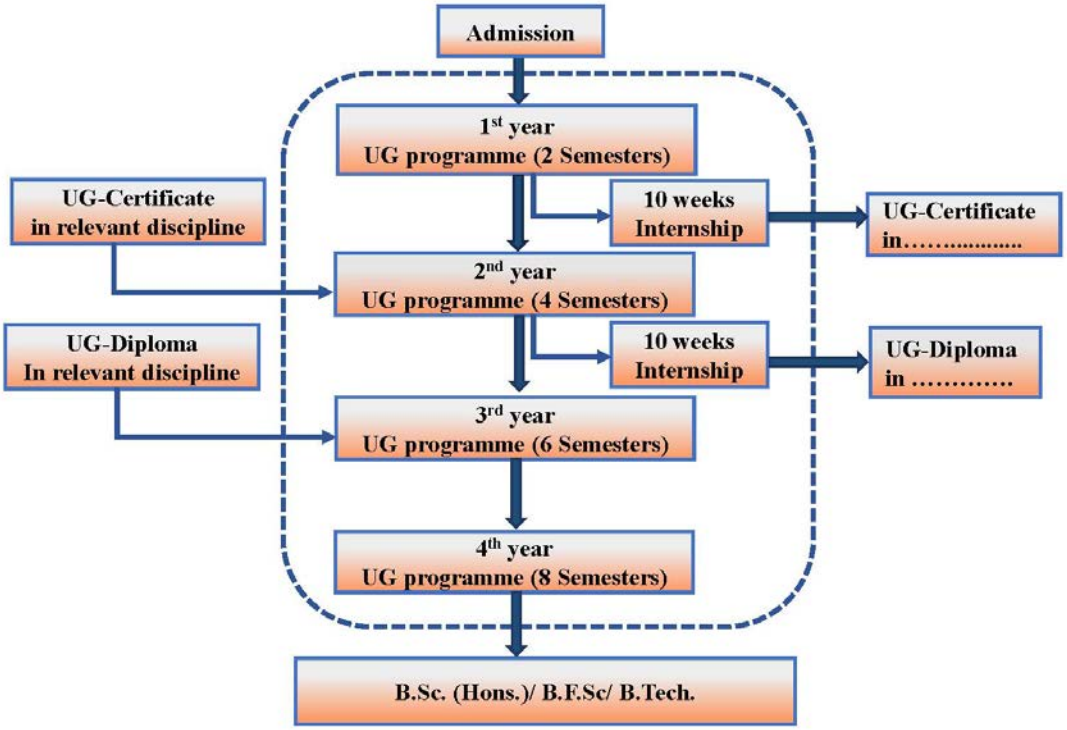


Figure 1: Entry and Exit Options for the UG Programmes

Entry Options: Students with UG-Certificate and UG-Diploma can take admission in 2nd and 3rd year, respectively of B.Sc.(Hons.)/ B.F.Sc./ B.Tech. degree programme.

Exit options

i. **UG-Certificate:** Exit after satisfactory completion of first year and 10 weeks' internship.

ii. **UG-Diploma:** Exit after satisfactory completion of second year and 10 weeks' internship.

iii. **B.Sc. (Hons.)/B.F.Sc./B.Tech.:** On successful completion of four-year degree requirements.

Examination and Evaluation System

Examination and evaluation system of under graduate programme of the University has been given below:

- External pattern of examination shall be followed only for the final theory portion to be conducted at the end of the semester for regular courses.
- External theory exam will be 50% and internal theory + practical- 50%.
- There will be mid-term examination for internal theory and evaluation will be internal.

- The question papers for non-credit courses will be set at the level of Dean/HOD concerned.
- The mid-term, practical and final-term examination shall be conducted during examination dates prescribed in the academic calendar.
- The date sheet will be provided by the Dean of the respective colleges.
- For a course with practical only, practical examination will be conducted twice during mid-term and final term.

Distribution of Marks for Various Examinations

Nature of courses Credit Hours (Theory + Practical)	**Internal (100)**				**External (100)**
	Mid-term Theory	**Assignment**	**Mid-term Practical**	**Final Practical**	
Courses with theory and practical					
1+1	30	20	NA	50	100
1+2	20	20	NA	60	100
2+1	40	20	NA	40	100
2+2	30	20	NA	50	100
3+1	50	20	NA	30	100
Courses with only theory	70	30	NA	NA	100
Courses with only practical	NA	30	70	100	NA

- After adding marks of all the examinations, the total will be divided by two for converting total marks out of 100 and combined (Theory + Practical) grade of each course will be awarded.
- The evaluation of the skill enhancement courses will be done as courses with practical only.
- Usually for any subject, there will be two assignment/quizzes within the semester, one before the midterm and one after midterm examination.
- The evaluation of internship will be done by the parent institute. The student shall submit a report to the parent institute and present the learnings before the other students and faculty after the internship programme.
- The online/MOOC courses, successfully completed by the student, will be indicated in the transcript with 'Satisfactory' grade.
- When students take deficiency course(s), they will be assessed as 'Satisfactory' or Unsatisfactory' without any grade points.

The course catalogue and examination & evaluation system as per the recommendations of Sixth Deans' committee implemented with effect from academic year 2025-26, starting from 1st year 4-year programme of all the colleges. In rest of the existing classes (2nd to 4th year 4-year programme) of all the colleges, the old course catalogue and examination system shall be followed.

COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY


CLAAS

COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

B.TECH (AGRICULTURAL ENGINEERING), 4-YEAR PROGRAMME
COURSES: SEMESTER-WISE

Course No.	Course Title	Credits
I Semester		
AE100[#]	*Deeksharambh* (Induction cum Foundation course of 2 weeks)	2 (0+2) NG
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)
CE 101	Surveying and Levelling	3 (1+2)
EE 101	Basic Electrical Gadgets and Instruments	3 (2+1)
ME 101	Workshop Technology and Practice	2 (0+2)
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)
AGRON 105 (MDC)	Crop Production and Protection Technologies	4 (3+1)
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**20 (10+10)**
II Semester		
AET 192[§] (SEC)- BE/FMPE/PFE/REE/SWE	Skill Enhancement	8 (0+8)
EE 102/ CSE 102 (AEC)	Computer Programming and Data Structures	2 (0+2)
EE 104/ CSE 104 (VAC)	Informatics and Artificial Intelligence	3 (2+1)
ME 102	Engineering Drawing	2 (0+2)
ENG 101 (AEC)	Communication Skills	2 (1+1)
SOILS 102 (VAC)	Environmental Studies and Disaster Management (To be taught jointly by Dept. of Soil Science, Agricultural Meteorology, Forestry and Microbiology)	3 (2+1)
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)
CCA 102	Co-curricular Activity	1 (0+1) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**21 (5+16)**
AE 200	Internship (10 weeks) Compulsory for students opting for an exit with UG-Certificate after 1st Year	10 (0+10)
AET 192[§] (SEC) course modules are to be selected from the list of baskets available under SEC modules offered by each department.		
III Semester		
CE 201	Engineering Mechanics	3 (2+1)
CE 203	Soil Mechanics	2 (1+1)
CHEM 201	Engineering Chemistry	3 (2+1)
FMPE 201	Farm Machinery and Equipment I	3 (2+1)

PFE 201	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)
SWE 201	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)
MATH 201	Engineering Mathematics I	3 (3+0)
PHY 203	Engineering Physics	3 (2+1)
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practice and Cultural Activities	2 (0+2)
NCC III/ NSS III	National Cadet Corps III/ National Service Scheme III	2 (0+2) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**25 (16+9)**
IV Semester		
CE 202	Theory of Structure	2 (1+1)
CE 204	Building Construction and Cost Estimation	2 (2+0)
FMPE 202	Farm Machinery and Equipment II	3 (2+1)
PFE 202	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)
REE 202	Renewable Energy Sources	3 (2+1)
SWE 202	Watershed Hydrology	3 (2+1)
SWE 204	Soil and Water Conservation Engineering	3 (2+1)
ABM 208 (MDC)	Entrepreneurship Development and Business Management	3 (2+1)
MATH 202	Engineering Mathematics II	3 (3+0)
CCA 202	Co-curricular Activity	1 (0+1) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**25 (18+7)**
AE 300	Internship (10 weeks) Compulsory for students opting for an exit with UG-Diploma after 2nd Year	10 (0+10)
V Semester		
CE 301	Strength of Materials	2 (1+1)
FMPE 301	Tractor and Automotive Engines	3 (2+1)
ME 301	Theory of Machines	2 (1+1)
PFE 301	Food and Dairy Engineering	4 (3+1)
SWE 301	Irrigation and Drainage Engineering	4 (3+1)
ENG 301 (AEC)	Human Values and Personality Development	2 (1+1)
AE 321#	Seminar	1 (0+1)
AE351#	Educational Tour	2 (0+2) NG
NCC IV / NSS IV	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG
TUT	Tutorial	1 (1+0) NG
	Total Credits	**18 (11+7)**
VI Semester		
CE 302	Agricultural Structures and Environment Control	3 (2+1)
EE 302	Sensors, AI and Robotics in Agriculture	3 (2+1)

FMPE 302	Tractor Systems and Controls	3 (2+1)
ME 302	Thermodynamics and Heat Transfer	3 (2+1)
ME 304	Refrigeration and Air-conditioning	3 (2+1)
PFE 302	Post-harvest Engineering of Horticultural Crops	2 (1+1)
REE 302	Bio-energy Systems: Design and Applications	3 (2+1)
SWE 302	Groundwater, Wells and Pumps	3 (2+1)
AET 392[§]- BE/FMPE/PFE/REE/SWE	Case Study	1 (0+1)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**24 (15+9)**
VII Semester		
AED 491[$]- FMPE/PFE/REE/SWE	Project I	3 (0+3)
EE 401	Electrical Machines	3 (2+1)
ME 401	Machine Design	2 (1+1)
ME 403	Engineering Graphics and Design	2 (0+2)
PFE 401	Food Quality and Safety	3 (2+1)
SWE 403	Watershed Planning and Management	3 (2+1)
SWE 405	Sprinkler and Micro Irrigation Systems	2 (1+1)
STAT 401	Agricultural Statistics and Data Analysis	2 (1+1)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**20 (9+11)**
VIII Semester		
AED 492[$]- FMPE/PFE/REE/SWE	Project II	4 (0+4)
AE 400[#]	In-plant Training/Internship (evaluation)	8 (0+8)
	Elective I[*]	3 (2+1)
	Elective II[*]	3 (2+1)
	Elective III[*]	3 (2+1)
TUT	Tutorial	1 (1+0) NG
	Total Credits	**21 (6+15)**
Online courses (MOOC) **		6
	Grand Total	**174+ 6**+ 18 NG**

$ AED 191 course to be taught jointly by Dept. of FMPE, PFE, REE and SWE on sharing basis

§ AET 192[§] / 392[§] courses to be taught by Dept. of BE, FMPE, PFE, REE and SWE on the basis of selection priorities by students

♀ AED 491/ AED 492 courses to be taught by Dept. of FMPE, PFE, REE and SWE

AE courses to be nominated by Dean of the college (COAE&T)

* From the bouquet of elective courses (Any three taken from the selected department)

** From SWAYAM, Diksha, NPTEL, mooKIT, edX, Coursera or any other portal under intimation to the Dean through advisors

B.TECH (AGRICULTURAL ENGINEERING), 4 YEAR PROGRAMME
FOUNDATION AND COMMON COURSES

Course No.	Course Title	Credits	Semester
FOUNDATION COURSES			
AE 100	*Deeksharambh* (Induction cum Foundation Course of 2 weeks)	2 (0+2) NG	I
AE 351	Educational Tour	2 (0+2) NG	V
	Total Credits	**4 (0+4) NG**	
COMMON COURSES			
Multidisciplinary Courses (MDC)			
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)	I
AGRON 105 (MDC)	Crop Production and Protection Technologies	4 (3+1)	I
ABM 208 (MDC)	Entrepreneurship Development and Business Management	3 (2+1)	IV
	Total Credits	**10 (7+3)**	
Value Added Courses (VAC)			
SOILS 102 (VAC)	Environmental Studies and Disaster Management	3 (2+1)	II
EE 104 (VAC)	Agricultural Informatics and Artificial Intelligence	3 (2+1)	II
	Total Credits	**6 (4+2)**	
Ability Enhancement Courses (AEC)			
EE 102 (AEC)	Computer Programming and Data Structures	2 (0+2)	II
ENG 101 (AEC)	Communication Skills	2 (1+1)	II
ENG 301 (AEC)	Human Values and Personality Development	2 (1+1)	V
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Service Scheme II National Cadet Corps II	2 (0+2)	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural Activities	2 (0+2)	III
	Total Credits	**12 (2+10)**	

B.TECH (AGRICULTURAL ENGINEERING), 4-YEAR PROGRAMME

CORE COURSES: DEPARTMENT-WISE

Course No.	Course Title	Credits	Semester
Basic Engineering			
AET 192[§] (SEC)-BE	Skill Enhancement	8 (0+8)	II
AET 392[§]-BE	Case Study	1 (0+1)	VI
	Total Credits	**9 (0+9)**	
Civil and Environmental Engineering			
CE 101	Surveying and Levelling	3 (1+2)	I
CE 201	Engineering Mechanics	3 (2+1)	III
CE 203	Soil Mechanics	2 (1+1)	III
CE 202	Theory of Structure	2 (1+1)	IV
CE 204	Building Construction and Cost Estimation	2 (2+0)	IV
CE 301	Strength of Materials	2 (1+1)	V
CE 302	Agricultural Structures and Environmental Control	3 (2+1)	VI
	Total Credits	**17 (10+7)**	
Computer Science, Electrical and Electronics Engineering			
EE 101	Basic Electrical Gadgets and Instruments	3 (2+1)	I
EE 102/CSE 102 (AEC)	Computer Programming and Data Structures	2 (0+2)	II
EE 104/ CSE 104 (VAC)	Informatics and Artificial Intelligence	3 (2+1)	II
EE 302	Sensors, Artificial Intelligence and Robotics in Agriculture	3 (2+1)	VI
EE 401	Electrical Machines	3 (2+1)	VII
	Total Credits	**14 (8+6)**	
Mechanical Engineering			
ME 101	Workshop Technology and Practices	2 (0+2)	I
ME 102	Engineering Drawing	2 (0+2)	II
ME 301	Theory of Machines	2 (1+1)	V
ME 302	Thermodynamics and Heat Transfer	3 (2+1)	VI
ME 304	Refrigeration and Air Conditioning	3 (2+1)	VI
ME 401	Machine Design	2 (1+1)	VII
ME 403	Engineering Graphics and Design	2 (0+2)	VII
	Total Credits	**16 (6+10)**	
	Grand Total	**56 (24+32)**	
Farm Machinery and Power Engineering			
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)	I
AET 192[§] (SEC)-FMPE	Skill Enhancement	8 (0+8)	II
FMPE 201	Farm Machinery and Equipment I	3 (2+1)	III
FMPE 202	Farm Machinery and Equipment II	3 (2+1)	IV
FMPE 301	Tractor and Automotive Engines	3 (2+1)	V

FMPE 302	Tractor Systems and Controls	3 (2+1)	VI
AET 392[§]-FMPE	Case Study	1 (0+1)	VI
AED 491[♀]- FMPE	Project I	3 (0+3)	VII
AED 492[♀]- FMPE	Project II	4 (0+4)	VIII
	Total Credits	**31 (10+21)**	
Processing and Food Engineering			
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)	I
AET 192[§] (SEC)-PFE	Skill Enhancement	8 (0+8)	II
PFE 201	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	III
PFE 202	Post-harvest Engineering of Cereals, Pulses and Oilseeds	2 (1+1)	IV
PFE 301	Food and Dairy Engineering	4 (3+1)	V
PFE 302	Post-harvest Engineering of Horticultural Crops	2 (1+1)	VI
AET 392[§]-PFE	Case Study	1 (0+1)	VI
PFE 401	Food Quality and Safety	3 (2+1)	VII
AED 491[♀]-PFE	Project I	3 (0+3)	VII
AED 492[♀]-PFE	Project II	4 (0+4)	VIII
	Total Credits	**33 (11+22)**	
Renewable and Bio-energy Engineering			
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)	I
AET 192[§] (SEC)-REE	Skill Enhancement	8 (0+8)	II
REE 202	Renewable Energy Sources	3 (2+1)	IV
REE 302	Bioenergy Systems: Design and Applications	3 (2+1)	VI
AET 392[§]-REE	Case Study	1 (0+1)	VI
AED 491[♀]-REE	Project I	3 (0+3)	VII
AED 492[♀]-REE	Project II	4 (0+4)	VIII
	Total Credits	**25 (6+19)**	
Soil and Water Engineering			
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)	I
AET 192[§] (SEC)-SWE	Skill Enhancement	8 (0+8)	II
SWE 201	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	III
SWE 202	Watershed Hydrology	3 (2+1)	IV
SWE 204	Soil and Water Conservation Engineering	3 (2+1)	IV
SWE 301	Irrigation and Drainage Engineering	4 (3+1)	V
SWE 302	Groundwater, Wells and Pumps	3 (2+1)	VI
AET 392[§]-SWE	Case Study	1 (0+1)	VI
SWE 403	Watershed Planning and Management	3 (2+1)	VII
SWE 405	Sprinkler and Micro Irrigation Systems	2 (1+1)	VII

AED 491♀-SWE	Project I	3 (0+3)	VII
AED 492♀-SWE	Project II	4 (0+4)	VIII
	Total Credits	**40 (16+24)**	

SKILL ENHANCEMENT COURSES/ PROJECT

Course No.	Course Title	Credits	Semester
AET 192§ (SEC)-BE/FMPE/PFE/REE/SWE	Skill Enhancement	8 (0+8)	II
AED 491♀-FMPE/PFE/REE/SWE	Project I	3 (0+3)	VII
AED 492♀-FMPE/PFE/REE/SWE	Project II	4 (0+4)	VIII
	Total Credits	**15 (0+15)**	

SKILL ENHANCEMENT COURSE MODULES: DEPARTMENT WISE

Module No.	Module Title	Credits	Semester
Students are required to choose any one package (maximum 2 modules) of AET 192 (SEC) course modules out of departmental offered package modules.			
Basic Engineering			
AET 192 (SEC)-BE-001	Installation and Maintenance of On-Grid and Off-Grid Solar Systems	4 (0+4)	II
AET 192 (SEC)-BE-002	Machine Vision, Sensors and Sensor Architectures	4 (0+4)	II
AET 192 (SEC)-BE-003	Operation and Maintenance of Soil Conservation Structures	4 (0+4)	II
AET 192 (SEC)-BE-004	Construction, Management and Maintenance of protected cultivation structures	4 (0+4)	II
Farm Machinery and Power Engineering			
AET 192 (SEC)-FMPE-001	Operation and Maintenance of Farm Machinery	4 (0+4)	II
AET 192 (SEC)-FMPE-002	Repair and Maintenance of Tractors and Power Tillers	4 (0+4)	II
AET 192 (SEC)-FMPE-003	Management of Agricultural Machinery Custom Hiring and Maintenance Facilities	4 (0+4)	II
AET 192 (SEC)-FMPE-004	Operation and Maintenance of Drones Used For Agricultural Applications	4 (0+4)	II
Processing and Food Engineering			
AET 192 (SEC)-PFE-001	Agro-processing methods, equipment operation and maintenance	4 (0+4)	II
AET 192 (SEC)-PFE-002	Operation and Management of Multi-Commodity Agro-Processing Centre	4 (0+4)	II

AET 192 (SEC)-PFE-003	Primary Processing and Value Addition and Cold Chain Logistics	4 (0+4)	II
AET 192 (SEC)-PFE-004	Food Grain Godown and Warehouse Management	4 (0+4)	II
AET 192 (SEC)-PFE-005	Post-harvest Value Chain Management Including Logistics	4 (0+4)	II
Renewable and Bio-energy Engineering			
AET 192 (SEC)-REE-001	Design of Solar PV Systems Using Software	4 (0+4)	II
AET 192 (SEC)-REE-002	Design and Maintenance of Agri-voltaic Systems	4 (0+4)	II
AET 192 (SEC)-REE-003	Valorisation of Agri-biomass and Organic Waste	4 (0+4)	II
AET 192 (SEC)-REE-004	Energy audit, Energy Conservation and Energy Efficiency	4 (0+4)	II
AET 192 (SEC)-REE-005	Fabrication, Operation and Maintenance of Renewable Energy Gadgets	4 (0+4)	II
Soil and Water Engineering			
AET 192 (SEC)-SWE-001	Repair and Maintenance of Pumps and Irrigation Systems	4 (0+4)	II
AET 192 (SEC)-SWE-002	Installation and Maintenance of Micro Irrigation Systems	4 (0+4)	II
AET 192 (SEC)-SWE-003	Application of Remote Sensing and GIS for Agricultural Water Management	4 (0+4)	II
AET 192 (SEC)-SWE-004	Operation and Maintenance of Hydro-Meteorological Instruments	4 (0+4)	II
AET 192 (SEC)-SWE-005	Geophysical Survey and Investigations for Groundwater Exploration and Installation of Tube Well/ Bore Well	4 (0+4)	II
AET 192 (SEC)-SWE-006	Installation and Maintenance of Rooftop Rainwater Harvesting System	4 (0+4)	II

ELECTIVE COURSES** (ANY THREE)

Course No.	Course Title	Credits	Semester
Students are required to choose any one package (3 courses) of elective courses out of Elective package I-V			
Elective Package I: Basic Engineering			
CE 402	Environmental Engineering	3 (2+1)	VIII
EE 402	MATLAB Programming	3 (2+1)	VIII
EE 404	Artificial Intelligence	3 (2+1)	VIII
EE 406	Mechatronics	3 (2+1)	VIII

EE 408/ REE 402	Photovoltaic Technology and Systems	3 (2+1)	VIII
ME 402/ EE 410	Machine Learning	3 (2+1)	VIII
ME 404	Operations Research	3 (2+1)	VIII
Elective Package II: Farm Machinery and Power Engineering			
FMPE 402	Mechanics of Tillage and Traction	3 (2+1)	VIII
FMPE 404	Farm Machinery Design and Production	3 (2+1)	VIII
FMPE 406	Tractor Design and Testing	3 (2+1)	VIII
FMPE 408	Human Engineering and Safety	3 (2+1)	VIII
FMPE 410	Hydraulic Drives and Controls	3 (2+1)	VIII
FMPE 412	Precision Agriculture and System Management	3 (2+1)	VIII
FMPE 414	Advances in Automation and Robotics in Agriculture	3 (2+1)	VIII
Elective Package III: Processing and Food Engineering			
PFE 402	Development of Processed Food Products	3 (2+1)	VIII
PFE 404	Food Packaging Technology	3 (2+1)	VIII
PFE 406	Food Plant and Equipment Design	3 (2+1)	VIII
PFE 408	Emerging Technologies in Food Processing	3 (3+0)	VIII
PFE 410	Processing of Livestock, Fish and Marine Products	3 (2+1)	VIII
PFE 412	Food Business Management and Entrepreneurship Development	3 (3+0)	VIII
Elective Package IV: Renewable and Bio-energy Engineering			
REE 402/ EE408	Photovoltaic Technology and Systems	3 (2+1)	VIII
REE 404	Wind Power Technology and Systems	3 (2+1)	VIII
REE 406	Waste and By-Products Utilization	3 (2+1)	VIII
REE 408	Solar Energy Utilization	3 (2+1)	VIII
REE 410	Biogas Technology and Mechanism	3 (2+1)	VIII
Elective Package V: Soil and Water Engineering			
SWE 402	Management of Canal Irrigation System	3 (2+1)	VIII
SWE 404	Remote Sensing and GIS Applications	3 (2+1)	VIII
SWE 406	Precision Farming Techniques for Protected Cultivation	3 (2+1)	VIII
SWE 408	Landscape Irrigation Design and Management	3 (2+1)	VIII
SWE 410	Floods and Control Measures	3 (2+1)	VIII
SWE 412	Minor Irrigation and Command Area Development	3 (2+1)	VIII

NON-GRADIAL COURSES

Course No.	Course Title	Credits	Semester
AE100#	*Deeksharambh* (Induction cum Foundation course of 2 weeks)	2 (0+2) NG	I
AE 351#	Educational Tour	2 (0+2) NG	V
TUT	Tutorial	1(1+0) NG	I to VIII
	Total Credits	**12 (8+4)**	

SUPPORTING COURSES: DEPARTMENT WISE

COLLEGE OF AGRICULTURE

Course No.	Course Title	Credits	Semester
Agronomy			
AGRON 101 (MDC)	Farming Based Livelihood Systems	3 (2+1)	I
AGRON 105 (MDC)	Crop Production and Protection Technologies	4 (3+1)	I
	Total Credits	**7 (5+2)**	
Business Management			
ABM 208 (MDC)	Entrepreneurship Development and Business Management	3 (2+1)	III
	Total Credits	**3 (2+1)**	
Soil Science			
SOILS 102 (VAC)	Environmental Studies and Disaster Management	3 (2+1)	II
	Total Credits	**3 (2+1)**	

COLLECE OF BASIC SCIENCES AND HUMANITIES

Course No.	Course Title	Credits	Semester
Chemistry			
CHEM 201	Engineering Chemistry	3 (2+1)	III
	Total Credits	**3 (2+1)**	
Languages And Haryanvi Culture			
ENG 101 (AEC)	Communication Skills	2 (1+1)	II
ENG 301 (AEC)	Human Values and Personality Development	2 (1+1)	V
	Total Credits	**4 (2+2)**	
Mathematics and Statistics			
MATH 201	Engineering Mathematics I	3 (3+0)	III

MATH 202	Engineering Mathematics II	3 (3+0)	IV
STAT 401	Agricultural Statistics and Data Analysis	2 (1+1)	VII
	Total Credits	**8 (7+1)**	
Physics			
PHY 203	Engineering Physics	3 (2+1)	III
	Total Credits	**3 (2+1)**	

DIRECTORATE OF STUDENTS' WELFARE

Course No.	Course Title	Credits	Semester
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)	II
CCA 102 (AEC)	Co-curricular Activity	1 (0+1) NG	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural activities	2 (0+2)	III
NCC III/ NSS III	National Cadet Corps III/ National Service Scheme III	2 (0+2) NG	III
CCA 202	Co-curricular Activity	1 (0+1) NG	IV
NCC IV/ NSS IV	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG	V
	Total Credits	**6 (0+6)**	

COURSE CONTENTS: DEPARTMENT-WISE

FOUNDATION COURSES

Course No.	Course Title	Credits	Semester
AE 100	*Deeksharambh* (Induction cum Foundation course of 2 weeks)	2 (0+2) NG	I
AE 351	Educational Tour	2 (0+2) NG	V
	Total Credits	**4 (0+4)**	

AE 100	DEEKSHARAMBH (Induction Cum Foundation Course of 2 Weeks)	2 (0+2) NG	SEM I

Objectives

- Help for cultural integration of students from different backgrounds,
- Know about the operational framework of academic process in the University/College/Institute
- Instilling life and social skills
- Social Awareness, Ethics and Values, Team Work, Leadership, Creativity, etc.
- Identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.
- Identify strength and weakness of the students in different core areas of the discipline.

Activities

i. Discussions on operational framework of academic process in the University, as well as interactions with academic and research managers of the University
ii. Interaction with alumni, business leaders, perspective employers, outstanding achievers in related fields, and people with inspiring life experiences
iii. Group activities to identify the strength and weakness of students (with expert advice for their improvement) as well as to create a platform for students to learn from each other's life experiences
iv. Activities to enhance cultural Integration of students from different backgrounds.
v. Field visits to related fields/ establishments
vi. Sessions on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills

AE 351	EDUCATIONAL TOUR	2 (0+2) NG	SEM V

To be conducted for 10-12 days after 5th Semester.
The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organizations/ industries (related to the profession), they will also be exposed to the geographical variability of different places/ states and the social and cultural differences existing in the country. After the visit, the students will submit a report/ make a presentation.

COMMON AGRICULTURAL ENGINEERING COURSES

Course No.	Course Title	Credits	Semester
AED 191[$]	Introduction to Agricultural Engineering (To be taught by departments on sharing basis)	3 (2+1)	I
AE 311	Seminar	1 (0+1)	V
AET 392[§]- BE/FMPE/PFE/REE/SWE	Case Study	1 (0+1)	VI
AED 491[♀]- FMPE/PFE/REE/SWE	Project I	3 (0+3)	VII
AED 492[♀]- FMPE/PFE/REE/SWE	Project II	4 (0+4)	VIII
AE 400	In-Plant Training/ Internship	8 (0+8)	VIII
	Total Credits	**18 (2+16)**	

AED 191	INTRODUCTION TO AGRICULTURAL ENGINEERING	3 (2+1)	SEM I

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post-harvest and allied activities

Theory

Agricultural Engineering as a discipline; Major divisions of Agricultural Engineering; Importance of Agricultural Engineering for today's agriculture; Different sectors of employment for Agricultural Engineers; Scope of research and higher studies in Agricultural Engineering in India and abroad.

Farm mechanization needs and strategy; Classification of farm machinery on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources; Different types of equipment for tillage, sowing, planting and transplanting, fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops; Functions and capabilities of tractor and power tillers; Introduction to the IC engine systems, fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor; Basic parts of a power tiller; Hitching system.

Introduction to renewable energy systems; Types of biogas plants, Types of solar energy collectors; Solar water heating systems, solar dryers, solar photovoltaic systems; Wind mills and their different parts.

Importance of soil and water conservation; Different agronomic measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures; gully control measures. Use of topographical survey and contour maps. Different types of water harvesting structures. Introduction to soil-plant-water relationship; Equipment for measurement of irrigation water, viz. weirs, notches, orifices; Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components; Underground water conveyance methods in pipes; Introduction to drainage systems; Introduction to centrifugal pumps and different components.

Different types of agricultural structures; Introduction to planning and layout of farmsteads, animal houses, poultry houses; Different types of grain storage structures; Greenhouse and its different parts; Low cost protected structures. Classification of different types of agricultural commodities as durables, perishables, etc.; Moisture content and its importance in grain storage; Common reasons of food spoilage, food preservation methods; Different primary processing operations and their necessity; Methods and equipment used for cleaning, washing, sorting, grading, peeling, size reduction; Different types of traditional and modern storage structures; Storage of perishable commodities; Different types of packaging materials and their suitability for various food products; Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, chemical preservation and other novel methods.

Practical

Study of various implements (tillage, sowing, planting, weeding, fertilizer application); Study of farm implements (pesticide application, harvesting and threshing); Study of various components of tractor and matching implements; Study of various components of power tiller and matching implements; Study of various types of biogas plants and operational parameters; Study of various solar energy application systems; Study on various components of sprinkler and drip irrigation; Study on various components centrifugal pump; Study of various post-harvest operations; Study of different food processing equipment; Value addition of common crops; Visit to a greenhouse with modern irrigation system; Visit to implement manufacturing unit; Visit to a mechanized farm; Visit to a watershed; Visit to a food processing industry.

Suggested Readings

1. Chakraverty A. 1999. Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
2. Dash S K, Bebartta J P and Kar. 2012. A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
3. Jain S C and Philip G. 2009. Farm Machinery - An Approach. Second Edition. Standard Publishers and Distributors, New Delhi.
4. Mal B C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
5. Michael A M and Ojha T P. 2003. Principles of Agricultural Engineering. Jain Brothers, New Delhi.

6. Michael A M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
7. Nakra C P. 1980. Farm Machines and Equipment. Dhanpat Rai Publishing Company Pvt. Ltd, New Delhi.
8. Rai G D. 1995. Solar Energy Utilization. Khanna Publishers, New Delhi.
9. Rai G D. 2013. Non-Conventional Energy Sources. Khanna Publishers, New Delhi.
10. Sahay K M and Singh K K. 1994. Unit Operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd, New Delhi.
11. Suresh R and Kumar Sanjay. 2018. Farm Power and Machinery Engineering. Standard Publisher Distributors, New Delhi.
12. Suresh R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

AE 311	SEMINAR	1 (0+1)	SEM V

Objectives

1. To enable students to improve their knowledge and understanding of a topic
2. To develop confidence and competence to identify and compare technical and practical issues related to the area of course specialization and to present it before a group of people

Practical

The student will be assigned to present on a technical and practical issue or on an emerging field. The activities should include establishing motivation for any topic of interest and develop a thought process for technical presentation, conduct a detailed literature survey and to build a document with respect to technical publications, analysis and comprehension of proof-of-concept and related data, and effective presentation with improved soft skills. It should also involve use of new and recent technologies for creating technical reports and presentation. The evaluation shall be based on the ability of the student to describe, interpret and analyze technical issues and competence in presenting

AET 392- BE/FMPE/PFE/REE/SWE	CASE STUDY	1 (0+1)	SEM VI

Objective

To enable the students to generate an in-depth, multi-faceted understanding of a specific case/ situation/ aspect related to the profession in its real-life context

Activities

The students will be assigned to visit to a nearby area/ entity to study and analyse any particular case. The case study can be either problem-solving type or descriptive type. The problem-solving case studies would aim to investigate a problem or situation in a particular individual or group, and recommend solution to the problem(s) based on analysis and theory.

Descriptive case studies would aim to understand a situation better. For example, identifying what happened and why by describing particular aspects of that situation and analysing it in terms of theoretical categories. This will help to make a choice about how to do things in a better way in future for another case having similar features.

Some indicative areas for the case studies are as follows.

1. Study the status of farm mechanization and agro-processing in a particular village and to suggest improvement measures
2. Study a specific watershed and suggest measures for rejuvenating the watershed
3. Study the losses of fruits and vegetables in a local market yard and suggest remedial measures
4. Study the supply chain for a commodity and suggest a suitable value chain
5. Visit to a village to study the energy consumption pattern and suggest measures for efficient energy use and integration of renewable energy for different farm operations
6. Visit to an orchard and suggest measures for optimized water use
7. Visit to a retail store/ farm machinery dealer and report on supply chain network
8. Visit to a retail store and study the different types of packaging materials
9. Visit to an entrepreneur and study his journey to success (or reasons of failure)

After the visit, the students will submit a report to the institution on their observations. They may also be asked to present the report before the other faculty members and students for interaction.

The activity and presentations are recommended to be accommodated on Saturdays. A teacher will be designated as the facilitator for the programme.

AED 491♀- FMPE/PFE/REE/SWE	**PROJECT I**	**3 (0+3)**	**SEM VII**

Objective

To strengthen the skill of the students and for developing their confidence to take up either research or employment/ entrepreneurship as a future career.

Activity

The activities should aim at development of advanced skill for research/ employment and entrepreneurship. The activities can be planned considering the total 7 credit hours allocated in the 7th and 8th semesters, viz. Project I (0+3 credit hours in 7th semester) and Project II (0+4 credit hours in the 8th semester). The course can be taken either for developing research skills in form of project (R and D based, field study based) or for entrepreneurship development (incubation/ experiential learning based). The student will have the option to choose the mode of this course in consultation with a faculty mentor (each student will be attached to a mentor either from the College/ University or from any organisation/ industry).

AED 492♀- FMPE/PFE/REE/SWE	**PROJECT II**	**4 (0+4)**	**SEM VIII**

Project-II This will be the continuation of work/ study taken under the course Project- I

AE 400	**IN-PLANT TRAINING/ INTERNSHIP**	**8 (0+8)**	**SEM VIII**

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute. In addition, students will have an opportunity to enhance those skills, obtain the perspective of a work environment and benefit from a mentor or supervisor's experience and advice.

Activity

The students will have internship/ training for 8 weeks' duration in industries/ research organisations/ institutions. The College/ University will facilitate attaching the students to the organisations. In-plant training may be conducted in split manner in more than one industry/ organization/ institute after 2nd and 3rd year with 4 weeks each. After completion of training/ internship, the students will have to submit a report of their learnings and also present in form of a seminar before nominated faculty members and other students. The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the University. Ideally the weightage will be 50% each for both internal and external. The HAEIs may modify the weightage and breakups.

Online Courses

The objective is to allow the students to groom their passion or strengthen their knowledge and competency in any field beyond prescribed courses. The students will have to take a minimum of 6 credits of online courses (as per UGC guidelines for online courses) as a partial requirement for the B. Tech. (Agricultural Engineering). As per UGC guideline, a 1- to 3- credit SWAYAM course is expected to be covered in 4-12 weeks' duration including the assessment component, in which it should be 40 hours for 3- credit courses to 80 hours for a 6-credit course for the learning from e-content, reading references material, discussion forum posting and assignment. The online courses can be from any field such as Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language, Communication skills/ Music, etc. and can be taken from NPTEL, Diksha, mooKIT, edX, Coursera, SWAYAM or any other portal. The students will take prior approval of the courses they opt from the concerned Dean/Assoc. Dean/Principal of the College. The courses will be non-gradial and a separate certificate would be issued by the Institute/ University offering the courses. These can be taken any time during the 3rd and 4th years of the UG programme. However, the University will keep a record of such courses registered and completed by each student and will indicate the title of the (successfully completed) courses in final transcript issued to the student.

BASIC ENGINEERING

Course No.	Course Title	Credits	Semester
Core Courses			
AET 192[§] (SEC)-BE	Skill Enhancement	8 (0+8)	II
AET 392[§]-BE	Case Study	1 (0+1)	VI
	Total Credits	**9 (0+9)**	
Civil and Environmental Engineering			
CE 101	Surveying and Levelling	3 (1+2)	I
CE 201	Engineering Mechanics	3 (2+1)	III
CE 203	Soil Mechanics	2 (1+1)	III
CE 202	Theory of Structure	2 (1+1)	IV
CE 204	Building Construction and Cost Estimation	2 (2+0)	IV
CE 301	Strength of Materials	2 (1+1)	V
CE 302	Agricultural Structures and Environmental Control	3 (2+1)	VI
	Total Credits	**17 (10+7)**	
Computer Science, Electrical and Electronics Engineering			
EE 101	Basic Electrical Gadgets and Instruments	3 (2+1)	I
EE 102/ CSE 102 (AEC)	Computer Programming and Data Structures	2 (0+2)	II
EE 104/ CSE 104 (VAC)	Informatics and Artificial Intelligence	3 (2+1)	II
EE 302	Sensors, Artificial Intelligence and Robotics in Agriculture	3 (2+1)	VI
EE 401	Electrical Machines	3 (2+1)	VII
	Total Credits	**14 (8+6)**	
Mechanical Engineering			
ME 101	Workshop Technology and Practice	2 (0+2)	I
ME 102	Engineering Drawing	2 (0+2)	II
ME 301	Theory of Machines	2 (1+1)	V
ME 302	Thermodynamics and Heat Transfer	3 (2+1)	VI
ME 304	Refrigeration and Air Conditioning	3 (2+1)	VI
ME 401	Machine Design	2 (1+1)	VII
ME 403	Engineering Graphics and Design	2 (0+2)	VII
	Total Credits	**16 (6+10)**	
Elective Courses (Any Three)			
CE 402	Environmental Engineering	3(2+1)	VIII
EE 402	MATLAB Programming	3(2+1)	VIII
EE 404	Artificial Intelligence	3(2+1)	VIII
EE 406	Mechatronics	3(2+1)	VIII
EE408/REE402	Photovoltaic Technology and Systems	3(2+1)	VIII
ME 402/ EE 410	Machine Learning	3(2+1)	VIII
ME 404	Operations Research	3(2+1)	VIII
	Total Credits	**21 (14+7)**	
	Grand Total	**77 (38+39)**	

AET 192 (SEC) BE	SKILL ENHANCEMENT	8 (0+8)	SEM II

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG-certificate, they can work as operators and technicians in the fields of farm machinery, micro-irrigation, solar and wind energy or food processing, etc. or can go for self-employment or start their own agro-service centre, agro-processing centre or similar activities. Thus, the broad objective of this course is Skill for Employment and Entrepreneurship Development.

Indicative Modules

BE 001	INSTALLATION AND MAINTENANCE OF ON-GRID AND OFF-GRID SOLAR SYSTEMS	4 (0+4)

- Overview of solar photovoltaic technology and its applications, Explanation of on-grid and off-grid solar systems
- Identification and explanation of key components in solar PV systems (solar panels, inverters, charge controllers, batteries, wiring, etc.)
- Understanding the differences between on-grid and off-grid system configurations
- Component identification and system layout design
- Conducting site assessments to determine solar potential and suitability for PV system installation. Considerations for system sizing, orientation, and tilt angle, Planning the layout of solar panels, mounting structures, and electrical components
- Installation of solar panels, inverters, and other components for on-grid systems, Techniques for mounting solar panels on rooftops or ground-mounted structures
- Wiring and connection of components to the electrical grid
- Setting up off-grid solar systems, including battery-based energy storage, Installation of charge controllers, batteries, and DC loads
- Designing and configuring off-grid systems for reliable and efficient operation
- Electrical wiring practices for solar PV systems
- Understanding safety precautions and regulations related to electrical installations
- Wiring solar panels, inverters, charge controllers, and battery banks
- Commissioning and testing of solar PV systems to ensure proper functionality, conducting performance tests and verifying system parameters
- Troubleshooting common issues and addressing installation errors
- Routine maintenance tasks for on-grid solar PV systems, including cleaning, inspection, and performance monitoring, Diagnosis and troubleshooting of grid-connected system components
- Specialized maintenance requirements for off-grid solar systems, including battery maintenance and charge controller calibration
- Techniques for integrating additional solar panels, batteries, or other components into existing systems

- System modification and expansion
- Introduction to remote monitoring systems for tracking the performance of solar PV systems, using data analytics tools to diagnose issues and optimize system performance, Hands-on practice in accessing system data and interpreting performance metrics, Visits to Solar and other industries/grids.

BE 002	MACHINE VISION, SENSORS AND SENSOR ARCHITECTURES	4 (0+4)

- Overview of machine vision systems and their applications, Importance of sensors in machine vision, Basic principles of image processing and analysis
- Classification of sensors based on various criteria (type of measurement, operating principle, etc.), Overview of common sensor types: optical sensors, proximity sensors, temperature sensors, pressure sensors, etc.
- Comparison of different sensor technologies in terms of accuracy, response time, cost, and suitability for specific applications
- Components of a sensor system (sensor element, signal conditioning circuitry, interface electronics, etc.)
- Sensor characteristics: sensitivity, resolution, linearity, hysteresis, etc.
- Considerations in sensor selection and integration for specific applications
- Basics of image acquisition: sensors, lenses, lighting, Image processing techniques: filtering, edge detection, segmentation, feature extraction, etc., Role of algorithms in image analysis and interpretation
- Components and architecture of a typical machine vision system, Integration of sensors and vision systems for industrial automation and quality control
- Applications of machine vision in various industries (manufacturing, automotive, pharmaceuticals, etc.)
- Principles of 3D vision and depth sensing technologies, Types of 3D sensors: stereo vision, structured light, time-of-flight, etc.
- Applications of 3D vision in robotics, metrology, object recognition, etc.
- Examples of multisensor systems in real-world applications
- Overview of smart sensors and their capabilities (self-calibration, self-diagnosis, etc.), Integration of sensors into IoT (Internet of Things) platforms Case studies of IoT applications in agriculture
- Introduction to sensor networks, Communication protocols for sensor networks (Bluetooth, Zigbee, LoRaWAN, etc.)
- Basics of embedded vision systems, Integration of sensors and vision processing capabilities into embedded systems
- Applications of embedded vision in autonomous vehicles, drones, consumer electronics, etc.
- Real-world examples of sensor systems and machine vision applications, Hands-on exercises and projects involving sensor integration and image processing, Industry visits or guest lectures from professionals working in the field.
- Emerging trends in sensor technology and machine vision, Challenges in developing advanced sensor systems (miniaturization, power efficiency, cost

reduction, etc.), Ethical and societal implications of widespread sensor deployment and data collection, Plants/Industrial visits for different area.

BE 003	OPERATION AND MAINTENANCE OF SOIL CONSERVATION STRUCTURES	4 (0+4)

- Survey for slope, stream order and land use/land cover
- Site selection of soil conservation structures based on survey
- Ground truthing of various structures
- Study of different types of soil conservation structures
- Trenching and diversions structures
- Study of types bunding and its features
- Study of types of terracing and its features
- Study of drop spill way: components, function, site suitability
- Study of drop inlet spillway: components, function, site suitability
- Study of chute spillway: components, function, site suitability
- Study of check dams- construction, site suitability
- Study of construction materials of different structures
- Cost estimation of different conservation structures
- Preparation of Detail Project Report, Site Visits

BE 004	CONSTRUCTION, MANAGEMENT AND MAINTENANCE OF PROTECTED CULTIVATION STRUCTURES	4 (0+4)

- Study of different protected structures and their uses
- Acquaint with different components of protected structures
- Construction of different protected structures
- Study of glazing materials and their properties
- Selection of different construction materials and their specifications
- Management of micro climate parameters in protected structures
- Monitoring of micro climate inside protected structures
- Automatic monitoring of micro climate inside protected structure
- Use of Irrigation and fertigation in protected cultivation
- Visit to different hydroponics systems under protected structures, Site visits

AET 392-BE	CASE STUDY	1(0+1)	SEM VI

Objective

To enable the students to generate an in-depth, multi-faceted understanding of a specific case/ situation/ aspect related to the profession in its real-life context

Activities

The students will be assigned to visit to a nearby area/ entity to study and analyse any particular case.

The case study can be either problem-solving type or descriptive type. The problem-solving case studies would aim to investigate a problem or situation in a particular individual or group, and recommend solution to the problem(s) based on analysis and theory.

Descriptive case studies would aim to understand a situation better. For example, identifying what happened and why by describing particular aspects of that situation and analysing it in terms of theoretical categories. This will help to make a choice about how to do things in a better way in future for another case having similar features.

Some indicative areas for the case studies are as follows.

- Study the status of farm mechanization in a particular village and to suggest improvement measures.
- Visit to a retail store/ farm machinery dealer and report on supply chain network

After the visit, the students will submit a report to the institution on their observations. They may also be asked to present the report before the other faculty members and students for interaction.

CIVIL AND ENVIRONMENTAL ENGINEERING

CE 101	SURVEYING AND LEVELLING	3 (1+2)	SEM I

Objectives

To enable the students to conduct the survey work for any area and also to prepare layout of engineering structures

Theory

Surveying: introduction, classification, and basic principles; Linear measurements, chain surveying, cross staff survey, compass survey; Errors in measurements, their elimination and correction; Plane table surveying, methods, advantages, and disadvantages. Levelling, error in levelling, contouring, computation of area and volume. Theodolite traversing, introduction to setting of curves; Total station, electronic theodolite; Introduction to GPS survey.

Practical

Linear measurements using different instruments; Reconnaissance survey in the field; Use of field book; Study on various types of chain used in chain survey and its components; Study of errors in chain surveying; Use of ranging rods and ranging in the field; Obstacles during chaining; Offsets in chain survey; Cross Staff; Survey of an area; Preparation of map; Study on various types of compass; Compass survey of an area; Plotting of compass survey; Plane table surveying and different methods; Study on various types of levels and its components; Setting up of dumpy level in the field; Computation of various methods for RL; Study on Levelling, L section and X sections and its plotting; Study on contour and its characteristics; Contour survey of an area and preparation of contour map;; Theodolite surveying; Ranging by Theodolite; Height of object by using Theodolite; Setting out curves by Theodolite; Use of minor instruments; Use of total station, EDM in the field.

Suggested Readings

1. Agor R. *A Text Book of Surveying & Levelling*. Khanna Publishers, New Delhi
2. Arora K R. 1990. *Surveying (Vol. I)*, Standard Book House, Delhi.
3. Kanetkar T P. 1993. *Surveying and Levelling*. Pune Vidyarthi Griha, Prakashan, Pune.
4. Punmia B C. 1987. *Surveying (Vol. I)*. Laxmi Publications, New Delhi.

CE 201	ENGINEERING MECHANICS	3 (2+1)	SEM III

Objective

To make the students acquainted with the principles of engineering mechanics and the calculation of different stresses to be helpful for design of engineering structures.

Theory

Basic concepts of engineering mechanics, statics, dynamics, kinetics, scalar quantities, vector quantities, systems of units. Composition and resolution of forces, analytical method, graphical method. Laws of forces, moments and their application, levers, parallel forces, and couples. Equilibrium of forces, free body diagrams. Centre of gravity (CG) of simple geometrical figures, CG by moments, plane figures, axis of references, CG of symmetric sections, unsymmetrical sections, solid bodies, and cut sections. Moment of inertia: Methods of finding out M.I., methods of integration, M.I. of different sections, Theorem of perpendicular axes, parallel axes, M.I. of composite sections and cut sections. Frictional forces, static friction, dynamic friction, limiting friction, normal reaction, angle of friction, coefficient of friction, laws of friction, equilibrium of a body lying in horizontal and inclined planes, ladder friction; wedge friction, screw friction, screw jack. Analysis of simple framed structures, methods of sections, force table, methods of joints, hinged joints, roller support, vertical and inclined loads. Simple stresses and strain, Hooke's law, Poisson's ratio, modulus of elasticity, Strain related problems. Shear force and bending moment, fundamentals of shear force and bending moment, SFD and BMD of cantilever and simply supported and overhanging beams, point of contra-flexture.

Practical

Problems on composition and resolution of forces; Study the moments of a force; Problems related to resultant of a concurrent-coplanar force system; Problems related to non-concurrent coplanar force system; Systems of couples in space; Problems related to centroids of composite areas; Problems on Moment of Inertia, radius of gyration of composite areas; Analysis of equilibrium of concurrent coplanar and non-concurrent coplanar force system; Problems involved with frictions; Analysis of simple trusses by methods of joints and methods of sections; Analysis of simple trusses by graphical method; Problems on simple stress and strains; Problems on shear and bending moment diagrams. Problems on stresses on beams. Problems on torsion of the shafts; Analysis of plane and complex stresses.

Suggested Readings

1. Bansal, R. K. 2005. A Text Book of Engineering Mechanics. Laxmi Publishers, New Delhi.
2. Khurmi, R. S. 2006. Strength of Materials. S. Chand Publishing.

3. Khurmi, R. S. 2018. A Text Book of Engineering Mechanics. S. Chand Publishing.
4. Prasad, I. B. 2004. Applied Mechanics and Strength of Materials. Khanna Publishers, New Delhi.
5. Prasad, I. B. 2004. Applied Mechanics. Khanna Publishers, New Delhi.
6. Sundarajan, V. 2002. Engineering Mechanics and Dynamics. Tata McGraw Hill Publishing Co. Ltd, New Delhi.
7. Timoshenko, S. and Young, D. H. 2003. Engineering Mechanics. McGraw Hill Book Co., New Delhi.

CE 203	SOIL MECHANICS	2 (1+1)	SEM III

Objective

To make the students acquainted with the principles of soil mechanics and the calculation of different stresses in soil, which will be helpful in designing the retaining walls and other engineering structures.

Theory

Introduction to soil mechanics, field and scope of soil mechanics; Phase diagram, physical and index properties of soil, particle size distribution, grain size distribution curve, soil indices; plastic limit, liquid limit, shrinkage limit; Classification of soils, effective and neutral stress, Boussinesq and Westerguard's analysis, New-mark's influence chart, stress distribution and diagrams. Shear stress, Mohr's circle, direct shear stress, triaxial test and vane shear test; Mohr coulomb failure theory, effective stress principle, determination of shear parameters by direct shear test, triaxial test and vane shear test. Numerical exercise based on various types of tests. Compaction of soils, standard and modified protector test, Abbot's compaction and Jodhpur mini compaction test, field compaction method and control; Consolidation of soils, Terzaghi's theory of one-dimensional consolidation, spring analogy, Laboratory consolidation test, calculation of void ratio and coefficient of volume change, Taylor's and Casagrande's method. Earth pressure: Plastic equilibrium in soils, active and passive states, Rankine's theory of earth pressure, active and passive earth pressure for cohesive soils, simple numerical exercises; Stability of slopes: introduction to stability analysis of infinite and finite slopes friction circle method, Taylor's stability number, friction circle method.

Practical

Determination of moisture content of soil sample; Determination of specific gravity of soil sample; Study of field density by core cutter; Study of bulk density, dry density by sand replacement method; Determination of grain size distribution of coarse grained soil by sieving; Determination of liquid limit by Casagrande apparatus; Determination of plastic limit of soil specimen; Determination of shrinkage limit of soil; Determination of optimum moisture content of saturated soil by compaction test; Determination of optimum moisture content of saturated soil by Proctor's mould; Consolidation characteristics of soil; Shear strength of soil by direct shear test; Shear strength of soil by tri-axial shear test.

Suggested Readings

1. Punmia, B. C., Jain, A. K. and Jain, A. K. 2005. Soil Mechanics and Foundations. Laxmi Publications (P) Ltd. New Delhi.
2. Ranjan, G. and Rao, A. S. R. 1993. Basic and Applied Soil Mechanics. Welley Easters Ltd., New Delhi. 3. Singh, A. 1994. Soil Engineering. Vol. I. CBS Publishers and Distributions, Delhi

CE 202	THEORY OF STRUCTURES	2 (1+1)	SEM IV

Objective

To make the students acquainted with the principles of structural design and to enable them to design small and medium RCC and steel structures.

Theory

Types of Load and use of BIS code Design of steel structures: Specifications, use of IS code (IS 800-2007) and steel table, design of steel sections under tension, compression and bending, use of any one design software such as Staad Pro, ETABS, etc. for design of roof truss. Design of RCC structures: Specifications, use of IS code (IS 456-2000), analysis and design of singly and doubly reinforced sections, design of beams, design of one way and two-way slabs, columns and foundations, design considerations for retaining walls and silos, use of design software for simple RCC structures.

Practical

Design and drawing of steel roof truss including tension member, compression member, and member under bending; Use of design softwares; Design and drawing of RCC building, including single reinforced beam, double reinforced beam, one-way slab, two-way slabs, columns and foundations; use of design softwares for simple RCC structures.

Suggested Readings

1. Bhavikatti, S. S. 2014. Design of Steel Structures: By Limit State Method as Per IS: 800-2007. I K International Publishing House Pvt. Ltd.
2. Duggal, S. K. 2017. Limit State Design of Steel Structures. McGraw Hill Education.
3. Punmia, B. C., Jain, A. K. and Jain, A. K. 2016. Limit State Design of Reinforced Concrete. Laxmi Publications.
4. Raju, N. K. 2019. Design of Reinforced Concrete Structures: IS:456-2000. CBS Publishers & Distributors
5. IS456-2000 Indian Code of Practice for Concrete Structures
6. IS800- 2007 Indian Code of Practice for Structural Steel
7. Steel table by Dhanpat Rai and Sons.

CE 204	BUILDING CONSTRUCTION AND COST ESTIMATION	2 (2+0)	SEM IV

Objective

To make the students acquainted with the methods of construction of agricultural buildings and to enable them to prepare various types of estimates of buildings

Theory

Building materials: Description of important building materials, rocks, different stones; formation of stones, types of stones, quarrying process, stone products and uses; Bricks, types, preparation and burning of bricks, properties and uses; Tiles, types and classification; Lime, properties and uses, cement, different uses and grades. Concrete: Grades, preparation, mixing and laying of concrete, use of sand; Use of ferrous material, iron and steel products; Use of non-ferrous metals, glass, rubber, plastics, aluminum, copper, nickel; Timber and its uses, seasoning, defects, commercial form of timber, miscellaneous building materials. Building construction: Building components, foundations, brick work, lintels, columns, roofs and stair cases, different types of floors, plastering and pointing, damp proofing and waterproofing, white washing, distempering and painting, steps for building construction, needs of different agricultural buildings, types and uses, types of roofs, slope and flat roof buildings. Estimating and costing: Types of estimates, rough cost, detailed and supplementary estimate, preparation of cost estimate, cost analysis, schedule of rates, analysis of rates, factors affecting building costs, building codes, estate development. Cost economics: Measurement and pricing, economic methods for evaluation of buildings, benefit cost calculation, rate of return period (payback period).

Suggested Readings

1. Duggal, S. K. 2012. Building Material. New Age International Publishers.
2. Dutta, B. N. 2000. Estimating and Costing. UBS publishers.
3. Punmia, B. C., Jain, A. K. and Jain, A. K. 1984. Building Construction. Laxmi Publications (P) Ltd., New Delhi.
4. Rangwala, S. C. 1994. Engineering Materials. Charotar Publishing House, Anand.
5. Sane, Y. S. 1964. Planning and Designing of Buildings. Engineering Book Publishing Co. Pune.

CE 301	STRENGTH OF MATERIAL	2 (1+1)	SEM V

Objective

To make the students acquainted with the importance of strength parameters of different materials and the techniques to calculate unknown forces in 2D structures

Theory

Introduction to strength of materials. Slope and deflection of beams: Slope and deflection of beam using integration techniques, moment area theorems, conjugate beam method, problems of slope and deflection. Theory of columns and struts, problems of column and struts. Steel connections: Analysis of rivet connections, analysis of welded connections. Stability analysis of masonry dam; problems on masonry dam. Statically indeterminate structures- analysis of propped beams, analysis of fixed beams, analysis of continuous beams using superimposition and three moment equation. Analysis of beam using moment distribution method and solving problem

Practical

To determine the quality of check of two different aggregates through impact test; To perform the tensile test of steel specimen - to observe the behaviour of materials under load - to calculate the value of e- ultimate stress, permissible stress, percentage elongation etc. And to study its fracture; To prepare mortar specimen of different cement, demoulding of the specimen next day for compression and tension test after 2nd and 4th week; To prepare concrete specimen to perform the compression, bending test and to measure elasticity - concrete cylinders, cubes and beams to test after 2nd and 4th week; To perform compression and tension test on mortar specimen prepared 2 weeks before; To perform compression and bending test of the concrete specimen prepared 2 weeks before; To perform compression and tension test on mortar specimen prepared 4 weeks before; To perform compression and bending test of the concrete specimen prepared 4 weeks before; To determine young's modulus of elasticity of beam with the help of deflection produced at centre due to loads placed at centre and quarter points; To perform Brinell's hardness tests on a given specimen; To study the behaviour of materials under torsion and to evaluate various elastic constants; To study load deflection and other physical properties of closely coiled helical spring in tension and compression; To write detail report emphasizing engineering importance of performing tension, compression, bending, torsion, impact and hardness tests on the materials. Principal stresses and strain, analysis of plane and complex stress, principal planes and principal stresses, Mohr's circle, finding out principal stresses, different analysis.

Suggested Readings

1. Junarkar, S. B. 2001. Mechanics of Structures (Vo-I). Choratar Publishing House, Anand.
2. Khurmi, R. S. 2006. Strength of Materials. S. Chand Publishing, New Delhi.
3. Lehri, R. S. and Leheri, R. S. 2006. Strength of Materials. S.K. Kataria & Sons, New Delhi.
4. Ramamrutham, S. and Narayanan, R. 2003. Strengths of Materials. Dhanpat Rai and Sons, Nai Sarak, New Delhi.
5. Vazirani, V. N., Ratawani, M. M. and Duggal, S. K. 2012. Analysis of Structures. Khanna Publishers, New Delhi

CE 302	AGRICULTURAL STRUCTURES AND ENVIRONMENTAL CONTROL	3 (2+1)	SEM VI

Objectives

1. To make the students acquainted with the different types of agricultural structures
2. To enable them to prepare plan and estimate for different farm structures and environment control measures.

Theory

Farm and farmstead, farmstead planning and lay out; Environmental control- scope, importance and need, physiological reaction of livestock, environmental control,

systems and design, control of temperature, humidity and air ventilation; BIS standards for dairy, piggery and other farm structures. Farm structures- design, construction and cost estimation of farm structures, animal shelters, compost pit, fodder silo, farm fencing, implement shed, barn for cows, buffalo, poultry etc.; Greenhouses- types, poly houses /shed nets, cladding materials, plant environment interactions, design and construction of greenhouses, site selection, orientation, design for ventilation requirement using exhaust fan system, selection of equipment, greenhouse cooling and heating system. Grain storage structures- grain storage methods, moisture and temperature change in grain bins, traditional storage structures and their improvement, improved storage structures (CAP, hermitage storage, Pusa bin, RCC ring bin), design consideration for grain storage go-down, bag storage structure, shallow and deep bins, calculation of pressure in bins; Storage of seeds. Rural housing and development; Farm roads- types of roads in the farm, construction methods, repair and maintenance of rural roads; Water supply and sanitation- sources of water supply for human beings and animals, drinking water standards, water treatment for rural community, site selection and orientation of buildings for sanitation; Sewage system and design, maintenance, septic tank for small family. Rural electrification- estimate of domestic power requirement, sources of power supply, electrification for rural housing.

Practical

Measurement of environmental parameters, Temp, RH, wind velocity, cooling load; Design and layout of a dairy farm; Design and layout of a poultry house; Design and layout of a goat/sheep house; Design and layout of a farm fencing system; Design and layout of a feed/fodder system; Design and layout of a green house; Design and layout of a grain storage structure; Design and layout of a bag storage structure; Performance of domestic storage structure; Design layout of a threshing floor.

Suggested Readings

1. Banerjee, G. C. 2007. A Text Book of Animal Husbandry. Oxford IBH Publishing Co, New Delhi.
2. Dutta, B. N. 2016. Estimating and Costing in Civil Engineering. Dutta & Co, Lucknow.
3. Garg, S. K. 2010. Water Supply Engineering. Khanna Publishers, New Delhi.
4. Khanna, P. N. 1958. Indian Practical Civil Engineer's Hand Book. Engineer's Publishers, New Delhi. 5. Nathonson, J. A. 1996. Basic Environmental Technology. Prentice Hall of India, New Delhi.
5. Ojha, T. P. and Michael, A. M. 1966. Principles of Agricultural Engineering. Vol. I. Jain Brothers, Karol Bag, New Delhi.
6. Pandey, P. H. 2004. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.
7. Rao, P. V. 2012. Text Book of Environmental Engineering. Prentice Hall of India, New Delhi.
8. Sahay, K. M. and Singh, K. K. 2004. Unit Operations of Agricultural Processing. Vikas Publishing Pvt. Ltd, Noida.

COMPUTER SCIENCE, ELECTRICAL AND ELECTRONICS ENGINEERING

EE 101	BASIC ELECTRICAL GADGETS AND INSTRUMENTS	3 (2+1)	SEM I

Objective

To enable the students to take up repair and maintenance of different common electrical gadgets and instruments.

Theory

Introduction to different electrical appliances used in agricultural buildings, structures, and farm operations; Difference between AC and DC supply systems; Introduction to AC fundamentals; AC through series RL, RC, and RLC circuits, parallel AC circuit, series, and parallel resonance; Q-factor and bandwidth.

Three-phase AC circuit: Concept of balanced three-phase AC circuits, line and phase quantity in star and delta network, power in three-phase circuit, various methods of three-phase power measurement like (one wattmeter and two–wattmeter method).

Diode and its applications: Rectifier, Clipper, Clamper, voltage multiplier, and capacitive filter Zener diode as voltage regulator.

Transistor and its applications: Bipolar junction transistor, operating point. Various biasing methods, fixed, self-biasing, and potential divider biasing method; OP-AMP, Ideal OP-AMP characteristics, Linear and non-linear applications of OP-AMP (adder, subtractor, integrator, active rectifier, comparator).

Principles of general instruments, measurement of displacement, temperature, velocity, force, and pressure using different instruments like strain gauges, load cells, thermistors, thermocouples, pyrometers, linear variable differential transformers (LVDT), capacitive transducers, RTD, instruments for measurement of speed, wind velocity, solar radiation, anemometer, multimeter, etc.

Practical

Basic Electrical and Electronics Gadgets

To prepare an electrical switchboard to control two light points, one plug point, one fan point, and fuse (House wiring); To prepare an electrical switchboard to control two light points using two two-way switch (staircase wiring); To connect and test a fluorescent lamp; To find faults and repair home appliances such as heater, electric iron, fans and mixer-grinder, etc.; To find faults and repair UPS; To measure the power requirement and power factor in an AC single-phase series RLC circuit; To measure the energy of a single-phase AC circuit with the help of ammeter, voltmeter, and power factor meter, and energy meter; To measure the power consumption in a three-phase circuit using two-wattmeter method.

Instrumentation

To prepare a DC power supply unit using diode and filter circuit; To study the Zener diode as voltage regulator circuit; To study transistor characteristics in CE configurations; To measure unknown resistance using Wheatstone bridge; To

measure the displacement and to determine the characteristics of LVDT; To measure the displacement using LVDT and potentiometer; To measure the pressure using strain gauge and Bourdentube; To measure the temperature using RTD, thermistors and thermocouple and study their characteristics; To measure the speed, wind velocity, solar radiation, etc, using different measuring tools like tachometer, anemometer, pyranometer, multimeter, etc.; To acquaint with different other types of instruments used in agriculture and food processing applications.

Suggested Readings

1. Boylestad R L and Nashelsky L N. 2011. Electronic Devices and Circuit Theory. Pearson.
2. Ghosh S. 2007. Fundamentals of Electrical and Electronics Engineering. Second edition. PHI Learning, New Delhi.
3. Metha V K and Metha R. 2012. Basic Electrical Engineering. Fifth edition. S Chand & Co., New Delhi.
4. Metha V K and Metha R. 2012. Principle of Electronics. Fifth edition. S Chand & Co., New Delhi.
5. Rajput R K. 2007. Basic Electrical and Electronics Engineering. Laxmi Publications, New Delhi.
6. Theraja B L and TherajaA K. 2005. A Text Book of Electrical Technology. Vol. I & II. S Chand & Co., New Delhi.

EE 102/ CSE 102	**COMPUTER PROGRAMMING AND DATA STRUCTURES**	**2 (0+2)**	**SEM II**

Objective

To make the students conversant on computer programming languages, specifically C language as well as to make him familiar with programming for simple agricultural engineering applications

Practical

Introduction to high-level languages; Structure programming, C programming, a simple C programming, execution of a C program, program and instruction; Familiarizing with Turbo C

IDE; Building an executable version of C program; Study of different operators such as arithmetic, relational, logical, assignment, increment and decrement, conditional, bitwise and special operators, precedence of arithmetic operators; Debugging a C program; Developing and executing simple programs; Creating programs using decision making statements such as if, go to and switch; Developing program using loop statements while, do and for; Using nested control structures; Familiarizing with one and two-dimensional arrays; Using string functions; Creating user-defined functions; Developing structures and union; Using local, global and external variables; Using pointers; Developing linked lists in C language; Inserting an item in Linked List; Deleting an item in Linked List; Implementing Stacks; Implementing push/pop functions; Creating queues, Insertion/Deletion in queues.

Suggested Readings

1. Augenstein, L. and Tanenbaum. 2003. Data structures using C and C++. PHI/Pearson Education.
2. Balagurusamy, E. 1990. Programming in 'C'. Tata McGraw Hill Publishing Co. Ltd., 12/4 Asaf Ali Road, New Delhi.
3. Bronson, G. and Menconi, S. 1995. A First Book of 'C' Fundamentals of 'C' Programming. Jaico Publishing House, New Delhi.
4. Drozdek, A. 2012. Data Structures and Algorithms in C++. Vikas Publishing House / Thomson International Student Edition.
5. Goodrich, M T, Tamassia, R and Mount, D. 2011. Data structures and Algorithms in C++. Wiley Student Edition, John Wiley and Sons.
6. Rajaraman, V. 1985. Computer Oriented Numerical Methods. Prentice Hall of India. Pvt. Ltd, New Delhi.
7. Rajaraman, V. 1995. Computer Programming in 'C'. Prentice Hall of India Pvt. Ltd., New Delhi.
8. Sahni, S. 2006. Data Structures, Algorithms and Applications in C++. University Press (India) Pvt. Ltd / Orient Longman Pvt. Ltd.
9. Weiss, M. A. 2007. Data Structures and Algorithm Analysis in C++. Pearson Education.
10. Agarwal, A. 2005. The Complete Reference Guide: Data Structure through C. ISBN: 8178840448; Publisher: Cyber Tech Publications.

EE 104/ CSE 104 (VAC)	INFORMATICS AND ARTIFICIAL INTELLIGENCE	3 (2+1)	SEM II

Objectives

1. To acquaint students with the basics of computer applications in engineering, multimedia, database management, application of mobile apps and decision-making processes, etc.
2. To provide basic knowledge of computers with applications in engineering and to make the students familiar with agricultural informatics, its components, and applications.

Theory

IT applications for computation farm operations; Computer-controlled devices (automated systems) for agri-input management; smartphone mobile apps in agriculture for farm advice: postharvest management, etc.; Geospatial technology: concepts, techniques, components, and uses for generating valuable information
e-Agriculture, Concepts, design, and development; Application of innovative ways to use information and communication technologies (IT) in Engineering; Computer Models: Statistical, weather analysis, and crop simulation models: concepts, structure, inputs outputs files, limitations, advantages, and application of models for understanding plant processes, sensitivity, verification, calibration, and validation

Decision support systems: concepts components and applications in engineering; agriculture expert system; Soil Information Systems, etc. for supporting farm

decisions. Preparation of contingent crop-planning and crop calendars using IT tools; Digital India and schemes to promote digitalization of agriculture in India.

Introduction to Artificial Intelligence, background, and applications, Turing test. Control strategies, Breadth-first search, Depth-first search; Heuristics search techniques: Best-first search, algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, and accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/ Linux, creating files and folders, File Management. Use of MS Word and MS PowerPoint for creating, editing, and presenting scientific documents, MS- EXCEL - Creating a spreadsheet. Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands-on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smartphones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial Technology, Hands on practice on preparation of Decision Support System, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA)

Suggested Readings

1. Choudhary K. R. Fundamentals of Artificial Intelligence. Springer
2. Date, C. J. 2000. Introduction to Database Management System. Addison-Wesley.
3. ITL Educations Solutions Ltd. Introduction to Information Technology. Pearson Education.
4. Kumar, E. 2020. Artificial Intelligence. Wiley.
5. Nilson, N.J. 2001. Principles of Artificial Intelligence. Narosa.
6. Rajaraman, V. and Adabala, N. Fundamentals of Computers. PHI Learning Pvt. Ltd, New Delhi.
7. Russell, Stuart. 2013. Artificial Intelligence: A Modern Approach. Pearson Edition.
8. Sethi, D. P. and Pradhan, M. 2017. Concepts and Techniques of Programming in C. I.K. International Publishing House Pvt. Limited.
9. Vanitha, G. 2023. Agro-Informatics. NIPA, New Delhi.

EE 302	SENSORS, ARTIFICIAL INTELLIGENCE AND ROBOTICS IN AGRICULTURE	3 (2+1)	SEM VI

Objectives

To enable the student to know the

1. Basics and selection of sensors for different agricultural applications
2. Application of artificial intelligence and AI programming techniques
3. Problem-solving through search and knowledge representation and reasoning with AI
4. Use of open-source hardware (Arduino and raspberry pi); robot programming, controlling algorithm and basics on neural network

Theory

Sensors Fundamentals: Introduction to sensors and transducers; Need for sensors in agriculture; Sensor Classification; Units of measurements; Sensor characteristics, Active and passive sensors– static characteristics, dynamic characteristics- first and second order sensors; Photoelectric effect – Photo dielectric effect – Hall effect – Thermoelectric effect– Piezoresistive effect – Piezoelectric effect – Pyroelectric effect- Magneto mechanical effect (magnetostriction) – Magneto resistive effect.

Sensors in different applications: Occupancy and motion detectors; Position, displacement, and level; Velocity and acceleration; Force, strain, and tactile Sensors; Pressure sensors, Temperature sensors, Optical sensors and electromagnetic wave detector. Capacitance sensors; Weather sensors, imaging sensors and their application in agriculture. Principle and working of sensors for soil moisture, soil temperature, chlorophyll meter, colour sensor, spectral sensor, temperature sensor, humidity sensor, wind speed, motion sensors, position sensor, etc.

Introduction to Artificial Intelligence: Overview- foundations, scope, problems, history and approaches of AI. Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents, AI programming techniques. Classical AI, concept of expert system, Advantages and limitations of AI systems.

Robotics: Introduction to Robotics-classification with respect to geometrical configuration (anatomy), selection based on the agriculture application; Hardware for robot, sensors and actuator in robot, control of robot, system interface and integration in robot; Communication- internal and external communications; Fundamentals of microprocessor architecture; Introduction to use of open-source hardware (arduino and raspberry pi); robot programming, controlling algorithm basic on neural network; Feedback system, safety sensors; components of Industrial robotics-precession of movement resolution, accuracy and Repeatability-Dynamic characteristics- speed of motion, load carrying capacity and speed of response.

Application in Agriculture: Introduction to precision farming tools for implementation of precision agriculture; Application of site-specific management - nutrient management, agrochemicals and fertilizer management, weeds management; Application of drone- pesticides/nutrient spraying, environmental monitoring; Yield monitoring and mapping, soil sampling and analysis; Protected cultivation - smart

irrigation system; precision livestock farming, application in food processing; gas and chemical sensor for electronic nose and electronic tongue.

Practical

Identify various sensors viz. Proximity sensors, ultrasonic sensors, optical sensors, electrochemical sensors and mechanical sensors; Measurement of displacement, force and pressure using different sensors; Use of load sensor on tractors to predict pulling requirements for ground engaging equipment; Introduction to open-source programming languages, advantages and drawbacks of open-source programming; Programming in Embedded- C, Concepts of C language;

Identify various components in open-source hardware (arduino and raspberry pi); Using of open source hardware and program for LED blink; Using of open source hardware and program for buzzer; Measurement of distance using ultrasonic sensor and IR sensor using open-source hardware and programs; Experiment using moisture, temperature and relative humidity sensors for automatic irrigation and protected cultivation; Detection based spraying system using ultrasound for spraying operation using opens source hardware by programming with sensor and testing; Detection based spraying system using ultrasound for spraying operation – installation on sprayer unit with actuator/sensor and testing; Learning about the different applications of robots in agriculture; Fabrication and integration of sensors; Visit to robot fabrication facilities/workshop.

Suggested Readings

1. Braunl, T. 2013. Embedded Robotics Mobile Robot Design and Applications with Embedded Systems. Springer Berlin Heidelberg.
2. Craig John, J. 2005. Introduction to Robotics. Pearson Education Inc., Asia, 3rd Edition.
3. Ghoshal, Asitava. 2006. Robotics: Fundamental Concepts and Analysis. Oxford University Press.
4. Gonzalez and Wintz. Digital Image Processing. 3rd edn.
5. Jha, S. N. 2015. Rapid Detection of Food Adulterants and Contaminants: Theory and Practice. Elsevier, USA (ISBN 9780124200845), p266.
6. Jha, S. N. (ed.). 2010. Non-destructive Evaluation of Food Quality: Theory and Practice. Springer Verlag GmbH Berlin Heidelberg, Germany, ISBN 978-3-642-15795-0, doi 10.1007/978-3-642-15796-7: 288p.
7. Nikku, S. B. 2020. Introduction to Robotics – Analysis, Control, Applications. 3rd edition. John Wiley & Sons Ltd., 2020.
8. Nilsson Nils, J. 1980. Principles of Artificial Intelligence. Elsevier.
9. Rich, Knight and Nair. Artificial Intelligence. Tata McGraw Hill.
10. Saha, S. K. 2014. Introduction to Robotics. Tata McGraw Hills Education, 2014.
11. Schilling Robert, J. 1990. Fundamentals of robotics – Analysis and control. Prentice Hall of India.

EE 401	ELECTRICAL MACHINES	3 (2+1)	SEM VII

Objectives

1. To make the students acquainted with operating principles of various electrical motors and other machines
2. To help them gain practical exposure of different electrical devices and their controls

Theory

Introduction to electrical machines; Basic principles of operation of electrical machines used in agricultural engineering such as DC generator, DC motor, 1-phase induction motor, 3-phase induction motor, and BLDC motor; Magnetic circuit: concept of magnetic flux production, magneto-motive force, reluctance, laws of magnetic circuits, determination of ampere-turns for series and parallel magnetic circuits, hysteresis, and eddy current losses.

Transformer: principle of working, construction of single-phase transformer, EMF equation, phasor diagram on load/load, leakage reactance, voltage regulation, power, and energy efficiency, open circuit and short circuit tests.

D.C. machines: principles operation and performance of DC machine (generator and motor), EMF and torque equations, excitation of DC generator and their characteristics, DC motor characteristics, starting of shunt and series motor, starters, speed control methods-field and armature control.

Three-phase induction motor: construction, operation, types, concept of slip; slip speed and slip frequency, torque equation, torque-speed, and torque-slip characteristics, maximum torquefor starting and running conditions. phasor diagram, starting and speed control methods.

Single-phase induction motor: principle of operation, double field revolving theory, equivalent circuit, characteristics, methods of starting, phase split and shaded pole motors.

Practical

To study different parts of DC/AC machines; To perform open circuit test on a single phase transformer and determine its iron loss as well as open circuit parameters; To perform short circuit test on a single phase transformer and hence find copper loss, equivalent circuit parameters, voltage regulation and efficiency; To study how to start the D.C motor using 3-point Starter; To start and run the D.C. motor (shunt, series and compound); To control the speed of DC shunt motor using flux control method; To control the speed of DC shunt motor using armature voltage control method; To conduct brake test on DC shunt motor and to determine its performance curves; To obtain the load characteristics of DC shunt motor and draw its characteristics; To start and run the 3-phase induction motor using star-delta starter and to find different voltage and current under star and delta connection; To perform no-load teston3-phase induction motor and to determine its no-load losses; To perform blocked-rotor tests on 3-phase induction motor to obtain the equivalent circuit parameters and to draw the circle diagram; To perform no load on1-phase induction motor to determine its no-load losses; To perform blocked-rotor test on 1-phase induction motor and to

determine the parameters of equivalent circuit on the basis of double revolving field theory; To perform load-test on1-phase induction motor and plot torque-speed characteristic.

Suggested Readings

1. Anwani, M. L. 1997. Basic Electrical Engineering. Dhanpat Rai & Co. (P) LTD. New Delhi.
2. Boylestad, Robert, L. and Louis, N. 2015. Electronic Devices and Circuit. 11th edn. Pearson India.
3. Shaney, A. K. 1997. Measurement of Electrical and Electronic Instrumentation. Khanna Publications
4. Thareja, B. L. and Theraja, A. K. 2005. A Textbook of Electrical Technology. Vol. I. S. Chand & Company LTD., New Delhi.
5. Theraja, B. L. and Theraja, A. K. 2005. A Textbook of Electrical Technology. Vol. II. S. Chand & Company LTD., New Delhi.

MECHANICAL ENGINEERING

ME 101	WORKSHOP TECHNOLOGY AND PRACTICE	2 (0+2)	SEM I

Objective

To expose the students to basic manufacturing processes involved for production of different machine elements and to facilitate hands-on experience of using these machines.

Practical

Introduction about different shops in the workshop, Safety and precautions to be taken in the workshops; Study of different tools used for fitting and different fitting operations; Study of various measuring instruments used for fitting; Exercise in fitting: sawing, filing and right angle fitting of MS flat, working with complex fitting jobs: operations of drilling, reaming, and threading and with tap dies; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: cross half lap joint or T-half joint, Mortise and Tenon joint in carpentry; Preparation of dovetail joint in carpentry; Study of welding, types of welding, oxyacetylene gas welding, types of flames, welding techniques and equipment used for gas welding, working with welding equipment; Working with electric arc welding; Equipment and tools, safety and precautions taken in arc welding; Preparation of Butt joint and lap joint with ARC welding; Preparation of Lap and butt joints using gas welding; Working on a lathe machine and study of different tools used in lathe machine; Exercise on simple turning, step turning in lathe machine; Preparation of job on taper turning, drilling, knurling and threading in lathe machine; Working with different machines in machine shop such as shaper, milling machine, etc. and with different tools used in machine shop; Exercise on bending, shaping etc.; Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets; Practice job on shaper with change in shape; Exercise on a milling machine for making a slot and others.

Suggested Readings

1. Chapman W A J. 2018. Workshop Technology (Vol. I and II). Arnold Publishers (India) Pvt. Ltd., AB/9, Safdarjung Enclave, New Delhi.
2. Hajra Choudhury S K, Roy N, Hajra Choudhury A K. 2017. Elements of Workshop Technology (Vol. I and II). Media Promoters and Publishers Pvt. Ltd, Mumbai.
3. Khurmi R S and Gupta J K. 2018. A Text Book of Workshop Technology. S. Chand & Company Ltd, New Delhi.
4. Raghuwansi B S. 2016. A Course in Workshop Technology (Vol. I and II). Dhanpat Rai and Sons, 1682, Nai Sarak, New Delhi.

ME 102	ENGINEERING DRAWING	2 (0+2)	SEM II

Objective

To enable the students to draw engineering drawings for some simple machines/ equipment

Practical

Introduction to engineering drawing, practice of different layout drawings; Drawing instruments and their use; Introduction to lines, letterings, single stroke letters and gothic letters; Dimensioning, dimension line, extension line, arrow head, continuous and progressive dimensioning; Introduction of drawing scales, representative fraction; Practice on orthographic projections, references planes, drawing for orthographic projection of points by first angle projection method, third angle methods of projection; Introduction to isometric scale, isometric view and isometric drawing, isometric projection of geometrical solids, preparation of working drawing from models and isometric views; Screw threads nomenclature, thread profiles, multi start threads, left and right hand threads; Screw threads: conventional representation of threads, Forms of screw threads like V-threads, square threads; Square headed and hexagonal nuts and bolts, drawing of stud screws, set screws, butt, hexagonal and square; Drawing of keys: Sunk key, saddle key; Symbols for different types of welded joints.

Suggested Readings

1. Bhatt, N. D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd.,
2. Bhatt, N. D. and Panchal, V. M. 2013. Machine Drawing. Charotar Publishing House Pvt. Ltd., Anand.
3. Narayana, K. L. and Kannaiah, P. 2010. Machine Drawing. Scitech Publications (India) Pvt. Ltd, Chennai.
4. Dhawan, R.K. 2014. A textbook of Machine Drawing, S.Chand& Co. pvt.ltd. N. Delhi-55

ME 301	THEORY OF MACHINES	2 (1+1)	SEM V

Objectives

1. To enable the students to analyse the relative motion between various parts of machine and forces which act on them
2. To apply the theories in designing the various parts of the machine

Theory

Simple mechanism: Elements, links, pairs, kinematics chain, and mechanisms, classification of pairs and mechanisms, lower and higher pairs, four bar chain, slider crank chain and their inversions; Velocity mechanisms: determination of velocity and acceleration using graphical (instantaneous centres) method; Types of gears, law of gearing, velocity of sliding between two teeth in mesh, involute and cycloidal profile for gear teeth, spur gear, nomenclature; Introduction to helical, spiral, bevel and worm gear; Simple, compound, reverted, and epicyclic trains; determining velocity ratio by tabular method; Turning moment diagrams, coefficient of fluctuation of

speed and energy, weight of flywheel, flywheel applications; Belt drives: Types of drives, belt materials, length of belt, transmitted power, velocity ratio, belt size for flat and V belts; effect of centrifugal tension, creep and slip on power transmission; Chain drives, classification of chain drive, terms used in chain drive; Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, Sensitiveness, stability, hunting, isochronism, power and effort of a governor; Cam and followers: Types, classification, displacement, velocity and acceleration diagrams when the follower moves with uniform velocity.

Practical

Study of pairs and mechanisms, lower and higher pairs; Four bar chain, slider crank chain and their inversions; Introduction to helical, spiral, bevel and worm gear; Study of simple, compound, reverted, and epicyclic trains; Study of belt drives and their types; Constructional details and analysis of Watt, Porter, Proell governors; study of cam and followers mechanism, types, classification.

Suggested Readings

1. Ballaney, P. L. 2016. *A Text Book of Theory of Machines*. Khanna Publishers, New Delhi.
2. Bansal, R. K. 2009. *A Text Book of Theory of Machines*. Laxmi Publications (P) Ltd., New Delhi.
3. Khurmi, R. S. and Gupta, J. K. 2010. *A Text Book of Theory of Machines*. Euresia PublishingHouse (P) Ltd, New Delhi.
4. Ratan, S. S. 2010. *A Text Book of Theory of Machines*. Tata McGraw Hill Publishing CompanyLtd, New Delhi.

ME 302	THERMODYNAMICS AND HEAT TRANSFER	3 (2+1)	SEM VI

Objectives

1. To make the students acquainted with principles of thermodynamics and heat transfer
2. To make them understand the mathematical and practical aspects of heat exchangers

Theory

Basic concepts and definitions of thermodynamics, statistical and classical thermodynamics, microscopic and macroscopic point of view; Thermodynamic systems- thermodynamic equilibrium, properties of systems; state, path, process, cycle; point function, path function; temperature and zeroth law of thermodynamics, pressure, specific volume, density, energy, work and heat. First law of thermodynamics: internal energy, law of conservation of energy, first law of thermodynamics, application of first law to a process; energy-a property of system, perpetual motion machine of the first kind-PMM1; Characteristic equation of state, specific heats; application of first law of thermodynamics to non-flow or closed system; free expansion and throttling process; Second law of thermodynamics: limitations of first law of thermodynamics and introduction to second law, statements of second law of thermodynamics: Clausius statement, Kelvin-Planck statement;

Perpetual motion machine of the second kind-PMM2, Clausius inequality, Carnot Cycle, Carnot's Theorem, entropy, entropy changes for a closed system.

Concept, modes of heat transfer, Thermal conductivity of materials, measurement, general differential equation of conduction, one dimensional steady state conduction through plane and composite walls, tubes and spheres without heat generation, electrical analogy, insulation materials and fins; Free and forced convection, Newton's law of cooling, heat transfer coefficient in convection non-dimensional numbers; Combined free and forced convection. Thermal radiation, black body radiation, Stefan-Boltzman law, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity. Heat transfer analysis involving conduction, convection and radiation; Types of heat exchangers; fouling, log mean temperature difference, heat exchanger performance, transfer units, Heat exchanger analysis restricted to parallel and counter flow heat exchangers; Introduction to mass transfer, analogy between heat and mass transfer, Fick's law of diffusion.

Practical

Study on thermodynamic air cycles; Study of Carnot cycle; Study of conduction heat transfer in composite wall, Study of temperature distribution along the length of a pin under free convection heat transfer and forced convection heat transfer; Study of fins and their types; Newton's law of cooling and thermal conductivity of metal bar; Emissivity of a test plate; Study of radiation heat transfer by black body and test plate; Calculate rate of heat transfer, LMTD and overall heat transfer coefficient for parallel flow heat exchanger and counter flow heat exchanger; Determine the Stefan Boltzman's constant.

Suggested Readings

1. Gupta, C. P. and Prakash, R. 2008. *Engineering Heat Transfer*. Nem Chand and Bros., Roorkee.
2. Kumar, D. S. 2016. *Engineering Thermodynamics*. S.K. Kataria & Sons, Delhi.
3. Rajput, R. K. 2019. *A Text Book of Heat and Mass Transfer*. S. Chand & Company Ltd., New Delhi.
4. Domkundwar. Heat and Mass transfer Data Book. Dhanpat Rai & Co. Delhi
5. Kothandaraman, C.P. Steam Tables, New Age International Publishers, New Delhi-110002

ME 304	REFRIGERATION AND AIR CONDITIONING	3 (2+1)	SEM VI

Objectives

1. To make the students acquainted with the principles of refrigeration, different types of refrigerating equipment
2. To enable them to design the refrigeration and air conditioning systems

Theory

Definition of pure substance, phases of a pure substance, phase change process of a pure substances; Compressed liquid and saturated liquid, saturated vapour and superheated vapour, saturated temperature and saturated pressure; T-V diagram for

heating of water at constant pressure. Latent heat: Latent heat of fusion, latent heat of vaporization, liquid vapour saturation curve; property diagram for phase change process, T-V diagram, P-V diagram, P-T diagram, property tables, state-liquid and vapour states, saturated liquid-vapour mixture, superheated vapour, compressed liquid. Principles of refrigeration, units, terminology, production of low temperatures, air refrigerators working on reverse Carnot cycle and Bell Coleman cycle; Vapour refrigeration-mechanism, P-V, T-S, P-h diagrams, vapour compression cycles, dry and wet compression, super cooling and sub cooling; Vapour absorption refrigeration system. Common refrigerants and their properties; Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric processes. Air conditioning: principles, type and functions of air conditioning, physiological principles in air conditioning, air distribution, and factors considered for designing an air conditioning system; Room ratio line, sensible heat factor, by-pass factor; types of air conditioners and their applications; Cold storage plants, calculation of refrigeration load and cold storage design considerations.

Practical

Study of P-V and T-S chart in refrigeration; Study P-h chart (or) Mollier diagram in refrigeration; Solving problems on air refrigeration cycle; Solving problems on vapour compression refrigeration cycle; Study of domestic water cooler; Study of domestic household refrigerator; Study of vapour absorption refrigeration system; Study of cooling tower and to find its efficiency; Study of heat pump test rig; Study of Ice plant test rig; Study of psychrometric chart and various psychrometric processes; Solving problems on psychometrics; Study of window air conditioner; Study cold storage for fruit and vegetables, freezing load and time calculations for food materials; Study on repair and maintenance of refrigeration and air-conditioning systems; Visit to chilling or ice making and cold storage plants.

Suggested Readings

1. Arora, C. P. 2012. Refrigeration and Air Conditioning. Tata-McGraw-Hill, New Delhi.
2. Khurmi, R. S. 2016. Refrigeration and Air Conditioning. S Chand and Co. Ltd, Ram Nagar, New Delhi.
3. Prasad, Manohar. RAC Data Book, New Age International Publishers, New Delhi-110002
4. Khurmi, R.S., Refrigeration tables & charts. S. Chand publishers, New Delhi

ME 401	MACHINE DESIGN	2 (1+1)	SEM VII

Objective

To make the students acquainted with design considerations for various machine components to enable them to take up the work of new design

Theory

Phases of design, design considerations; Common engineering materials and their mechanical properties; Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress, stress concentration, elementary fatigue and creep aspects; Design of shafts under torsion and combined bending and torsion; Design of keys; Design of muff or sleeve couplings; Design of welded subjected to static loads; Cotter joints, design of socket and spigot cotter joint; knuckle joint; Design of helical and leaf springs; Design of flat belt and V-belt drives and pulleys; Terminologies and types of gears; Selection of anti-friction bearings.

Practical

To enumerate the most commonly used engineering materials with their property and applications. To discuss the mechanical properties of engineering metals. Tutorials on the manufacturing considerations in machine design with limit systems. Tutorials on the solution of design of shafts, keys and couplings, design of helical and leaf spring, design of belts.

Suggested Readings

1. Bhandari, V. B. 2007. *Introduction to Machine Design*. Tata Mc. Graw Hill Publishing House. New Delhi.
2. Jain, R. K. 2013. *Machine Design*. Khanna Publishers, 2-B Nath Market, Nai Sarak, New Delhi.
3. Khurmi, R. S. and Gupta, J. K. 2014. *A Text Book of Machine Design*. S. Chand & Company Ltd., New Delhi.
4. Sharma, P. C. and Agarwal, D. K. 2010. *Machine Design*. S. K. Kataria & Sons, New Delhi.
5. Kumar, Arun. Data Book for designing machine elements. S.K.Kataria& Sons Publication.

ME 403	ENGINEERING GRAPHICS AND DESIGN	2 (0+2)	SEM VII

Objectives

1. To acquaint the students with CAD software for drawing of machine components
2. To integrate the computers at various levels of planning and manufacturing

Practical

Application of computers for design; CAD- introduction, overview of CAD window; Various options on drawing screen; Practice on draw and dimension tool bar; Practice on OSNAP, line thickness and format tool bar; Practice on mirror, offset; Practice on array commands; Practice on trim, extend; Practice on trim chamfer and fillet commands; Practice on copy, move, scale and rotate commands; Drawing of 2 D-drawing using draw tool bar; Practice on creating boundary, region, hatch and gradient commands; Practice on Editing polyline- PEDIT and Explode commands; Setting of view ports for sketched drawings; Printing of selected view ports in various paper sizes; 2D- drawing of machine parts with all dimensions and allowances; Drawing of foot step bearing, knuckle joint; Sectioning of foot step bearing and stuffing box; Drawing of hexagonal, nut and bolt and other machine parts; Practice on

3-D commands- Extrusion and lift, sweep and press pull, revolving, joining; Design of farm machinery equipment using 3D modelling CAD software (Auto CAD, Fusion 360,solid works etc),Practice with drawing problem with allied software; Demonstration on CNC machine and practice problems.

Suggested Readings

1. Lee, K. 1999. *Principles of CAD/CAM/CAE Systems*. Addison Wesley Longman, Inc.
2. Rao, P. N. 2002. *CAD/CAM Principles and Applications*. McGraw-Hill Education Pvt. Ltd.,New Delhi.
3. Sareen, K. and Grewal, C. D. 2010. *CAD/CAM Theory and Practice*. S. Chand & Company Ltd., New Delhi.
4. Zeid, I. 2011. *Mastering CAD/CAM with Engineering*. McGraw-Hill Education Pvt. Ltd., New Delhi.

CE 402	ENVIRONMENTAL ENGINEERING	3 (2+1)	SEM VIII

Objectives

To enable the students to understand

1. The water requirements for domestic, industrial and commercial demand and sources of water supply, analysis of water quality. importance to sanitation, domestic waste water treatment, sewer design, disposal of waste water in urban and rural areas
2. The air pollution, types of pollutants, and their abetments

Theory

Importance of safe water supply system; Water requirements for urban and rural areas; domestic, industrial and commercial demand, per capita demand- variation in demand, population estimation- design period, population forecasting methods; Sources of water supply- surface and sub-surface sources of water, surface sources-lakes, rivers, reservoirs; Intakes and transportation of water- various types of conduits including gravity conduits such as canals, flumes, aqueducts, pressure conduits-design of pressure pipes as gravity mains, Darcy-Wesbach, Manning, Hazen William formula, flow in pipes system- forces acting on pressure conduits-cast iron pipes, steel, RCC, PVC, asbestos and concrete pipes, laying of pipes and testing of pipes, testing of pipes; Selection of pumps, efficiency of pumps, economic diameter of pumping mains; Drinking water quality: Indian standards of drinking water; Introduction to water treatment: purification of water supply, sedimentation, filtration-coagulation, water softening, water treatment methods.

Importance to sanitation, domestic waste water: quantity, characteristics, disposal in urban and rural areas; Sewer: types, design discharge and hydraulic design, Introduction to domestic wastewater treatment. Design of septic tank, sewerage system- domestic and municipal wastes, storm sewage, flow through sewers, design of sewers, manhole, sewage characteristics, BOD, COD, dissolved oxygen, nitrogen; Solid water collection and disposal, Solid waste quantity, characteristics and disposal for urban and rural areas.

Introduction to air pollution, types of pollutants, properties and their effects on living beings, BIS standards for pollutants in air and their abetments.

Practical

Study of population forecasting problems; Determination of turbidity, pH and EC of water; Study of suspended solids, dissolved solids and total solids; Study of temporary and permanent hardness; Determination of fluorides and chlorides in drinking water; Determination of dissolved oxygen, COD and BOD of water; Study of hydraulics of pipe lines and distribution network design; Visit to a water treatment plant; Study of maintenance of distribution system; Collection of air samples and their analysis; Design of septic tank, sewer pipe lines and waste disposal measures; Visit to a sewage treatment plant; Visit to a municipal solid waste management plant; Visit to a community bio gas plant.

Suggested Readings

1. Chatterjee, A. K. 2006. Water Supply, Waste Disposal & Environmental Engineering. Khanna Publishers, Delhi
2. Garg, S. K. 1977. Environmental Engineering. Vol, I and II. Khanna Publishers, Delhi
3. Rao, P. V. 2002. Text book of Environmental Engineering. Prentice Hall of India Pvt. Ltd.

EE 402	MATLAB PROGRAMMING	3 (1+2)	SEM VIII

Objective

To enable the students to know the different features of MATLAB and have hands-on exercise on it and use the MATLAB for different agricultural engineering applications

Theory

Introduction: platform and features, prerequisites and system requirements, advantages and disadvantages.

Commands, environment, working with variables and arrays, workspace, variables and functions, data types, operator, formatting text.

MATLAB Control Statements: if statement, if-else statement, if-elseif statement, nested if-else, switch.

MATLAB loops: for loop, while loop, nested loop, break, continue.

MATLAB error control: error control statement-try and catch.

Arrays and functions: matrices and arrays, multi-dimensional arrays, compatible array, sparse matrices; Functions: normal functions, predefined functions, user-defined functions, anonymous Function

2D Plots: fplot(), Semilogx(), Semilogy(), loglog(), fill(), Bar(), errorbar(), barh(), plotyy(), area(), Pie(), hist(), stem(), Stairs(), compass(), comet(), contour(), quiver(), pcolor();

3D Plots: plot3(), fill3(), contour3(), surf(), surfc(), mesh(), meshz(), waterfall(), stem3(), ribbon(), sphere(), ellipsoid(), cylinder(), slice()

Practical

Hands on experience with MATLAB functionalities and its installation on different platforms; MATLAB project based on real time Agricultural Engineering problems.

Suggested Readings

1. Getting Started with MATLAB by Rudra Pratap, Oxford University Press
2. MATLAB: A Practical Introduction to Programming and Problem Solving by Stormy Attaway published by Elsevier India
3. MATLAB Programming for Engineers by Stephen J. Chapman, Published by CL Engineering
4. MATLAB for Dummies by Jim Sizemore

EE 404	ARTIFICIAL INTELLIGENCE	3 (2+1)	SEM VIII

Objective

To enable the students to know the details of problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning, communicating, perceiving, and acting in artificial intelligence

Theory

Foundation and history of artificial intelligence; Intelligent agents, structure of agents; AI programming languages, introduction to LISP and PROLOG; Solving problems by searching, problem solving agents, infrastructure for search algorithms, measuring problem solving performance, blind search strategies, breadth first search, depth first search, heuristic search techniques, best first- A* algorithm, AO* algorithm; Hill climbing search, Genetic algorithms; Games, game tree, game playing, min-max algorithms, alpha beta pruning; Logical agents, knowledge representation issues, predicate logic, logic programming; Constraint satisfaction problems, backtracking search; Knowledge representation- representing knowledge using rules, rules based deduction systems, semantic nets, frames, inheritance, temporal reasoning; Quantifying uncertainty, reasoning under uncertainty; Probabilistic reasoning- review of probability, Baye's probabilistic interferences, Dempstershafer theory, fuzzy reasoning; Classical planning- planning, representation for planning, partial order planning algorithm; Planning and acting in the real world-planning in situational calculus, high level actions; Supervised learning, artificial neural networks, neural network structures, single-layer feed-forward neural networks (perceptron), multilayer feed-forward neural networks, learning in multilayer networks; Knowledge in learning- a logical formulation of learning, explanation-based learning; Natural language processing- principles of natural language processing; Expert systems, knowledge acquisition concepts; Robotics, AI application to robotics; Current trends in intelligent systems.

Practical

Hands on exercise on problem solving in artificial intelligence, details of knowledge, reasoning, and planning in artificial intelligence, learning in artificial intelligence, communicating, perceiving, and acting in artificial intelligence and verifying engineering concepts in artificial intelligence.

Suggested Readings

1. Nilson, N. J. 2002. Principles of Artificial Intelligence. Narosa Publishing House. Rich, E. and Knight, K. 1991.
2. Artificial Intelligence. Times McGraw-Hill. Russell, S. and Norvig, P. 1998.
3. Artificial Intelligence: A Modern Approach. Prentice Hall. Winston, P. H. 1992. Artificial intelligence. Addition Wesley 3rd edn.

EE 406	MECHATRONICS	3 (2+1)	SEM VIII

Objectives

To enable the students to

1. Know the measurement system, control systems, microprocessor-based controllers of A.C. & D.C. motor
2. Understand the principles behind the working of different data acquisition, digital signal processing
3. Know the different application of microcontrollers, PLC. robotics, robot components, robot classification and specification

Theory

Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach; Sensors and transducers- performance terminology, displacement, position and proximity sensors, photo-electric transducers, flow transducers, optical sensors and transducers; Actuators and mechanical actuation systems- hydraulic and pneumatic actuation systems, measurement system, electrical actuation systems, A.C. motor, D.C. motor, stepper motor, signal conditioning process, filtering digital signal, data acquisition system, multiplexers, digital signal processing, pulse modulation, data presentation systems. System modelling and control- mathematical models, engineering systems, electro-mechanical and hydraulic-mechanical systems, modelling dynamic systems, transfer functions, control modes and PID controller. Micro-processor and computer-computer and interfacing, micro-computer structure, micro controllers, application of microcontrollers, PLC, robotics, robot classification and specification, robot components, work envelopes, other basic parameters of robots, robot applications, robot applications in manufacturing, material transfer and machine loading/ unloading, processing operations like welding and painting, assembly operations, inspection, automation, future applications.

Practical

Study of different types transducers; Selection of sensor for a particular application from catalogue and internet; Design of a mechatronics product/ system; Application of mechatronics for enhancing product values; Study of electrical actuation systems with A.C. Motor and with D.C. Motor; Study of electrical actuation systems with Stepper Motor; Study of the PID Controller; Study of the hardware and software of mechatronics kit; Study of the pulse modulation, data presentation systems; Moving a table in X-direction within the range of proximity sensors using Control-X software; Running a motor with PLC; Running a conveyor with computer; Study of the movement of actuating cylinders and sensors

Suggested Readings

1. Bolton, W. 2015. Mechatronics. Pearson Education Asia.
2. Craig, J. J. 1986. Introduction to Robotics. Pearson Education International.
3. Doeblin, E. O. 1966. Measurement Systems. McGraw-Hill Inc.
4. Malvino, A. P. 1983. Digital Computer Electronics. McGraw-Hill Inc.
5. Niku, S. Y. 2001. Introduction to Robotics: Analysis, systems and Applications. Pearson Education International.
6. Stadler, W. 1995. Analytical Robotics and Mechatronics. McGraw-Hill Inc.

EE 408/ REE 402	PHOTOVOLTAIC TECHNOLOGY AND SYSTEMS	3 (2+1)	SEM VIII

Objectives

1. To enable the students to understand the basic elements of photovoltaics, working of PV cells, designs of PV systems

2. To know the installation of PV system both off grid and on grid

Theory

Solar PV Technology: advantages, limitations, current status of PV technology, SWOT analysis of PV technology; Types of solar cells: Wafer based silicon cell, Thin film amorphous silicon cell, Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell; Solar photo voltaic module: solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module, balance of solar PV system; Solar PV system designing and cost estimation.

Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters; Charge controller: types and function of charge controller, PWM (Pulse width modulation) type, MPPT (Maximum Power Point Tracking) type charge controller; Converters: DC to DC converter and DC to AC type converter.

Application of solar PV system, solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, roof top solar photovoltaic power plant and smart grid.

Practical

Study of V-I characteristics of solar PV system; Smart grid technology and application; Manufacturing technique of solar array; Different DC to DC and DC to AC converter; Domestic solar lighting system; Various solar module technologies; Safe measurement of PV modules electrical characteristics and commissioning of complete solar PV system.

Suggested Readings

1. Derrick, A., Francis, C. and Bokalders, V. 1991. Solar Photo-voltaic Products. Intermediate Technology Publications.
2. Meinel, A. B. and Meinel, M. P. 1976. Applied Solar Energy: An Introduction. Addison-Wesley Educational Publishers Inc.
3. Rai, G. D. 1998. Non-conventional Sources of Energy. Khanna Pub.

4. Rathore, N. S., Kurchania, A. K. and Panwar, N. L. 2006. Renewable Energy: Theory & Practice. Himanshu Publications.
5. Solanki, C. S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications. PHI Learning Private Ltd.

ME 402/EE 410	MACHINE LEARNING	3 (2+1)	SEM VIII

Objectives

To enable the students to

1. Know the basics of machine learning
2. Know the applications of machine learning in different fields

Theory

Introduction to Machine Learning, Preliminaries, what is machine learning; varieties of machine learning, learning input/output functions, bia, sample application. Boolean functions and their classes, CNF, DNF, decision lists. Version spaces for learning, version graphs, learning search of a version space, candidate elimination methods; Neural Networks, threshold logic units, linear machines, networks of threshold learning units, Training of feed forward networks by back propagations, neural networks vs. knowledge-based systems; Statistical Learning, background and general method, learning belief networks, nearest neighbor. Decision-trees, supervised learning of uni-variance decision trees, network equivalent of decision trees, over fitting and evaluation. Inductive Logic Programming, notation and definitions, introducing recursive programs, inductive logic programming vs decision tree induction; Computational learning theory, fundamental theorem, VapnikChernonenkis dimension, linear dichotomies and capacity. Unsupervised learning, clustering methods based on Euclidian distance and probabilities, hierarchical clustering methods. Introduction to reinforcement and explanation-based learning.

Practical

Hands on experience with Machine Learning functionalities and its use in agricultural engineering and allied fields.

Suggested Readings

1. Ethem, Alpaydin. 2009. Introduction to Machine Learning. 3rd edn. MIT Press.
2. Muller, Andreas C. 2009. Introduction to Machine Learning with Python- A Guide for Data Scientists.
3. Sarah Guido, O'Reilly Muller, J P. and Massaron, L. 2021. Machine Learning for Dummies. 2nd edn. Weily.

ME 404	OPERATIONS RESEARCH	3 (2+1)	SEM VIII

Objectives

To enable the students to

1. Understand the importance of operations research for solving field problems
2. Understand and apply linear programming, transportation problem, etc. for agricultural engineering applications

3. Understand the project planning and network analysis

Theory

Introduction to operations research: elementary concepts and objectives, applications of operations research in decision making; Linear programming problem- mathematical formulation of the linear programming problem and its graphical solution, simplex method, simplex method for maximizing and minimizing, mixed constraints, duality theory, the Primal-vs- Dual solutions; Transportation problem, definition and mathematical formulation, initial basic feasible solution, optimal solution; Assignment problem, introduction and mathematical formulation, solution of Assignment problem; Inventory control, introduction and general notations, economic lot size models with known demand; Replacement theory, introduction and elementary concepts, replacement of items deteriorating with time; Sequencing problem: introduction and general notations, solution of a sequencing problem; Queuing theory: introduction and classification of queues, solution of queuing models; Project planning and network analysis: introduction and basic definitions in Network Analysis, rules for drawing Network Analysis, Critical Path Method (CPM), Project Evaluation and Review Technique (PERT).

Practical

Hands on practice with Transportation problem, various methods and techniques to identifying deteriorating time and planning. Tutorials with numerical problems for formulation and network analysis

Suggested Readings

1. Taha, H. 2003. Operations Research. Macmillan Publishing Company.
2. Winston, W. L. 2004. Operations Research: Applications and Algorithms. Indian University.

FARM MACHINERY AND POWER ENGINEERING

Course No.	Course Title	Credits	Semester
Core Courses			
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)	I
AET 192[§] (SEC)-FMPE	Skill Enhancement	8 (0+8)	II
FMPE 201	Farm Machinery and Equipment I	3 (2+1)	III
FMPE 202	Farm Machinery and Equipment II	3 (2+1)	IV
FMPE 204	Farm Machinery and Power (For B.Sc.(Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	2 (1+1)	IV
FMPE 301	Tractor and Automotive Engines	3 (2+1)	V
FMPE 302	Tractor Systems and Controls	3 (2+1)	VI
AET 392[§] (SEC)-FMPE	Case Study	1 (0+1)	VI
AED 491♀-FMPE	Project I	3 (0+3)	VII
AED 492♀-FMPE	Project II	4 (0+4)	VIII
	Total Credits	**33 (11+22)**	
Elective Courses (Any Three)**			
FMPE 402	Mechanics of Tillage and Traction	3 (2+1)	VIII
FMPE 404	Farm Machinery Design and Production	3 (2+1)	VIII
FMPE 406	Tractor Design and Testing	3 (2+1)	VIII
FMPE 408	Human Engineering and Safety	3 (2+1)	VIII
FMPE 410	Hydraulic Drives and Controls	3 (2+1)	VIII
FMPE 412	Precision Agriculture and System Management	3 (2+1)	VIII
FMPE 414	Advances in Automation and Robotics in Agriculture	3 (2+1)	VIII
	Total Credits	**21 (14+7)**	
	Grand Total	**54 (25+29)**	

[$] On sharing basis with other departments

AED 191	INTRODUCTION TO AGRICULTURAL ENGINEERING	3 (2+1)	SEM I

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post-harvest and allied activities

Theory

Farm mechanization needs and strategy; Classification of farm machinery on the basis of unit operations; Principles of selection of machinery for different sizes of land and matching power sources; Different types of equipment for tillage, sowing, planting and transplanting, fertilizer application, weed control, plant protection; Harvesting and threshing equipment for rice, wheat, maize, cotton, sugarcane, fruits, tuber crops and other locally important crops; Functions and capabilities of tractor and power tillers; Introduction to the IC engine systems, fuel and air supply systems, cooling and lubricating systems, and electrical systems in a tractor; Basic parts of a power tiller; Hitching system.

Practical

Study of various implements (tillage, sowing, planting, weeding, fertilizer application); Study of farm implements (pesticide application, harvesting and threshing); Study of various components of tractor and matching implements; Study of various components of power tiller and matching implements; Visit to implement manufacturing unit; Visit to a mechanized farm

Suggested Readings

1. Jain S C and Philip G. 2009. Farm Machinery - An Approach. Second Edition. Standard Publishers and Distributors, New Delhi.
2. Michael A M and Ojha T P. 2003. Principles of Agricultural Engineering. Jain Brothers, New Delhi.
3. Nakra C P. 1980. Farm Machines and Equipment. Dhanpat Rai Publishing Company Pvt. Ltd, New Delhi.
4. Suresh R and Kumar Sanjay. 2018. Farm Power and Machinery Engineering. Standard Publisher Distributors, New Delhi.

AET 192 (SEC)-FMPE	SKILL ENHANCEMENT	8(0+8)	SEM II

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG-certificate, they can work as operators and technicians in the fields of farm machinery, micro-irrigation, solar and wind energy or food processing, etc. or can go for self-employment or start their own agro-service centre, agro-processing centre or similar activities. Thus, the broad objective of this course is Skill for Employment and Entrepreneurship Development.

INDICATIVE MODULES

FMPE 001	OPERATION AND MAINTENANCE OF FARM MACHINERY	4 (0+4)

- Constructional details, adjustment and working of primary tillage equipment such as mould board plough and disc plough
- Constructional details, adjustment and working of secondary tillage equipment such as cultivators, harrows
- Constructional details, adjustment and working of weeding equipment such as manual weeder, power weeder/ dry land weeders/ low land weeders/ interculture equipment
- Constructional details, adjustment and working of rotary tillage / active tillage equipment such as tractor operated /power tiller operated rotavator
- Constructional details, adjustment and working of sowing equipment such as seed drills, planters and transplanters, minimum tillage equipment
- Adjustments and calibration of seed drills
- Working with different types of furrow openers with seed drills/ planters
- Constructional details, adjustment and working of metering mechanisms of drills and planters
- Details of precision farm equipment such as laser 242arburett, zero till drills, pneumatic planters etc.
- Constructional details, adjustment and working with earth moving equipment such as bulldozers, trenchers and elevators, etc.
- Constructional details, adjustment and working of transplanting equipment such as rice transplanters and vegetable transplanters
- Seedling raising technique for transplanters
- Constructional details, adjustment and working of harvesting equipment such as root crop harvesters (bullock drawn as well as tractor operated groundnut diggers) and grain crop harvesters (self-propelled / tractor operated/ power tiller operated vertical conveyer reapers) etc.
- Constructional Details, adjustment and working of threshing equipment such as axial flow paddy threshers, combine harvesters etc.

FMPE 002	REPAIR AND MAINTENANCE OF TRACTORS AND POWER TILLERS	4 (0+4)

- Study of different systems of tractor and power tiller
- Study of different terminology related to engine: piston, cylinder, rings, fly wheel, firing interval, firing order
- Study of fuel system, working principle, repair and maintenance
- Working of fuel pumps, fuel filters and injectors
- Study of lubrication system, working principle, repair and maintenance
- Working of oil filters, oil pumps etc.
- Study of cooling system, working principle, repair and maintenance

- Working of thermostat valve
- Study of tractor/ power tiller engine system
- Study of power transmission system of tractor/ power tiller (different types of clutches/gears/sliding mesh gear box/constant mesh gear box/ planetary gear box etc. in tractor; power transmission in power tiller)
- Study of differential / final drive/ PTO drive, their working principle/ repair and maintenance
- Study of braking system: different types of brakes/ their components and working principle/ adjustment / repair
- Study of steering system, types of steering system, steering geometry: caster angle, camber angle, toe-in, toe-out etc. working principle, adjustments, repair and maintenance
- Steering in power tiller: Dog clutch and other arrangements
- Study of hydraulic system of tractor, automatic draft and position control, hitch system, their working principle, practical hitching, repair and maintenance
- Study of tyres, rims, their construction and specification, repair and maintenance
- Daily, weekly and monthly maintenance schedule. Maintenance after each 50, 125, 250 and 500 hours of operation
- Engine overhauling and assembling.
- Implement hitching and detaching from tractor as well as power tiller
- Safety rules

FMPE 003	**MANAGEMENT OF AGRICULTURAL MACHINERY CUSTOM HIRING AND MAINTENANCE FACILITIES**	**4 (0+4)**

- Terms associated with machinery management for correct understanding
- Different ways machinery can be obtained for use on the farm
- Factors that affect the purchase of machinery
- Advantages and limitations of two-wheel drive tractors
- Advantages and limitations of four-wheel drive tractors
- Calculation of the theoretical capacity of a farm machines
- General rules concerning field efficiency
- Calculation of field capacity of a farm machines
- Distinguishing between types of costs of machinery ownership
- Understanding how cost and machine use are related
- Calculation of salvage value of a farm machine
- Calculation of average machine investment of a farm machine
- Calculation of annual fixed cost of a farm machine
- Calculation of repair cost for a farm machine
- Calculation of fuel and lubrication costs for a tractor
- Calculation of labor cost for a farm machine
- Understanding causes of fatal tractor accidents
- Learning of procedures for safe machine operation

- Understanding the reasons for efficiency in tractor operation
- Preventative maintenance of farm Machinery
- List five areas of servicing machinery
- Calculate estimated variable cost of a farm machine
- Calculate overall cost per acre for farm machinery
- Calculate equipment width (size) to match tractor horsepower

FMPE 004	OPERATION AND MAINTENANCE OF DRONES USED FOR AGRICULTURAL APPLICATIONS	4 (0+4)

- Overview of drone technology, Importance of drones in agriculture. Types of agricultural drones (fixed-wing, rotary-wing, multi-rotor), Regulatory framework and compliance requirements for agricultural drone operations
- Understanding the components of a drone (frame, motors, propellers, flight controller, sensors, etc.), functionality of each component and its role in drone operation, basics of drone aerodynamics and flight principles
- Introduction to various sensors used in agricultural drones (RGB cameras, multispectral cameras, thermal cameras, LiDAR, etc.)
- Applications of different sensors in agriculture (crop monitoring, pest detection, irrigation management, etc.), Payload integration and compatibility considerations
- Principles of flight planning for agricultural drone missions, Selection of appropriate flight parameters (altitude, speed, overlap, etc.), Use of mission planning software and tools, Pre-flight checks and safety protocols
- Techniques for data acquisition during drone flights, Post-flight data processing and analysis,
- Interpretation of aerial imagery and sensor data, Software tools for data processing and visualization
- Applications of drones in crop monitoring (plant health assessment, yield estimation, disease detection, etc.), Integration of drone data with precision agriculture techniques; Decision support systems for crop management based on drone data
- Using drones for early pest and disease detection, Identification of common pests and diseases in crops, Monitoring strategies for pest infestations and disease outbreaks
- Role of drones in assessing soil moisture levels and irrigation needs, Optimizing irrigation scheduling with drone data, Water resource management and conservation using drone technology
- Routine maintenance procedures for agricultural drones, Diagnosing and troubleshooting common issues (motor failure, GPS signal loss, sensor calibration, etc.), Battery management and care
- Safety protocols for drone operations in agricultural settings, Understanding airspace regulations and restrictions, Emergency procedures and risk mitigation strategies

- Real-world examples of successful drone applications in agriculture, Hands-on exercises and field demonstrations
- Challenges and opportunities for the widespread adoption of drone technology in agriculture, Ethical and societal implications of drone use in farming

FMPE 201	FARM MACHINERY AND EQUIPMENT I	3 (2+1)	SEM III

Objective

To make the students acquainted with the basic construction and operational features of different farm machineries used in operations such as seed-bed preparation, sowing, planting and transplanting, etc., and their economics of operation.

Theory

Introduction to farm mechanization; Classification of farm machines; Unit operations in crop production; Identification and selection of machines for various operations on the farm.

Materials used in construction of farm machines; Heat treatment processes and their use in farm machines; Properties of materials used for critical and functional components of agricultural machines; Different types of steels and alloys for agricultural applications; Identification of heat treatment processes specially for the agricultural machinery components.

Seed-bed preparation and its classification; Land reclamation and earth moving equipment; Machines used for primary tillage, secondary tillage, rotary tillage, deep tillage and minimum tillage, viz. mould-board plough, disc plough, chisel plough, sub-soiler, harrows, puddler, cultivators, identification of their major functional components; Attachments with tillage machinery; Hitching systems and controls.

Calculation of field capacities and field efficiency; Draft of tillage tools and calculations for power requirement for the tillage machines; Calculation for economics of machinery usage; Comparison of ownership with hiring of machines.

Sowing, planting and transplanting equipment, viz. seed drills, no-till drills, strip-till drills, different types of planters, bed-planters; Planting equipment for crops like sugarcane, potato; Furrow openers and metering systems in drills and planters; Calibration of seed-drills/ planters; Adjustments during operation.

Testing and Evaluation of tillage and sowing equipment and their test codes.

Practical

Familiarization with different farm implements and tools; Study of hitching systems; Study on draft measurement; Study of different problems on machinery management.; Study of primary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of secondary tillage machinery- types, construction, operation, adjustments and calculations of power and draft requirements; Study of different types of puddlers and determination of puddling index in the field; Study of sowing and planting equipment- construction,

types, calculation for calibration and adjustments; Study of seed drill and its calibration; Study of different types of metering mechanisms used in seed drills and planters; Study of paddy transplanters; Study of various pre-germinated paddy seeder; Study of vegetable transplanters; Identification of materials of construction in agricultural machinery and study of material properties; Testing and Evaluation of tillage and sowing equipment; Visit to a site to observe field operations of paddy transplanters; Visit to an implement manufacturing unit.

Suggested Readings

1. Jain, S. C. and Phillips, G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors.
3. Lal, Radhey and Datta, A. C. 1978. Agricultural Engineering through worked out examples. Saroj Prakashan, Allahabad.
4. Nakra, C. P. 2003. Farm Machines and Equipment. Dhanpat Rai and Publishing Co.
5. Smith, H. P. and Wilkes, L. H. 2011. Farm Machinery and Equipment. McGraw Hill Publication, New York.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Mich.
7. Srivastava, A. C. 1991. Elements of Farm Machinery. Oxford and IBH Publication.
8. Srivastava, T. K. 2007. A Work Book on Practical Farm Machinery (Vol. I and II). Saroj Prakashan, Allahabad.

FMPE 202	FARM MACHINERY AND EQUIPMENT II	2 (1+1)	SEM IV

Objective

To make the students acquainted with the basic construction and operational features, and economics of operation of different farm machineries used in operations such as weeding, harvesting, etc., including operations done by combines, etc.

Theory

Plant protection equipment: Different types of sprayers and dusters; Classification of sprayers and sprays; Types of nozzles; Calculations for calibration of sprayers and chemical application rates; Introduction to interculture equipment; Weeders- different types of manual and powered weeders; Functional requirements of weeders and main components; Different types of fertilizer application methods and equipment.

Harvesting of crops: Harvesting methods, harvesting terminology; Mowers– types, constructional details, working and adjustments; Shear type harvesting devices- cutter bar, inertia forces, counter balancing, terminology, cutting pattern; Reapers, binders and windrowers- principle of operation and constructional details; Hay conditioning, importance, methods of hay conditioning, and calculation of moisture content of hay.

Threshing: manual and mechanical systems; Types of threshing drums and their applications; Types of threshers- tangential and axial, constructional details and cleaning systems; Factors affecting thresher performance; Grain combines- combine terminology and features, classification of grain combines, study of material flow in combines; Computation of combine losses; Combine troubles and troubleshooting; Chaff cutters- working principle, constructional features and capacity calculations; Straw combines- working principle and constructional details.

Root crop diggers: Principles of operation, functional components, blade adjustment and approach angle, calculation of material handled; Potato and groundnut diggers; Cotton harvesting-cotton harvesting mechanisms, cotton pickers and strippers; Maize harvesting combines; Vegetables and fruit harvesting equipment and tools.

Testing and Evaluation of intercultural, plant protection and harvesting machinery and their test codes.

Practical

Familiarization with plant protection and interculture equipment; Study of sprayers- types, functional components, calibration; Study of dusters- types and functional components; Calculations for chemical application rates; Study of nozzle types and spread pattern using patternator; Familiarization with manual and powered weeding equipment and identification of functional components; Study of fertilizer application equipment including manure spreaders and fertilizer broadcasters; Study of various types of mowers, reaper, reaper binder; Study of functional components of mowers and reapers; Study of threshing systems, cleaning systems in threshers, calculations of losses in threshers; Study of functional units of grain combines and their types, calculations for grain losses in a combine; Study of root crop diggers and familiarization with the functional units and attachments; Study of the working of cotton and maize harvesters; Study of different vegetable and fruit harvesters; Testing and evaluation of intercultural, plant protection and harvesting machinery; Visit to field showing operations various machines; Visit to implement manufacturing unit.

Suggested Readings

1. Jain, S. C. and Phillips, G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors.
2. Kepner, R. A., Bainer, R. and Barger, E. L. 2005. Principles of Farm Machinery. CBS Publishers and Distributors.
3. Lal Radhey and Datta, A. C. 1978. Agricultural Engineering through Worked Out Examples. Saroj Prakashan, Allahabad.
4. Nakra, C. P. 2003. Farm Machines and Equipment. Dhanpat Rai and Publishing Co.
5. Smith, H. P. and Wilkes, L. H. 2011. Farm Machinery and Equipment. McGraw Hill Publication, New York.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Mich.

7. Srivastava, A. C. 1991. Elements of Farm Machinery. Oxford and IBH Publication.
8. Srivastava, T. K. 2007. A work Book on Practical Farm Machinery. Vol. I and II. Saroj Prakashan, Allahabad.
9. Suresh, R. and Kumar, S. 2018. Farm Power and Machinery Engineering. Standard Publishers.

FMPE 204	FARM MACHINERY AND POWER (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	2 (1+1)	SEM IV

Objective

To enable the students to understand the need of farm power, basic principles and parts of IC engine, different tillage, sowing, intercultural, plant protection equipment, working principles of threshers, harvesting of field and horticultural crops.

Theory

Status of Farm Power in India; Sources of Farm Power, I.C. engines, working principles of I Cengines; comparison of two stroke and four stroke cycle engines, Study of different components of I.C. engine, I.C. engine terminology and solved problems; Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication, fuel supply and hydraulic control system of a tractor; Familiarization with Power transmission system : clutch; gear box, differential and final drive of a tractor; Tractor types; Cost analysis of tractor power and attached implement; Criteria for selection of tractor and machine implements. Familiarization with Primary and Secondary Tillage implement; Implement for hill agriculture; implement for intercultural operations; Familiarization with sowing and planting equipment; calibration of a seed drill and solved examples; Familiarization with Plant Protection equipment; Familiarization with harvesting and threshing equipment.

Practical

Study of different components of I.C. engine. To study air cleaning and cooling system of engine; Familiarization with clutch, transmission, differential and final drive of a tractor; Familiarization with lubrication and fuel supply system of engine; Familiarization with brake, steering, hydraulic control system of engine; Learning of tractor driving; Familiarization with operation of power tiller; Implements for hill agriculture; Familiarization with different types of primary and secondary tillage implements: mould plough, disc plough and disc harrow; Familiarization with seed-cum-fertilizer drills their seed metering mechanism and calibration, planters and trans planter; Familiarization with different types of sprayers and dusters; Familiarization with different inter-cultivation equipment; Familiarization with harvesting and threshing machinery; Calculation of power requirement for different implements.

Suggested Readings

1. Sahay, J. 2015. Elements of Agricultural Engineering. Standard Publishers Distributors. New Delhi
2. Jain, S.C. and Rai, C.R. 2012. Farm Tractor Maintenance and Repair. Standard Publishers Distributors, New Delhi.
3. Kumar, Sanjay. 2008. Textbook of Tractor at a Glance A Unique Book of Farm Power International Book Distributing Company, Lucknow.
4. Nakra, C. P. 2016. Farm Machines and Equipments. Dhanpat Rai Publishing Company, New Delhi.

FMPE 301	TRACTOR AND AUTOMOTIVE ENGINES	3 (2+1)	SEM V

Objective

To make the students acquainted with the working principles of different systems of internal combustion engines and tractor.

Theory

Sources of farm power: conventional and non-conventional energy sources; Classification of tractors and IC engines.

Review of thermodynamic principles of IC (CI and SI) engines and deviation from ideal cycle; General energy equation and heat balance sheet; Derivation of thermal efficiency of Otto cycle, Diesel cycle and Dual cycle; Mechanical, thermal and volumetric efficiencies.

Study of engine components their construction, operating principles and functions; Engine strokes and comparison of 2-stroke and 4-stroke engine cycles and CI and SI engines; Engine valve systems, valve mechanism, valve timing diagram, valve clearance adjustment; Cam profile, valve lift and valve opening area.

Inlet and exhaust systems; Importance of air cleaning system; Types of air cleaners and performance characteristics of various air cleaners; Fuel supply system, types of fuels, properties of fuels, calculation of air-fuel ratio.

Different tests on fuel for SI and CI engines; Detonation and knocking in IC engines; Carburetion system, carburetors and their main functional components; Fuel injection system- injection pump, their types, working principles; Fuel injector nozzles- types and working principles. Engine governing- need of governors, governor types and governor characteristics; Lubrication system- need, types, functional components; Lubricants- physical properties, additives and their application. Engine cooling system- need, cooling methods and main functional components; Need and types of thermostat valves; Additives in the coolant; Radiator efficiency.

Ignition system of SI engines; Electrical system including battery, starting motor, battery charging, cut-out, etc.; Comparison of dynamo and alternator; Basics of engine testing.

Practical

Study of different systems of CI engines; Study of engine parts and functions, working principles, etc.; Study of valve systems construction and adjustments; Determination of physical properties of oil and fuel; Study of air cleaning system; fuel supply system of SI engine; Study of diesel injection system and timing; Study of cooling system, and fan performance, thermostat and radiator performance evaluation; Study of part load efficiencies and governing; Study of lubricating system and adjustments; Study of starting and electrical system; Study of ignition system; Study of tractor engine heat balance and engine performance curves; Study of dynamo; Visit to a nozzle calibration unit; Visit to engine manufacturer/ assembler/ spare parts agency.

Suggested Readings

1. Ganesan, V. 1999. Internal Combustion Engines. Mc Graw Hill, New Delhi.
2. Goering, C. E. and Hansen, A. C. 2004. Engine and Tractor Power. ASAE. St Joseph, Michigan.
3. Heitner, J. 2004. Automotive Mechanics: Principles and Practices. CBS Publishers.
4. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 1989. Tractors and Their Power Units. Van Nostrand Rainhold, New York.
5. Mathur, M. L. and Sharma, R. P. 1996. A course in Internal Combustion Engines. Dhanpat Rai and Sons, New Delhi.
6. Rodichev, V. and Rodicheva, G. 1984. Tractors and Automobiles. Mir Publishers, Moscow.
7. Singh, K. 2020. Automobile Engineering. Vol II. Standard Publishers and Distributors.

FMPE 302	TRACTOR SYSTEMS AND CONTROLS	3 (2+1)	SEM VI

Objective

To make the students acquainted with different systems in a tractor, such as the transmission, brake, steering and hydraulic systems

To understand the ergonomic and safety considerations in tractor

Theory

Transmission system- need of the system in a tractor, types, major functional systems; Clutch- need, types, functional requirements, construction and principle of operation; Single plate, multi-plate, centrifugal and dual clutch systems; Gear box- principle of operation, gear box types, functional requirements, and calculation for speed ratio; Differential system- need, functional components, construction, calculation for speed reduction; Final drive; Brake system- types, principle of operation, construction, calculation for braking torque; Steering system- requirements, steering geometry characteristics, functional components, calculation for turning radius; Ackerman steering; Steering systems in track type tractors; Hydraulic system- principle of operation, types, main functional components, functional requirements. hydraulic system adjustments and ADDC; Tractor power outlets- PTO standards, types and functional requirements.

Traction- traction terminology, theoretical calculation of shear force and rolling resistance of traction device; Wheels and tyres- solid tyres and pneumatic tyres, tyre construction and tyre specifications; Traction aids; Tractor mechanics- forces acting on the tractor, determination of CG of a tractor, importance and determination of moment of inertia of a tractor, tractor static equilibrium, tractor stability especially at turns; Maximum drawbar pull and its determination; Tractor as a spring-mass system; Ergonomic considerations and operational safety; Tractor testing; Engine test codes.

Practical

Study of basic transmission systems and components; Study of clutch functioning, parts and design problem on clutch system; Study of different types of gear box, calculation of speed ratios, design problems on gear box; Study on differential, final drive and planetary gears; Study of brake systems and some design problems; Study of geometry and adjustments of tractor steering; Study of hydraulic systems in a tractor, hydraulic trainer and design problems; Study of various controls in different makes of tractors in relation to anthropometric measurements; Determination of CG and moment of inertia of a tractor; Study of traction performance of a traction wheel; Study of power transmission system of tractor; Study of hitching system of tractor with various matching implements; Study on safety requirements of tractor during operation; Study of tractor testing; Visit to tractor dealers' outlet/ tractor manufacturers.

Suggested Readings

1. Barger, E. L., Liljedahl, J. B. and McKibben, E. C. 1967. Tractor and their Power Units. Wiley Eastern.
2. BIS Test codes for tractor.
3. Giri, N. K. 2013. Automobile Mechanics (SI Units). Khanna Publishers, Delhi.
4. Jain, S. C. and Rai, C. R. 2013. Farm Tractor, Maintenance and Repair. Standard Publisher and Distributers, Delhi.
5. Singh, K. 2020. Automobile Engineering. Standard Publisher and Distributers, Delhi.
6. Srivastav, A. K., Goering, C. E. and Rohrbach, R. P. 2005. Engineering Principles of Agricultural Machines. ASAE. St. Joseph, Michigan.

AET 392-FMPE	CASE STUDY	1(0+1)	SEM VI

Objective

To enable the students to generate an in-depth, multi-faceted understanding of a specific case/ situation/ aspect related to the profession in its real-life context

Activities

The students will be assigned to visit to a nearby area/ entity to study and analyse any particular case.

The case study can be either problem-solving type or descriptive type. The problem-solving case studies would aim to investigate a problem or situation in a particular individual or group, and recommend solution to the problem(s) based on analysis and theory.

Descriptive case studies would aim to understand a situation better. For example, identifying what happened and why by describing particular aspects of that situation and analysing it in terms of theoretical categories. This will help to make a choice about how to do things in a better way in future for another case having similar features.

Some indicative areas for the case studies are as follows.

- Study the status of farm mechanization in a particular village and to suggest improvement measures.
- Visit to a retail store/ farm machinery dealer and report on supply chain network

After the visit, the students will submit a report to the institution on their observations. They may also be asked to present the report before the other faculty members and students for interaction.

FMPE 402	MECHANICS OF TILLAGE AND TRACTION	3 (2+1)	SEM VIII

Objectives

To enable the students to

1. Know various engineering properties of soil and to understand the effect of these properties on the performance of tillage tools
2. Know the application of dimensional analysis on soil dynamics and traction
3. Understand the effect of soil compaction on crop growth
4. Know the use of GIS in soil dynamics

Theory

Introduction to mechanics of tillage tools, engineering properties of soil, principles and concepts, stress strain relationship; Design of tillage tools, principles of soil cutting, design equation, force analysis; Application of dimensional analysis in soil dynamics and traction prediction equation.

Introduction to traction and mechanics, off-road traction and mobility, traction model, traction improvement, tyres-functions, size, lug geometry and their effects, tyre selection and testing; Soil compaction and plant growth and variability; Application of GIS in soil dynamics.

Practical

Measurement of static and dynamic soil parameters related to tillage; Soil parameters related to puddling and floatation; Draft for passive rotary and oscillating tools, slip and sinkage under dry and wet soil conditions and load and fuel consumption for different farm operations; Weight transfer and tractor loading including placement and traction aids; Studies on tyres, tracks and treads under different conditions, and soil compaction and number of operations.

Suggested Readings

1. Gill and Vandenberg. 1968. Soil Dynamics in Tillage and Traction. Agricultural Research Service, USDA, Govt. Printing Press, Washington, D.C.

2. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 2004. Tractors and their Power Units. CBS Publishers
3. Macmillan R H. 2002. The Mechanics of Tractor-Implement Performance. International Development Technologies Centre, University of Melbourne.
4. Terzaghi K and Peck R B and Mesri G. 1996. Soil Mechanics in Engineering Practices. John Willey & Sons.

FMPE 404	FARM MACHINERY DESIGN AND PRODUCTION	3 (2+1)	SEM VIII

Objective

To enable the students to design farm machinery and to understand the production principles

Theory

Introduction to design parameters of agricultural machines and design procedure, characteristics of farm machinery design, research and development aspects of farm machinery; Introduction to safety in power transmission; Design of standard power transmission components used in agricultural machines: mechanical and hydraulic units; Application of design principles to the systems of selected farm machines such as design of disc plough, cultivator, seed drill, reaper, thresher and digger; Critical appraisal in production of agricultural machinery, advances in material used for agricultural machinery; Cutting tools including CNC tools and finishing tools; Heat treatment of steels including pack carburizing, shot pining process, etc., limits, fits and tolerances, jigs and fixtures; Industrial lay-out planning, quality production management, reliability; Economics of process selection, familiarization with project report.

Practical

Familiarization with different design aspects of farm machinery and selected components; Solving design problems on farm machines and equipment; Visit to agricultural machinery manufacturing industry, tractor manufacturing industry; Study of jigs and fixtures in relation to agricultural machinery; Study of fits, tolerances and limits; Layout planning of a small scale industry; Problems on economics of process selection; Preparation of a project report; Case study for manufacturing of simple agricultural machinery.

Suggested Readings

1. Adinath, M. and Gupta, A. B. 1996. Manufacturing Technology. New Age International (P) Ltd.
2. Narula, V. 2009. Manufacturing Processes. S K Kataria & Sons, New Delhi.
3. Richey, C. B. 1961. Agricultural Engineering Handbook. McGraw-Hill Inc., US.
4. Sharma, D. N. and Mukesh, S. 2021. Farm Machinery Design (Principles and Problems). 4th Revised Edition. Jain Brothers, New Delhi.
5. Sharma, P. C. and Aggarwal, D. K. 2010. Machine Design. S K Kataria & Sons, New Delhi.
6. Singh, S. 2016. Mechanical Engineer's Handbook. Khanna Publications, New Delhi.

FMPE 406	TRACTOR DESIGN AND TESTING	3 (2+1)	SEM VIII

Objectives

To enable the students to understand

1. Parameters for balanced design of tractor for stability and weight distribution
2. Special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.
3. Perform testing of tractor

Theory

Procedure for design and development of agricultural tractor; Study of parameters for balanced design of tractor for stability and weight distribution; Traction theory, hydraulic lift and hitch system design; Design of mechanical power transmission in agricultural tractors: single disc, multi disc and cone clutches; Rolling friction and anti-friction bearings; Design of Ackerman Steering and tractor hydraulic steering; Study of special design features of tractor engines and their selection, viz. cylinder, piston, piston pin, crankshaft, etc.; Design of seat and controls of an agricultural tractor; Tractor Testing.

Practical

Design problem of tractor clutch (single/multiple disc clutch); Design of gear box (synchromesh/ constant mesh), variable speed constant mesh drive; Selection of tractor tires; Problem on design of governor; Design and selection of hydraulic pump; Engine testing as per BIS code; Drawbar performance in the lab; PTO test and measure the tractor power in the lab/field; Determining the turning space, turning radius and brake test; Hydraulic pump performance test and air cleaner and noise measurement test; Visit to tractor testing centre/ industry.

Suggested Readings

1. Liljedahl, J. B., Turnquist, P. K., Smith, D. W. and Hoki, M. 2004. Tractors and their Power Units. CBS Publishers and Distributors Pvt. Ltd.
2. Maleev, V. L. 1964. Internal Combustion Engines. McGraw-Hill Inc., US.
3. Mehta, M. L., Verma, S. R., Mishra, S. K. and Sharma, V. K. 1995. Testing and Evaluation of Agricultural Machinery. National Agricultural Technology Information Centre. Ludhiana.
4. Richey, C. B. 1961. Agricultural Engineering Handbook. McGraw-Hill Inc., US.
5. Singh, K. 2018. Automobile Engineering – Vol I and Vol II. Standard Publishers and Distributors. New Delhi.

FMPE 408	HYDRAULIC DRIVES AND CONTROLS	3 (2+1)	SEM VIII

Objective

To enable the students to understand the basic principles of hydraulic power system and tractor hydraulic system and different control measures

Theory

Basics of hydraulics: Pascal's law, flow, energy, work, and power; Hydraulic systems, colour coding, reservoirs, strainers and filters, filtering material and

elements, accumulators, pressure gauges and volume meters; Hydraulic circuit, fittings and connectors; Pumps and its classifications, operation, performance, displacement; Design of gear pumps, vane pumps, piston pumps. Hydraulic actuators; Cylinders, construction and applications, maintenance; Hydraulic motors, valves, pressure-control valves, directional- control valves, flow-control valves, valve installation, valve failures and remedies, valve assembly, troubleshooting of valves; Hydraulic circuit diagrams; USA Standards Institute (USASI) symbols; Tractor hydraulics, nudging system, ADDC, application of hydraulics and pneumatics drives in agricultural systems.

Practical

Introduction to hydraulic systems; Study of hydraulic pumps, hydraulic actuators; Study of hydraulic motors, hydraulic valves, colour codes and circuits; Building simple hydraulic circuits, hydraulics in tractors; Introduction to pneumatics, pneumatics devices, pneumatics in agriculture.

Suggested Readings

1. Anthony, E. 2014. Fluid Power and Applications. Pearson Education Limited. USA.
2. Kepner, R. A., Roy, B. and E. L. B. 2000. Principles of Farm Machinery. CBC Publishers & Distributors, New Delhi.
3. Kuhar, J. E. (Ed.). 1992. Hydraulics (Fundamentals of Service Series). John Deere and Co.
4. Majumdar, S. 2002. Oil Hydraulic System: Principles and Maintenance. McGraw-Hill
5. Meritt, H. E. 1991. Hydraulic Control Systems. John Wiley & Sons.

FMPE 410	HUMAN ENGINEERING AND SAFETY	3 (2+1)	SEM VIII

Objective

To enable the students to understand the importance of human factors/ human engineering in farm machine design as well as for Implementation of ODMR and other safety aspects in farm operation

Theory

Human factors in system development- concept of systems, basic processes in system development, performance reliability, human performance; Information input process, visual displays, major types and use of displays, auditory displays; Speech communications; Biomechanics of motion, types of movements, range of movements, strength and endurance, speed and accuracy, human control of systems; Human motor activities, controls, tools and related devices; Anthropometry: arrangement and utilization of work space, atmospheric conditions, thermo- regulation in human, thermal comfort, environmental factors, air pollution; Dangerous machine (Regulation) act, rehabilitation and compensation to accident victims; Safety gadgets for spraying, threshing, chaff cutting and tractor and trailer operation, etc.

Practical

Calibration of the subject in the laboratory using bi-cycle ergo-meter; Study and calibration of the subject in the laboratory using mechanical treadmill; Use of respiration gas meter from human energy point of view; Use of heart rate monitor; Study of general fatigue of the subject using Blink ratio method, anthropometric measurements of a selected subject; Optimum work space layout and locations of controls for different tractors; Familiarization with the noise and vibration equipment; Familiarization with safety gadgets for various farm machines; Studies on drudgery of farm women in manual drawn equipment.

Suggested Readings

1. Astrand, P. and Rodahl, K. 1977. Textbook of Work Physiology. Mc Hill Corporation, New York.
2. Chapanis, A. 1996. Human Factors in System Engineering. John Wiley & Sons, New York.
3. Dul, J. and Weerdmeester, B. 1993. Ergonomics for Beginners. A Quick Reference Guide. Taylor and Francis, London.
4. Keegan, J. J. and Radke, A. O. 1964. Designing Vehicle Seats for Greater Comfort. SAE Journal, 72:50~5.
5. Mark, S. S. and McCormick, E. J. 1993. Human Factors in Engineering and Design. Mc Hill Corporation, New York.
6. Mathews, J. and Knight, A. A. 1971. Ergonomics in Agricultural Equipment Design. National Institute of Agricultural Engineering.
7. Yadav, R. and Tewari, V. K. 1998. Tractor Operator Workplace Design-A Review. Journal of Terra mechanics, 35: 41-53.

FMPE 412	PRECISION AGRICULTURE AND SYSTEM MANAGEMENT	3 (2+1)	SEM VIII

Objectives

1. To enable the students to understand the principles of precision agriculture and system management and the use of different equipment in precision agriculture
2. To learn the GIS based precision agriculture, sensors and application of sensors for data generation

Theory

Precision agriculture- need and functional requirements; Familiarization with issues relating to natural resources; Equipment for precision agriculture including sowing and planting machines, power sprayers, land clearing machines, laser guided land levellers, straw-chopper, straw-balers, grain combines, etc.; Introduction to GIS based precision agriculture and its applications; Introduction to sensors and application of sensors for data generation; Database management; System concept, system approach in farm machinery management, problems on machinery selection, maintenance and scheduling of operations; Application of PERT and CPM in machinery system management.

Practical

Familiarization with precision agriculture problems and issues; Familiarization with various machines for resource conservation; Solving problems related to various

capacities, pattern efficiency, system limitation, etc; Problems related to cost analysis, inflation and problems related to selection of equipment, replacement, break-even analysis, time value of money, etc.

Suggested Readings

1. DeMers M N. 2008. Fundamentals of Geographic Information Systems. Wiley.
2. Dutta, S. K. 1987. Soil Conservation and Land Management. International Book Distributors. Dehradun.
3. Hunt, D. 1956. Farm Power and Machinery Management. Iowa State College Press.
4. Kuhar, J. E. 1977. The Precision Farming Guide for Agriculturist. Lori J. Dhabalt, USA.
5. Sharma, D. N., Jain, M. and Lohan, S. K. 2021. Farm Power and Machinery Management. Jain Brothers.
6. Sigma and Jagmohan. 1976. Earth Moving Machinery. Oxford & IBH
7. Wood, S. 1977. Heavy Construction: Equipment and Methods. Prentice Hall.

PROCESSING AND FOOD ENGINEERING

Course No.	Course Title	Credits	Semester
Core Courses			
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)	I
AET 192[§] (SEC)- PFE	Skill Enhancement	8 (0+8)	II
PFE 201	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	III
PFE 203/ SWE 203/ ABM 209	Protected Cultivation and Secondary Agriculture (For B.Sc. (Hons.) Agribusiness Management)	2 (1+1)	III
PFE 202	Post-harvest Engineering of Cereals, Pulses and Oilseeds	2 (1+1)	IV
PFE 301	Food and Dairy Engineering	4 (3+1)	V
PFE 302	Post-harvest Engineering of Horticultural Crops	2 (1+1)	VI
AET 392[§]-PFE	Case Study	1 (0+1)	VI
PFE 401	Food Quality and Safety	3 (2+1)	VII
AED 491[♀]-PFE	Project I	3 (0+3)	VII
AED 492[♀]-PFE	Project II	4 (0+4)	VIII
	Total Credits	**35 (12+23)**	
Elective Courses(Any Three)**			
PFE 402	Development of Processed Food Products	3 (2+1)	VIII
PFE 404	Food Packaging Technology	3 (2+1)	VIII
PFE 406	Food Plant and Equipment Design	3 (2+1)	VIII
PFE 408	Emerging Technologies in Food Processing	3 (3+0)	VIII
PFE 410	Processing of Livestock, Fish and Marine Products	3 (2+1)	VIII
PFE 412	Food Business Management and Entrepreneurship Development	3 (3+0)	VIII
	Total Credits	**18 (14+4)**	
	Grand Total	**53 (26+27)**	

[$]On sharing basis with other departments

AED 191	INTRODUCTION TO AGRICULTURAL ENGINEERING	3 (2+1)	SEM I

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post-harvest and allied activities.

Theory

Classification of different types of agricultural commodities as durables, perishables, etc.; Moisture content and its importance in grain storage; Different types of agricultural structures; Different types of grain storage structures; Greenhouse and its different parts; Low cost protected structures. Moisture content and its importance in grain storage, Common reasons of food spoilage, food preservation methods; Different primary processing operations and their necessity; Methods and equipment used for cleaning, washing, sorting, grading, peeling, size reduction; Different types of traditional and modern storage structures; Storage of perishable commodities; Different types of packaging materials and their suitability for various food products; Basic principles of value addition of food as drying and dehydration, evaporation, thermal processing, refrigerated and frozen storage, chemical preservation and other novel methods.

Practical

Study of various post-harvest operations; Study of different food processing equipment; Value addition of common crops; Visit to a greenhouse with modern irrigation system; Visit to implement manufacturing unit; Visit to a mechanized farm; Visit to a watershed; Visit to a food processing industry.

Suggested Readings

1. Chakraverty A. 1999. Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH publishing Co. Ltd., New Delhi.
2. Dash S K, Bebartta J P and Kar. 2012. A. Rice Processing and Allied Operations. Kalyani Publishers, New Delhi.
3. Michael A M and Ojha T P. 2003. Principles of Agricultural Engineering. Jain Brothers, New Delhi.
4. Rai G D. 1995. Solar Energy Utilization. Khanna Publishers, New Delhi.
5. Rai G D. 2013. Non-Conventional Energy Sources. Khanna Publishers, New Delhi.
6. Sahay K M and Singh K K. 1994. Unit Operations of Agricultural Processing. Vikas Publishing house Pvt. Ltd, New Delhi.

AET 192 (SEC)-PFE	SKILL ENHANCEMENT	8 (0+8)	SEM II

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG-certificate, they can work as operators and technicians in the fields of farm machinery, micro-irrigation, solar and wind energy or food processing, etc. or can go for self-employment or start their own agro-service centre, agro-processing centre or similar activities. Thus, the broad objective of this course is Skill for Employment and Entrepreneurship Development.

Indicative Modules

PFE 001	AGRO PROCESSING METHODS, EQUIPMENT OPERATION AND MAINTENANCE	4 (0+4)

- Acquaintance with different unit operations involved in agro-processing
- Cleaning and grading of agricultural commodities: operation and maintenance of different cleaners, graders and destoners
- Operation and maintenance of dehusker, dehuller, degermer and dryer
- Operation and maintenance of rice milling machineries
- Operation and maintenance of dal mills and oil mill
- Operation and maintenance of flour mills and pulverisers
- Operation and maintenance of boiler, pasteurizer and sterilizer
- Operation and maintenance of peeler, slicer, pulper and juicer
- Operation and maintenance of canning machineries
- Operation and maintenance of packaging machineries

PFE 002	OPERATION AND MANAGEMENT OF MULTI-COMMODITY AGRO-PROCESSING CENTRE	4 (0+4)

- Acquaintance with different agro-processing models
- Site selection, plant layout and project report preparation
- Manufacturing and management of primary processing centre
- Preparation of grain, pulse and oilseed- based products and acquaintance with operation of different equipment
- Preparation of products using flour mill
- Spice processing and acquaintance with operation of different equipment
- Operation and management of fruit and vegetable pack house
- Preparation of different fruit- based products and acquaintance with operation of different equipment
- Preparation of different vegetable- based products and acquaintance with operation of different equipment
- Manufacturing of snack foods
- Acquaintance with food safety and hygiene, and certifications
- Record keeping, inventory, finance and human resource management for agro-processing

PFE 003	PRIMARY PROCESSING AND VALUE ADDITION AND COLD CHAIN LOGISTICS	4 (0+4)

- Primary processing of fruits and vegetables
- Operation and maintenance of washer and graders
- Study of refrigeration system and freezing equipment
- Operation of precooling systems
- Operation and maintenance of cold storage and solar cold room

- Operation and maintenance of ripening chamber
- Cool chain logistics and cold transport: chilled transport van, semi chilled transport, refrigerated van system
- Cooling systems/ cold chain technology: Gel pack, dry ice, liquid nitrogen, eutectic plates, reefers, cold chain standards and regulations
- Supply chain management systems planning, sourcing, manufacturing, delivering, returning, types of SCM models
- Supply chain logistics, contract logistics

PFE 004	FOOD GRAIN GODOWN AND WAREHOUSE MANAGEMENT	4 (0+4)

- Conversant with technical terms of grain storage, measurement of temperature, relative humidity, grain sampling and moisture content measurement, grain quality
- Acquaintance with different factors for grain deterioration during storage and main insects of stored commodities
- Acquaintance with warehouse equipment and different storage structures
- Cleaning, drying and aeration of stored products
- Determination of dimension of warehouse for bag storage
- Acquaintance with constructional features, maintenance, sanitation and hygiene of warehouses
- Study on integrated pest management, chemical and non-chemical pest and rodent control measures in grain storage system
- Detection methods of insect infestation in food grains and prevention and control of storage fungi
- Acquaintance with inventory, logistics, and collateral management
- Guideline for procurement and disposal of food grains
- Quality control of food grains

PFE 005	POST-HARVEST VALUE CHAIN MANAGEMENT INCLUDING LOGISTICS	4 (0+4)

- Understanding the concept of post-harvest value chain
- Study of existing supply chain of different commodities
- Case study and analysis of value chain of food grains
- Case study and analysis of value chain of horticultural commodities
- Sourcing and material management
- Handling, packing and storage of agricultural commodities
- Transportation and marketing of agricultural commodities
- Ware house management
- Cold storage management
- Cold chain logistics and supply chain management system
- Quality management and tracking food supply chain

PFE 201	ENGINEERING PROPERTIES OF AGRICULTURAL PRODUCE AND FOOD SCIENCE	3 (2+1)	SEM III

Objective

To make the students acquainted with the different engineering properties of agricultural produce and to help them understand the importance of these properties in handling, processing and storage

Theory

Different engineering properties of food and their importance; Application of engineering properties in handling, processing and storage; Physical properties, viz. shape, size, roundness, sphericity, volume, density, porosity, specific gravity, surface area; Colour properties, CIE colour model. Thermal properties, viz. heat capacity, specific heat, thermal conductivity, thermal diffusivity, heat of respiration, co-efficient of thermal expansion; Electrical and dielectric properties as resistance, capacitance, dielectric loss factor, loss tangent, and dielectric constant; Frictional properties, viz. static friction, kinetic friction, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials; Aero-dynamic characteristics such as drag coefficient, terminal velocity. Rheological characteristics of food, elastic, plastic and viscous behaviour, visco-elasticity; rheological models to explain food characteristics; Fluid behaviour as Newtonian, non-Newtonian, pseudo-plastic, dilatant, thixotropic, rheopectic and Bingham plastic; Textural characteristics of foods. Non-destructive methods of quality determination of foods; Principles of machine vision systems, spectroscopy, hyperspectral imaging and acoustic techniques. Introduction to food science and food technology; Biochemical reactions involved in food processing and storage; Food spoilage agents, general methods for food preservation (physical, chemical and biological methods); Food microbiology: Classification of microorganisms, multiplication of bacteria, Different beneficial and harmful microorganisms in relation to food preservation and spoilage, industrial bacteriology and food fermentation.

Practical

Determination of the size of grains, fruits and vegetables using measuring instruments and using projection system; Determination of the shape (sphericity and roundness); Determination of the bulk and particle volume, bulk and particle density, specific gravity and porosity of grains; Determination of the volume, density and specific gravity of large individual objects (F and V); Determination of the surface area of the F and V; Determination of angle of repose, co-efficient of friction of different grains on different surfaces and angle of internal friction; To study the terminalvelocity of grains and separating behavior of grains in a vertical wind tunnel; Determination of specific heat and thermal conductivity of some food grains; Determination of electrical properties of food materials; Determination of hardness of food materials; Determination of viscosity of food; Study and comparison of colour of food materials; Determination of carbohydrates; Determination of total nitrogen; Determination of oil content; Determination of ash content; Study of different types of microorganisms and microbiological examination of food products.

Suggested Readings

1. Mohesin, N. N. 1980. *Physical Properties of Plants & Animals*. Gordon & Breach Science Publishers, New York.
2. Rao, M. A. and Rizvi, S. H. 1995. *Engineering Properties of Foods*. Marcel Dekker Inc. New York.
3. Serpil, S. and Servet, G. S. 2005. *Physical Properties of Foods*. Springer Science+Business Media, LLC, 233 Spring Street, New York.
4. Singhal, O. P. and Samuel, D. V. K. 2003. *Engineering Properties of Biological Materials*. Saroj Prakasan, New Delhi.

PFE 202	POST-HARVEST ENGINEERING OF CEREALS, PULSES AND OILSEEDS	3(2+1)	SEM IV

Objective

To make the students acquainted with the different unit operations in processing of major cereals, pulses and oilseeds, and the different equipment for the operations

Theory

General unit operations in agricultural process engineering and importance of these unit operations in grain processing; Structure and composition of cereals, pulses and oil seeds. Cleaning and grading: Principles of cleaning, scalping, sorting and grading; screens, different types of screen separators, fixed and variable aperture screens, capacity and effectiveness of screens, sieve analysis; various types of separators as specific gravity, magnetic, disc, spiral, pneumatic, inclined belt draper, velvet roll separator, colour sorter, cyclone separator. Drying: Moisture content and water activity, free moisture, bound moisture and equilibrium moisture content, isotherm, hysteresis effect, EMC determination; Psychrometric chart and its use in drying; Drying principles and theory, thin layer and deep bed drying analysis, falling rate and constant rate drying periods, maximum and decreasing drying rate periods, drying equations, mass and energy balance, Shedd's equation; Drying methods (conduction, convection, radiation, batch, continuous); Different types of grain dryers (bin, flat bed, LSU, columnar, RPEC, fluidized, rotary and tray), tempering during drying; dryer performance. Principles of grain storage; different types of grain storage structures; deep bin and shallow bin; design of a silo, structural and functional requirements of a grain storage go-down. Size reduction: Principle; Bond's law, Kick's law, Rittinger's law; Sieve analysis; Different classifications of size reduction machines; description of jaw crusher, hammer mill, attrition mill, and ball mill; Material handling: Basic parts of different types of conveyors and elevators, viz. belt, roller, chain, screw, and bucket elevator, cranes and hoists, pneumatic conveying, power requirement for conveying and elevating. Milling of rice: Parboiling- merits and demerits, changes during parboiling of rice, parboiling methods, viz. traditional methods, CFTRI method, Jadavpur method, pressure parboiling; different unit operations and equipment involved in traditional and modern rice milling methods; Milling of wheat: Unit operations and equipment; Milling of corn: unit operations and equipment in dry and wet milling methods; Milling of pulses: pre-conditioning, dry milling and wet milling methods, CFTRI and Pantnagar methods, pulse milling machines; Milling of oilseeds: preconditioning of oilseeds, mechanical expression,

screw press, hydraulic press, solvent extraction method, refining of oil, stabilization of rice bran.

Practical

Study of different types of screens and study of screen effectiveness; Study of construction and operation of different types of cleaners and separators; Measurement of moisture content: dry basis and wet basis; Study on drying characteristics of grains and determination of drying constant; Determination of EMC (static and dynamic method); Study of psychrometric chart; Study of various types of dryers; Study of different size reduction machines; Sieve analysis, determination of fineness modulus and uniformity index; Study of different unit operations and machineries in rice mills; Study of different unit operations and machineries in pulse mills; Study of different unit operationsand machineries in oil mills; Study of different unit operations and machineries in wheat/ flour mills; Study of different unit operations and machineries in corn processing units; Study of extrusion process; Study of different types of conveying and elevating equipment.

Suggested Readings

1. Chakraverty, A. 1999. *Post Harvest Technology of Cereals, Pulses and Oilseeds*. Oxford & IBH publishing Co. Ltd, New Delhi.
2. Dash, S. K., Bebartta, J. P. and Kar, A. 2012. *Rice Processing and Allied Operations*. Kalyani Publishers, New Delhi.
3. Geankoplis, C. J. 2002. *Transport Processes and Unit Operations*. Prentice Hall of India Pvt. Ltd, New Delhi.
4. Mangaraj, S., Dash, S. K., Swain, S. and Ali, N. 2016. *Agricultural Process Engineering*. Vol II. Kalyani Publishers, New Delhi.
5. McCabe, W. L., Smith, J. C. and Harriott, P. 1993. *Unit Operations of Chemical Engineering*. McGraw Hill.
6. Sahay, K. M. and Singh, K. K. 1994. *Unit Operations of Agricultural Processing*. Vikas Publishing House Pvt. Ltd, New Delhi.
7. Swain, S., Dash, S. K., Mangaraj, S. and Ali, N. 2016. *Agricultural Process Engineering*. Vol I. Kalyani Publishers, New Delhi.

PFE 203/ SWE 203/ ABM 209	**PROTECTED CULTIVATION AND SECONDARY AGRICULTURE (For B.Sc. (Hons.) Agribusiness Management)**	**2 (1+1)**	**SEM III**

Objectives

1. Understand the principles and techniques of protected cultivation, such as greenhouse and polyhouse farming
2. Learn about secondary agriculture practices like value addition, processing, and post-harvest management
3. Explore methods to optimize production, quality, and profitability in controlled environments
4. Develop skills to integrate protected cultivation and secondary agriculture techniques to enhance yield, quality, and market value of agricultural products

Theory

Green house technology: Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipment, materials of construction for traditional and low-cost green houses. Irrigation systems used in green houses, passive solar green house, hot air greenhouse heating systems, greenhouse drying. Cost estimation and economic analysis.

Important Engineering properties such as physical, thermal and aero and hydrodynamic properties of cereals, pulses and oilseeds. Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flatbed dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.

Practical

Study of different type of greenhouses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of greenhouse equipment. Visit to various Post-Harvest Laboratories. Determination of Moisture content of various grains by oven drying and infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

Suggested Readings

1. Green house technology - Aruprathan Ghosh, Kalyani Publishers, New Delhi.
2. Green House Technology and Management - K. Radha Manohar, C. Igathinathane, BS Publications, Koti, Hyderabad, A.P.
3. Greenhouse Management for Horticultural Crops - S. Prasad and U. Kumar, Agrobios, AgroHouse, Jodhpur.
4. Principles and Practices of Post Harvest Technology - P. H. Pandey, Kalyani Publishing, Ludhiana.
5. Unit Operations of Agricultural Processing - K. M. Sahay and K.K. Singh, Vikas Publishing House Pvt Limited, New Delhi.

PFE 301	FOOD AND DAIRY ENGINEERING	4 (3+1)	SEM V

Objectives

1. To make the students acquainted with the different unit operations in processing and value addition of different dairy and food products
2. To make them understand the different types of equipment and their working principles used for these.

Theory

Introduction to different unit operations in food processing; Process flow charts for preparation of various food products; Mass and energy balance. Dehydration of foods; dryers for solid foods, construction and operation of direct and indirect type

solar dryers, tray dryer, tunnel dryer, vacuum dryer, microwave dryer, freeze dryer, etc.; dryers for liquid foods, construction and operation of drum dryer, spray dryer and vacuum band dryer; Evaporation of food products: principle, different types of evaporators, factors affecting steam economy, multiple effect evaporation, vapour recompression; Thermal processing: thermobacteriology, D value, Z value, reaction quotient, process time, different types of retorts and continuous sterilizers, canning process, aseptic processing. Principles and applications of different non-thermal processing methods as vacuum processing, high pressure processing, PEF processing, Ultrasonication, radiation processing; Principles and applications of novel heating methods, viz. ohmic, infrared and dielectric heating. Mixing: Theory of mixing of solids and pastes, mixing index, mixers for solids, liquid foods and pastes, viz. tumbling mixer, screw mixer, ribbon mixer, liquid mixers, sigma-blade mixer, anchor and gate agitator; Separation processes: principle and equipment for sedimentation of solids in liquid and solids in air; Principle and operation of tubular bowl centrifuge and disc bowl centrifuge; Filtration: principle, construction and working principles of different types of filters as plate and frame filter press, shell and leaf filter, centrifugal filter, rotary drum filter, continuous belt filter; Membrane separation: principle, characteristics and applications of reverse osmosis, nanofiltration, ultra-filtration and macro-filtration; membrane modules; Extrusion cooking: principle, factors affecting extrusion cooking, single and twin screw extruders. Unit operations in milk processing: Engineering, thermal and chemical properties of milk and milk products; Principles and equipment related to receiving of milk, pasteurization, sterilization, homogenization, cream separation, preparation of butter, cheese, paneer and ice cream. Filling and packaging: Selection of different types of packaging materials for different types of food products; Equipment for filling and packaging of liquid foods such as gravity filler, filling by metering-FFS system, piston type filler, metering cup filler, filling of pastes, filling of powders; aseptic filling of pouches and bottles. Nanotechnology and its applications in food industry; Basics of food plant design and layout; Plant utilities.

Practical

Preparation of flow charts for different food processing industries; Study of different parts of retort and canning process; Study of different types of evaporators and multiple effect evaporation system; Study of drum dryer and spray dryer and comparison of product qualities; Study of different types of mixers for solids and liquids; determination of mixing effectiveness and mixing index; Study of settling and sedimentation process in a tank; Study of different types of filters; Study of membrane modules and different types of membranes; Study of measurement of different properties of milk and milk products; Study of milk pasteurizer, sterilizer and homogenizer; Study on preparation of cream and butter; Study of preparation of cheese, paneer and ice cream; Study of different types of packaging materials; Study of different types of filling machines for liquids and powder/ granules; Study of layout of a food processing plant; Visit to food processing industries and dairy plants to study the plant layout and unit operations.

Suggested Readings

1. Ahmed, T. 1997. *Dairy Plant Engineering and Management*. Kitab Mahal.

2. Dash, S. K., Chandra, P. and Kar, A. 2024. *Food Engineering Principles and Practice*. CRC Press, Boca Raton, USA
3. McCabe, W. L., Smith, J. C. and Harriott. 1999. *Unit Operations of Chemical Engineering*. McGraw Hill.
4. Rao, D. G. 2009. *Fundamentals of Food Engineering*. PHI learning Pvt. Ltd, New Delhi.
5. Singh, R. P. and Heldman, D. R. 1993. *Introduction to Food Engineering*. Academic Press.
6. Toledo, R. T. 1997. *Fundamentals of Food Process Engineering*. CBS Publishers

PFE 302	POST-HARVEST ENGINEERING OF HORTICULTURAL CROPS	2 (1+1)	SEM VI

Objective

To make the students acquainted with unit operations in processing of major horticultural crops and working principles of different machineries for these.

Theory

Importance of processing of fruits and vegetables, spices, condiments; characteristics and properties of horticultural crops important for processing; General methods of preservation of fruits and vegetables and their relative advantages and disadvantages; Flowcharts for preparation of different finished products. Sorting and grading methods specific to fruits and vegetables, shape and size sorting, weight sorting, image processing, colour sorting, sorting effectiveness; Peeling: different peeling methods and devices (manual, mechanical, chemical and thermal peeling). Minimal processing and pack house activities; Size reduction and juice extraction: equipment for slicing, shredding, crushing, chopping, juice extraction; Blanching: importance and objectives; effects on food (nutrition, colour, pigment, texture); blanching methods and equipment. Drying: Dryers for fruits and vegetables, osmo-dehydration, foam mat drying; advanced drying techniques; quality deterioration during drying of fruits and vegetables; Canning of fruits and vegetables: methods and equipment, types of cans, failures of cans; Chilling and freezing: Chilling requirements of different fruits and vegetables; Freezing of food, freezing time calculations, slow and fast freezing; Equipment for chilling and freezing (mechanical and cryogenic); Cold chain logistics and reefer containers; Cold storage heat load calculations and selection of matching equipment; Design of cold stores. Post-harvest management and equipment for spices; Post-harvest management and equipment for flowers; Packaging and storage: packaging requirements (for containment, protection and other purposes); Characteristics of different packaging materials used for raw and processed fruits and vegetables products; bulk and retail packages; Modified atmosphere packaging, smart packaging; Packaging machines; Shrink packaging; Storage methods as low temperature storage, evaporatively cooled storage and controlled atmospheric storage.

Practical

Preparation of different processed horticultural products; Study of fruit graders; Study of different types of peelers and slicers; Study of juicer and pulper; Study of minimal processing of vegetables; Study of blanching equipment, testing the adequacy of blanching; Study of different dryers for fruits and vegetables; Study of foam mat drying and osmotic dehydration processes; Study of different activities in pack house; Cold storage heat load calculations and design; Study of different types of packaging materials; Study of CAS and MAP of vegetables; Study of shrink packaging of foods; Study of hammer mill, pulveriser for grinding of spices to powder; Visit to fruit and vegetable processing/ spice processing plant.

Suggested Readings

1. Dash, S. K., Chandra, P. and Kar, A. 2024. *Food Engineering Principles and Practice*. CRC Press, Boca Raton, USA
2. Fellows, P. J. 2008. *Food Processing Technology Principles and Practices*. Woodhead Publishing.
3. Lal, G., Siddappa, G. S. and Tondon, G. L. 2009. *Preservation of Fruits and Vegetables*. ICAR, New Delhi.
4. Mangaraj, S., Ali, N., Swain, S. and Dash, S. K. 2016. Agricultural Process Engineering Vol. III. Kalyani Publishers, New Delhi
5. Pandey, P. H. 1997. *Post-harvest Technology of Fruits and Vegetables (Principles and practices)*. Saroj Prakashan, Allahabad.
6. Srivastava, R. P. and Kumar, S. 2019. *Fruit and Vegetable Preservation: Principles and Practices*. Kalyani Publishers, New Delhi.
7. Sudheer, K. P. and Indira, V. 2007. *Post-Harvest Engineering of Horticultural Crops*. New India Publishing House.

AET 392-PFE	CASE STUDY	1(0+1)	SEM VI

Objective

To enable the students to generate an in-depth, multi-faceted understanding of a specific case/ situation/ aspect related to the profession in its real-life context

Activities

The students will be assigned to visit to a nearby area/ entity to study and analyse any particular case.

The case study can be either problem-solving type or descriptive type. The problem-solving case studies would aim to investigate a problem or situation in a particular individual or group, and recommend solution to the problem(s) based on analysis and theory.

Descriptive case studies would aim to understand a situation better. For example, identifying what happened and why by describing particular aspects of that situation and analysing it in terms of theoretical categories. This will help to make a choice about how to do things in a better way in future for another case having similar features.

Some indicative areas for the case studies are as follows.

- Study the status of agro-processing in a particular village and to suggest improvement measures.
- Study the losses of fruits and vegetables in a local market yard and suggest remedial measures
- Study the supply chain for a commodity and suggest a suitable value chain
- Visit to a retail store and study the different types of packaging materials

After the visit, the students will submit a report to the institution on their observations. They may also be asked to present the report before the other faculty members and students for interaction.

PFE 401	FOOD QUALITY AND SAFETY	3 (2+1)	SEM VII

Objectives

To enable the student to know about the concept and aim of food quality and safety, food quality characteristics –physical, chemical and biological properties, different hazards and their prevention, different methods for measuring food quality as well as the food safety management system

Theory

Basics of food quality, safety and food analysis; Concept, objectives and need of food quality; definition, objective measurement of quality and quality and safety indices. Quality control, quality control tools, statistical quality control; Sampling (Chemical and Microbiological): purpose, sampling techniques, sampling procedures for liquid, powdered and granular materials; Instrumental method for testing food quality, measurement of colour, flavour, consistency, viscosity, texture and their relationship with food quality and composition. Non-destructive methods for evaluation of food quality. NIR, FTIR and chemometrics theory and application in food quality prediction. Theory and application of X-ray, CT, MRI, Ultrasound for internal quality inspection of fruits and vegetables. Sorting grading using external image analysis, internal biochemical analysis using spectroscopy. Sensory evaluation methods, panel selection methods, Interpretation of sensory results. Food hazards and food safety, Food borne infections, contaminants (physical, chemical, biological), adulteration, food safety strategies- Food Safety Management Systems, GAP, GHP, GMP, TQM, TQC; Hazards and HACCP, Sanitation in food industry (SSOP); Food Laws and Regulations, BIS, AGMARK, FSSAI; International Food standards (ISO-22000, CAC); Food Recall, Traceability; Bio safety and Bioterrorism; Sanitation in food industry.

Practical

Study of statistical process control in food processing industry; Study of sampling techniques, tools and protocols used in different types of from food handling, processing and marketing establishments; Study of registration process and licensing procedure under FSSAI; Examination of cereals, oilseeds and pulses from go-downs and market shops in relation to specifications provided by standardization techniques; Detection of adulteration and examination of ghee for various standards of Agmark/ FSSAI; Detection of adulteration and examination of spices for Agmark/ FSSAI

standards; Detection of adulteration and examination of milk and milk products for FSSAI standards; Detection of adulteration in fruit products such as jam, jelly, marmalades as per FSSAI specification; Visit to a professional quality control laboratory; Visit to food processing laboratory in an industry and study of records and reports maintained by food processing laboratory.

Suggested Readings

1. Acharya, K. T. 2017. *Everyday Indian Processed foods*. National Book Trust.
2. Gupta, V. (Ed.). 2006. *The Food Safety and Standards Act along with Rules & Regulations*. Commercial Law Publishers (India) Pvt. Ltd.
3. Jha, S. N. 2015. *Rapid Detection of Food Adulterants and Contaminants: Theory and Practice*. Elsevier, USA (ISBN 9780124200845), p266.
4. Jha, S. N. (Ed.). 2010. *Nondestructive Evaluation of Food Quality: Theory and Practice*. Springer – Verlag GmbH Berlin Heidelberg, Germany, ISBN 978-3-642-15795-0, doi 10.1007/978-3- 642-15796-7: 288p.
5. Mudambi, S. R., Rao, S. M. and Rajgopal, M. V. 2006. *Food Science*. New Age International Publishers.
6. Negi, H. P. S., Sharma, S. and Sekhon, K. S. 2007. *Hand book of Cereal Technology*. Kalyani Publishers, New Delhi.
7. Potter, N. N. and Hotchikss, J. H. 1995. *Food Science*. Chapman and Hall Pub.
8. Raj, D., Sharma, R. and Joshi, V. K. 2011. *Quality for Value Addition in Food Processing*. New India Publishing Agency, New Delhi
9. Ranganna, S. 1986. *Hand book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill Education.
10. Sharma, A. 2017. *A Textbook of Food Science and Technology*. CBS Publishers & Distributors.
11. Srivastava, R. P. and Kumar, S. 2017. *Fruit and Vegetable Preservation: Principles and Practices*. International Book Distributing Company.

Websites and weblinks:

12. https://www.fssai.gov.in/cms/food-safety-and-standards regulations.php
13. https://www.fssai.gov.in/cms/food-recall.php
14. https://www.fao.org/fao-who-codexalimentarius/en/

PFE 402	DEVELOPMENT OF PROCESSED FOOD PRODUCTS	3 (2+1)	SEM VIII

Objectives

To enable the students to know about the

1. Unit operations and equipment used for different food processing operations
2. Processing technologies for value addition of cereals, pulses, oilseeds, vegetables, fruits, milk, fish, meat and poultry products

Theory

Process of new product development; Process flow chart with mass and energy balance; Unit operations and equipment for processing; Technologies for value addition of cereals, pulses and oil seeds- milled, puffed, flaked, roasted and malted products, bakery products, snack food, extruded products; Technologies for value

added products from fruits, vegetables and spices as canned foods, frozen foods, dried foods, fried foods, fruit juices, sauce, sugar based confectionery, candy, fermented products, spice extract; Technologies for value addition of liquid foods such as milk, sugarcane juice, etc.; Technologies for value addition of forest produce as mahua and tamarind; Technology for processing of animal produce, viz. meat, poultry, fish, egg products; Technologies for preparation of health foods, nutraceuticals and functional food; Organic food processing.

Practical

Process design and preparation of process flow chart; Preparation of different value added products; Visit to roller flour mill, rice mill, spice grinding mill, milk plant, dal and oil mill, fruit/ vegetable processing plant, sugar mill and other food processing industries & study of operations and machinery.

Suggested Readings

1. Acharya, K. T. 2017. *Everyday Indian Processed Foods*. National Book Trust.
2. Dash, S. K., Chandra, P. and Kar, A. 2024. *Food Engineering Principles and Practice*. CRC Press, Boca Raton, USA
3. Mudambi, S. R., Rao, S. M. and Rajgopal, M. V. 2006. *Food Science*. New Age International Publishers.
4. Negi, H. P. S., Sharma, S. and Sekhon, K. S. 2007. *Handbook of Cereal Technology*. Kalyani Pub.
5. Potter, N. N. and Hotchkiss, J. H. 1995. *Food Science*. Chapman and Hall Pub.
6. Rao, D. G. 2009. *Fundamentals of Food Engineering*. PHI Learning Pvt. Ltd, New Delhi.
7. Srivastava, R. P. and Kumar, S. 2019. *Fruit and Vegetable Preservation: Principles and Practices*. International Book Distributing Company.

PFE 404	FOOD PACKAGING TECHNOLOGY	3 (2+1)	SEM VIII

Objectives

To enable the students to

1. Understand the interaction of food, packaging and environment
2. Understand the different methods of package development and packaging
3. Select the best type and form of packaging of specific food for specific end users

Theory

Factors affecting shelf life of food material during storage, interactions of spoilage agents with environmental factors as water, oxygen, light, pH, etc. and general principles of control of the spoilage agents; Difference between food infection, food intoxication and allergy. Packaging of foods, requirement, importance and scope, environmental considerations; Packaging systems, types: flexible and rigid; retail and bulk; levels of packaging; Different types of packaging materials, their key properties and applications; Metal cans- manufacture of two piece and three piece cans; Plastic packaging- different types of polymers and lamination used in food packaging and their barrier properties; Manufacture of plastic packaging materials, profile extrusion, blown film/ sheet extrusion, blow molding, extrusion blow molding, injection blow molding, stretch blow molding, injection molding; Glass containers- types of glass

used in food packaging, manufacture of glass and glass containers, closures for glass containers; Paper and paper board packaging- paper and paper board manufacture process, modification of barrier properties and characteristics of paper/ boards; Relative advantages and disadvantages of different packaging materials, effect of these materials on packed commodities. Nutritional labelling on packages; CAS and MAP, shrink and cling packaging, vacuum and gas packaging; Active packaging, Smart packaging; Packaging requirement for raw and processed foods and selection of packaging materials; Disposal and recycle of packaging waste. Package testing-testing methods for flexible materials, rigid materials and semi rigid materials, tests for paper (thickness, bursting strength, breaking length, stiffness, tear resistance, folding endurance, ply bond test, surface oil absorption test, etc.), plastic film and laminates (thickness, tensile strength, gloss, haze, burning test to identify polymer, etc.), aluminium foil (thickness, pin holes, etc.), glass containers (visual defects, colour, dimensions, impact strength, etc.), metal containers (pressure test, product compatibility, etc.)

Practical

Identification of different types of packaging materials; Determination of tensile/ compressive strength of given material/ package; To perform different destructive and non-destructive tests for glass containers; Vacuum packaging of agricultural produces; Determination of tearing strength of paper board; Measurement of thickness of packaging materials; To perform grease-resistance test in plastic pouches; Determination of bursting strength of packaging material; Determination of water vapour transmission rate; Shrink wrapping of various horticultural produce; Testing of chemical resistance of packaging materials; Determination of drop test of food package and visit to relevant industries.

Suggested Readings

1. Coles, R., McDowell, D. and Kirwan, M. J. 2003. *Food Packaging Technology*. Blackwell Publishing Co.
2. Gosby, N. T. 2001. *Food Packaging Materials*. Applied Science Publication
3. John, P. J. 2008. *A Handbook on Food Packaging.* Narendra Publishing House.
4. Mahadevia, M. and Gowramma, R. V. 2007. *Food Packaging Materials*. Tata McGraw Hill.
5. Robertson, G. L. 2001. *Food Packaging and Shelf life: A Practical Guide*. Narendra Publishing House.
6. Robertson, G. L. 2005. *Food Packaging: Principles and Practice*. Second Edition. Taylor and Francis.

PFE 406	FOOD PLANT AND EQUIPMENT DESIGN	3 (2+1)	SEM VIII

Objectives

To enable the students to

1. Understand the managerial aspects of food processing plant
2. Understand Govt. policy on small and medium scale food processing enterprise
3. Understand the procedure of obtaining license and registration for operating food processing business

Theory

Food plant location, selection criteria for plant location; Selection of processes and plant capacity; Requirements of plant building and its components, flow diagrams; Selection of equipment, process and controls; Objectives and principles of food plant layout; Different types of plant layout; Consideration of salient features of processing plants for cereals, pulses, oilseeds, horticultural and vegetable crops, poultry, fish and meat products, milk and milk products for equipment selection and layout. Application of design engineering for processing equipment; Design parameters and general design procedure; Material specification, types of material for process equipment; Design codes, pressure vessel design; Design of cleaners; Design of tubular heat exchanger, shell and tube heat exchanger and plate heat exchanger; Design of belt conveyer, screw conveyer and bucket elevator; Design of grain dryers; Design of milling equipment; Optimization of design with respect to process efficiency, energy and cost; Computer Aided Design.

Practical

Study of salient features and layout of preprocessing house; Study of salient features, design and layout of different types of food processing industries, viz. milk and milk product plants, modern rice mill, bakery, fruits and vegetables processing unit; Evaluation of given layout; Design of pressure vessel; Design of cleaners; Design of milling equipment; Design of tubular heat exchanger, shell and tube type heat exchanger, plate heat exchanger; Design of grain dryer; Design of belt conveyor, bucket elevator, screw conveyor.

Suggested Readings

1. Bhattacharyya, B. C. 2008. *Introduction to Chemical Equipment Design*. CBS Publishers and Distributors.
2. Dawande, S. D. 1999. *Process Design of Equipment*. Central Techno Publication, Nagpur.
3. Geankoplis, C. J. 1993. *Transport Processes and Unit Operations*. Prentice-Hall.
4. Hall, H. S. and Rosen, Y. S. 1963. *Milk Plant Layout*. FAO Publication, Rome.
5. Lopez Antonio Gomez. 2005. *Food Plant Design*. T&F India.
6. Mahajan, M. 2016. *Operations Research*. Dhanpat Rai and Company Private Limited, Delhi.
7. Mahajani, V. V. and Umarji, S. B. 2009. *Process Equipment Design*. Macmillan.
8. Maroulis, Z. B. and Saravacos, G. D. 2007. *Food Plant Economics*. Taylor and Francis, LLC.
9. Maroulis, Z. B. 2003. *Food Process Design*. Marcel Dekker, Inc, Cimarron Road, Monticello, New York 12701, USA.
10. Robberts Theunis, C. 2016. *Food Plant Engineering Systems.* CRC Press, Washington.

PFE 408	EMERGING TECHNOLOGIES IN FOOD PROCESSING	3 (3+0)	SEM VIII

Objectives

To enable the students to

1. Know about various emerging technologies in food processing.

2. Know the practical applications of various emerging technologies in food processing.

Theory

Introduction, different emerging technologies and their scope and applications. Principle, equipment and applications of ohmic heating, infrared heating, dielectric heating, microwave heating systems, radio frequency heating equipment, combined microwave vacuum drying new hybrid drying technologies. Principles and equipment for Vacuum processing, High pressure processing, Pulsed electric field processing, Ultrasonication, Gamma irradiation/ ionising radiation, Ultraviolet radiation processing. Pulsed X-ray processing, Pulsed light processing, Cold plasma Processing, Ozone treatment, Electron beam processing, Static and oscillating magnetic fields, Dense phase carbon dioxide, High voltage arc discharge. Nanomaterial utilisation in food processing, manufacture of nanomaterials, applications.

Suggested Readings

1. Dash, S. K., Chandra, P. and Kar, A. *Food Engineering Principles and Practices*. CRC Press
2. Passos and Ribeiro. *Innovation in Food Engineering – New Techniques and Products*. CRC Press
3. Sun Da-Wen. *Thermal Food Processing – New technologies and Quality Issues*. CRC Press
4. SunDa-Wen. *Emerging technologies in food processing*. Elsevier
5. Tewari and Juneja. *Advances in Thermal and Non-Thermal Food Preservation*. Blackwell

PFE 410	PROCESSING OF LIVESTOCK, FISH AND MARINE PRODUCTS	3 (2+1)	SEM VIII

Objectives

To enable the students to

1. Learn various processes and methods for processing of livestock, fish and marine products
2. Understand the livestock and marine product processing and its applications in industries

Theory

Production, economics, and processing scenario of meat, fish, and poultry; Processing and preservation of eggs, production of egg yolk and egg yellow powder; Poultry processing: Unit operations for various poultry products; Fish processing: Unit operations for various fish products; Preservation of meat by dehydration, freezing, pickling, curing, cooking and smoking; preservation of meat using ionizing radiation; preservation of meat using antibiotics and chemical additives; Eating quality of meat and discoloration; water-holding capacity and juiciness in cooked and uncooked meat; Meat texture and tenderness: measurement, factors affecting texture and tenderness, artificial tenderizing; Abattoir design and layout, meat plant sanitation and safety; By-products utilization.

Practical

Hands on exercise on the processing of fish, meat and egg and preparation of value-added products; Visit to processing plants.

Suggested reading

1. Bechtel, P.J. *Muscle as Food*. Academic Press.
2. Hui, Y. H. *Handbook of Meat and Meat Processing*. CRC Press.
3. Lawrie, R. A. and Ledward, D. *Lawrie's Meat Science*. Woodhead Publishing.
4. Stadelmen, W. J. and Cotterill, O.J. *Egg Science and Technology*. CRC press.

PFE 412	FOOD BUSINESS MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT	3 (3+0)	SEM VIII

Objective

To enable the students to learn various aspects of business management and entrepreneurship development in food processing

Theory

Introduction and definitions related with project management and entrepreneurship; Fundamentals of project management and entrepreneurship development; Project formulation: market survey techniques, project identification, project selection, project proposal, work breakdown structure; Network scheduling: activity, networks, use of CPM, PERT in project scheduling. Resource planning, resource allocation, project scheduling with limited resources; Estimation of project costs, earned value analysis, project techno-economic viability, break-even analysis. Identification of business opportunity in food processing sector; Government policies for promotion of entrepreneurship in food processing; Launching and organizing an enterprise, enterprise selection, market assessment, feasibility study, SWOT analysis; Resource mobilization. Financial institution in promoting entrepreneurship; Supply chain management; Case study of a food business.

Suggested Readings

1. Awasthi D and Jaggi R. *Entrepreneurship and Management Inputs for Entrepreneurs in Food Processing Sector*. Ahmedabad EDII
2. Bell, G. F. and Balkwill, J. *Management and Engineering*. Prentice Hall International.
3. Bharatia, C. R. *Food Technology and Entrepreneurship Management*. Surendra Publications
4. Jordan, Lisa. *Food Industry: Food Processing and Management.* 2 edn. Callisto

RENEWABLE AND BIO-ENERGY ENGINEERING

Course No.	Course Title	Credits	Semester
Core Courses			
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)	I
AET 192[§] (SEC)-REE	Skill Enhancement	8 (0+8)	II
REE 202	Renewable Energy Sources	3 (2+1)	IV
REE 301	Renewable energy in Agriculture and Allied Sector (For B.Sc. (Hons.) Agriculture)	2 (1+1)	V
REE 302	Bioenergy Systems: Design and Applications	3 (2+1)	VI
AET 392[§]-REE	Case Study	1 (0+1)	VI
AED 491♀-REE	Project I	3 (0+3)	VII
AED 492♀-REE	Project II	4 (0+4)	VIII
Total Credits		**27 (7+20)**	
Elective Courses(Any Three)**			
REE 402/ EE 408	Photovoltaic Technology and Systems	3 (2+1)	VIII
REE 404	Wind Power Technology and Systems	3 (2+1)	VIII
REE 406	Waste and By-Products Utilization	3 (2+1)	VIII
REE 408	Solar Energy Utilization	3 (2+1)	VIII
REE 410	Biogas Technology and Mechanism	3 (2+1)	VIII
	Total Credits	**15 (10+5)**	
	Grand Total	**42 (17+25)**	

[$] On sharing basis with other departments

AED 191	INTRODUCTION TO AGRICULTURAL ENGINEERING	3 (2+1)	SEM I

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post-harvest and allied activities

Theory

Agricultural Engineering as a discipline; Major divisions of Agricultural Engineering; Importance of Agricultural Engineering for today's agriculture; Different sectors of employment for Agricultural Engineers; Scope of research and higher studies in Agricultural Engineering in India and abroad. Introduction to renewable energy systems; Types of Biogas plants, Types of solar energy collectors; Solar water heating systems, solar dryers, solar photovoltaic systems; Wind mills and their different parts.

Practical

Study of various types of biogas plants and operational parameters; Study of various solar energy application systems.Visit to various plants for biogas and solar etc.

Suggested Readings

1. Michael A M and Ojha T P. 2003. Principles of Agricultural Engineering. Jain Brothers, New Delhi.
2. Rai G D. 1995. Solar Energy Utilization. Khanna Publishers, New Delhi.
3. Rai G D. 2013. Non-Conventional Energy Sources. Khanna Publishers, New Delhi

AET 192 (SEC)-REE	SKILL ENHANCEMENT	8 (0+8)	SEM II

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG-certificate, they can work as operators and technicians in the fields of farm machinery, micro-irrigation, solar and wind energy or food processing, etc. or can go for self-employment or start their own agro-service centre, agro-processing centre or similar activities. Thus the broad objective of this course is Skill for Employment and Entrepreneurship Development.

Indicative Modules

REE 001	DESIGN OF SOLAR PV SYSTEMS USING SOFTWARE	4 (0+4)

- Overview of software tools commonly used for solar PV system design (e.g., PV*SOL, Helioscope, PVSyst, SAM), Purpose and capabilities of each software tool, Installation and setup instructions for the selected softwares.
- Features for designing a solar PV system (location, load requirements, shading analysis, etc.),
- Gathering necessary input data: site location, solar irradiance data, system specifications, electrical load profile, etc.
- Conducting a site analysis to assess the solar potential and available space for PV system installation, using software tools to perform shading analysis and identify potential obstructions or shading issues
- Determining the appropriate size of the solar PV system, Selecting PV modules, inverters, mounting structures, and other system components. Optimizing the system configuration to maximize energy production and efficiency
- Creating a layout for the solar PV array using the software's design tools, Placing PV modules on the roof or ground in optimal orientations and configurations
- Designing the electrical wiring and connection scheme for the PV array, inverters, and other components
- Running simulations to estimate the performance and energy yield of the proposed PV system, analyzing simulation results to evaluate the system's energy production, capacity factor, and financial viability Fine-tuning system parameters to optimize performance and maximize energy output
- Performing a financial analysis to assess the economic feasibility of the solar PV project, Calculating the return on investment (ROI), payback period, net present value (NPV), and other financial metrics, Considering incentives, subsidies, and financing options for solar PV installations

- Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., module efficiency, system size, electricity tariffs) on project economics, iteratively refining the system design to achieve the desired performance and economic outcomes
- Generating detailed reports and documentation summarizing the design process, simulation results, and project economics
- Case studies based on real-world projects to apply learned concepts and techniques
- Addressing common challenges and troubleshooting issues encountered during the design process.

REE 002	DESIGN AND MAINTENANCE OF AGRI-VOLTAIC SYSTEMS	4 (0+4)

- Overview of agrivoltaic systems and their benefits, Explanation of how solar panels and agriculture can coexist synergistically
- Factors to consider when selecting a site for an agrivoltaic system (climate, soil, topography, etc.), Conducting site assessments to determine solar potential and suitability for agricultural activities
- Design principles for integrating solar panels with agricultural crops or livestock, Planning the layout and configuration of the agrivoltaic system to maximize energy production and crop yield
- Selection of appropriate crops and planting strategies for agrivoltaic systems
- Installation of solar panels on support structures (ground-mounted or elevated) with proper panel orientation and tilt angle for maximum energy capture
- Safety protocols and best practices for working with solar panel arrays
- Crop selection and management practices suitable for agrivoltaic systems, Monitoring soil moisture, nutrient levels, and crop health Implementing irrigation, fertilization, and pest management strategies tailored to agrivoltaic conditions
- Designing the electrical layout for connecting solar panels to the grid or off-grid systems, Installation of wiring, inverters, combiner boxes, and other electrical components, Compliance with electrical codes and safety standards
- Routine maintenance tasks for solar panels, support structures, and electrical components, Monitoring system performance and troubleshooting common issues, equipment inspection, cleaning, and maintenance
- Introduction to data monitoring systems for tracking energy production, crop yield, and environmental conditions, Interpretation of data to optimize system performance and agricultural productivity, using data analytics tools to identify trends and patterns
- Overview of regulations, permits, and incentives related to agrivoltaic installations, Compliance with zoning laws, land use regulations, and environmental regulations, Advocacy for supportive policies and incentives to encourage the adoption of agrivoltaics

- Visits to agrivoltaic installations and research sites for hands-on learning opportunities, Practical demonstrations of agrivoltaic techniques and technologies, Interaction with practitioners and experts in the field

REE 003	VALORISATION OF AGRI-BIOMASS AND ORGANIC WASTE	4 (0+4)

- Concept of valorization and its role in waste-to-value processes, Introduction to the types of agri-biomass and organic waste commonly generated in agriculture and food production
- Methods for characterizing agri-biomass and organic waste (composition, moisture content, calorific value, etc.), Understanding the properties and potential uses of different types of biomass and waste materials
- Sample collection, preparation, and analysis
- Introduction to biological conversion methods such as anaerobic digestion and composting, Principles of microbial decomposition and fermentation in biomass conversion
- Overview of thermochemical conversion techniques including pyrolysis, gasification, and hydrothermal processing, Understanding the principles of heat transfer, chemical reactions, and product formation in thermochemical processes
- Introduction to biochemical and biotechnological approaches for valorizing biomass and organic waste, Utilization of enzymes, microorganisms, and fermentation processes in bioconversion
- Methods for producing biofuels from agri-biomass and organic waste (biogas, biodiesel, bioethanol, etc.)
- Valorization of agri-biomass and organic waste into value-added products such as biochar, biobased chemicals, and biomaterials
- Strategies for waste minimization, reuse, and recycling in agricultural and food production systems
- Emerging trends such as agri-biomass and organic waste valorization technologies, precision biomass conversion and integrated bio-refinery concepts
- Overview of regulations, standards, and policies governing the valorization of agri-biomass and organic waste

REE 004	ENERGY AUDIT, ENERGY CONSERVATION AND ENERGY EFFICIENCY	4 (0+4)

- Key concepts and definitions related to energy conservation and efficiency
- Introduction to the principles of energy auditing and analysis
- Methods for collecting and analyzing energy consumption data
- Interpretation of energy bills, utility data, and meter readings
- Conducting energy audits for residential, commercial, and industrial facilities
- Introduction to energy auditing tools and equipment (e.g., power meters, data loggers, thermal imaging cameras)

- Use of software tools for energy data analysis and visualization
- Identifying potential areas for energy savings and efficiency improvements, Evaluation of
- building systems, equipment, and operations
- Hands-on exercises in identifying ECOs through site inspections and data analysis
- Overview of energy-efficient technologies and best practices in lighting, HVAC, insulation, appliances, etc, Demonstration of energy-saving devices and equipment, Case studies of successful energy efficiency projects
- Analysis of building energy performance using energy modelling software
- Integration of renewable energy systems (solar PV, wind, geothermal, etc.) with energy conservation and efficiency measures
- Overview of energy efficiency policies, regulations, and incentives at local, national, and international levels
- Energy efficiency standards, labeling programs, and building codes
- Cost-benefit analysis, return on investment (ROI) calculations, and lifecycle cost analysis
- Use of measurement and verification (M&V) protocols and reporting

REE 005	**FABRICATION, OPERATION AND MAINTENANCE OF RENEWABLE ENERGY GADGETS**	**4 (0+4)**

- Acquaintance with different renewable energy sources (solar, wind, hydro biomass, geothermal)
- Principles of photovoltaic (PV) technology, fabrication processes for solar panels and Installation and maintenance of solar power systems
- Grid-tied vs. off-grid solar systems
- Wind turbine technology and components, fabrication and installation of wind turbines., operation and maintenance practices for wind farms
- Pico hydro and their construction and maintenance
- Biomass sources and conversion technologies (combustion, gasification, anaerobic digestion)
- Fabrication of biomass energy systems like gasifier, Improved challah, etc.
- Routine maintenance procedures for renewable energy systems, Troubleshooting common issues
- Safety protocols for maintenance tasks; Monitoring and performance optimization
- Real-world examples of successful renewable energy projects, Hands-on projects to reinforce learning
- Acquaintance with the emerging trends in renewable energy, exploration of innovative technologies (tidal, wave, solar thermal, etc.)
- Renewable energy policies and incentives, regulatory compliance for renewable energy projects, environmental considerations and permitting processes

REE 202	RENEWABLE ENERGY SOURCES	3 (2+1)	SEM IV

Objective

To make the students acquainted with the different renewable energy sources and to enable them to analyse and select the appropriate technology to meet the energy demand in different types of agricultural operations

Theory

Different sources of renewable energy: Concepts and limitations of different renewable energy sources (RES) as solar, wind, geothermal, biomass, ocean energy sources; Criteria for assessing the potential of RES; Comparison of renewable energy sources with non-renewable sources.

Solar energy: Energy available from sun, solar radiation data, solar energy conversion into heat through flat plate and concentrating collectors, different solar thermal devices, principle of natural and forced convection solar drying system; Solar photo voltaics- basics and applications, p-n junctions; Solar cells, PV systems, stand alone, grid connected solar power station; Calculation of energy through photovoltaic power generation and cost economics.

Wind energy: Energy availability, general formula, lift and drag; Basics of wind energy conversion, effect of density, frequency variances, angle of attack, wind speed, types of windmill rotors, determination of torque coefficient, induction type generators; Working principle of wind power plant; Wind farms, aero-generators, wind power generation system.

Biogas: Basics of anaerobic digestion, types and constructional details of biogas plants, biogas generation and its properties, factors affecting biogas generation and usages, design considerations, advantages and disadvantages of biogas spent slurry; Generation of power from biogas; Design and use of different commercial biogas plants.

Power generation from urban, municipal and industrial waste; Ocean thermal and electric power generation, wave and tidal power; Power generation from biomass (gasification and Dendrothermal); Mini and micro hydel plants; Fuel cells and its associated parameters.

Practical

Study of solar thermal devices like solar cookers; Study of solar water heating system; Study of natural convection solar dryer; Study of forced convection solar dryer; Study of solar desalination unit; Study of solar greenhouse for agriculture production; Study of cost economics of solar thermal devices including solar panels; Study of solar photovoltaic system and study of characteristics of solar photovoltaic panel; Study of evaluation of solar air heater/dryer; Study of biogas plants and its components; Performance evaluation of a fixed dome type biogas plant; Performance evaluation of floating drum type biogas plant; Study of biomass gasifiers; Study of cost economics of biogas system; Visit to a windmill plant.

Suggested Readings

1. Basu, P. 2018. Biomass Gasification and Pyrolysis Practical Design and Theory. Academic Press.
2. Deublein, D. and Steinhauser, A. 2008. Biogas from Waste and Renewable Resources. WILEYVCH Verlag GmbH & Co. KGaA, Weinheim.
3. Duffie, J. A. and Beckman, W. A. 2013. Solar Engineering of Thermal Process. John Wiley and Sons.
4. Julian Chen, C. 2011. Physics of Solar Energy. John Wiley & Sons, Inc.
5. Khan, B. H. 2006. Non-Conventional Energy Resources. The McGraw Hill Publishers.
6. Knothe, G., Gerpen, J. V. and Krahl, J. (Eds). 2010. The Biodiesel Handbook. AOCS Press.
7. Patel, M. R. 2005. Wind and Solar Power Systems. CRC Press, Bota Racon.
8. Rai, G. D. 2013. Non-Conventional Energy Sources. Khanna Publishers, New Delhi.
9. Rai, G. D. 2020. Solar Energy Utilization. Khanna Publishers, New Delhi.
10. Reed, T. B. and Das, A. 1988. Handbook of Biomass Downdraft Gassifier Engine Systems. SERI, USA.
11. Ryszard, Petela. 2010. Engineering Thermodynamics of Thermal Radiation for Solar Power Utilization. The McGraw-Hill Companies.
12. Stefan, C. W. and Krauter. 2008. Solar Electric Power Generation – Photovoltaic Energy Systems. Springer.

REE 301	RENEWABLE ENERGY IN AGRICULTURE AND ALLIED SECTOR (For B.Sc. (Hons.) Agriculture)	2 (1+1)	SEM V

Objectives

1. To gain the knowledge on different types of materials used in Renewable Energy
2. To understand the importance of Renewable Energy technology and its applications
3. To train the students on the applications of solar thermal technology

Theory

Classification of energy sources, contribution of these of sources in agricultural sector; Familiarization with biomass utilization for biofuel production and their application; Familiarization with types of biogas plants and gasifiers, biogas, bioalcohol, biodiesel and biooil production and their utilization as bioenergy resource; introduction of solar energy, collection and their application; Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar pond, solar distillation, solar photovoltaic system and their application; Introduction of wind energy and their application. Availability of bio mass and their application in different places.

Practical

Familiarization with renewable energy gadgets. To study biogas plants, gasifier, production process of biodiesel, briquetting machine, production process of bio-fuels. Familiarization with different solar energy gadgets. To study solar photovoltaic system: solar light, solar pumping, solar fencing, solar cooker and solar drying system. To study solar distillation, solar pond and solar wind hybrid system. Field visit to Solar –Wind farm.

Suggested Readings

1. C.S. Solanki. 2011. Solar Photovoltaic –Fundamentals, Technologies and Applications. PHI Learning Pvt. Ltd.
2. S. Sukhatme and J. Nayak. 2008. Solar Energy: Principles of Thermal Collection and Storage. Third Edition (Tata McGraw-Hill).
3. V.V.N. Kishore. 2008. Renewable Energy Engineering and Technology: Principles and Practice, Teri, India.

REE 302	BIOENERGY SYSTEMS: DESIGN AND APPLICATIONS	3 (2+1)	SEM VI

Objective

To make the students acquainted with the different biomass sources, and the different thermochemical and biochemical processes for bioenergy and fuel production

Theory

Biomass sources and characteristics; Fermentation processes and its general requirements; Aerobic and anaerobic fermentation processes and their industrial applications; Heat transfer processes in anaerobic digestion systems.

Biomass production- wastelands, classification and their use through energy plantation; Selection of species, methods of field preparation and transplanting; Harvesting of biomass and coppicing characteristics; Biomass preparation techniques for harnessing (size reduction, densification and drying).

Bio-energy- properties of biomass and conversion technologies, pyrolysis of biomass to produce solid, liquid and gaseous fuels; Biomass gasification, types of gasifiers, various types of biomass cook stoves for rural energy needs; Thermo-chemical degradation; History of small gas producer engine system; Chemistry of gasification; Producer gas- type, operating principle; Gasifier fuels, properties, preparation, conditioning of producer gas; Applications, shaft power generation, thermal application and economics; Trans-esterification for biodiesel production and application in CI engines; production process, properties and application of ethanol; Bio-hydrogen production routes. Environmental aspect of bio-energy; Assessment of greenhouse gas mitigation potential; Cost economics of bio-energy systems.

Practical

Study of anaerobic fermentation system for industrial application; Study of gasification for industrial process heat; Study of biodiesel production unit; Study of ethanol production unit; Study of biomass densification technique (briquetting, pelletization, and cubing); Study of integral bio energy system for industrial application; Study of bio energy efficiency in industry and commercial buildings; Study of energy efficiency in building, study of Brayton, Striling and Rankine cycles; Study of Biomass gasifiers; Study of biomass improved cook-stoves; Estimation of calorific value of biogas and producer gas; Testing of diesel engine operation using dual fuels and gas alone;

Performance evaluation of biomass gasifier engine system (throat less and downdraft); Study on producer gas- types, application, shaft power generation, thermal application and economics; Study of cost economics of biofuel.

Suggested Readings

1. Basu, P. 2018. Biomass Gasification, Pyrolysis and Torrefaction. Academic Press.
2. Butler, S. 2005. Renewable Energy Academy: Training Wood Energy Professionals.
3. Knothe, G., Gerpen, J. V. and Krahl, J. (Eds). 2010. The Biodiesel Handbook. AOCS Press.
4. Rai, G. D. 2013. Non-Conventional Energy Sources. Khanna Publishers, New Delhi.
5. Reed, T. B. and Das, A. 1988. Handbook of Biomass Downdraft Gasifier Engine Systems. SERI.

AET 392-REE	CASE STUDY	1(0+1)	SEM VI

Objective

To enable the students to generate an in-depth, multi-faceted understanding of a specific case/ situation/ aspect related to the profession in its real-life context

Activities

The students will be assigned to visit to a nearby area/ entity to study and analyse any particular case.

The case study can be either problem-solving type or descriptive type. The problem-solving case studies would aim to investigate a problem or situation in a particular individual or group, and recommend solution to the problem(s) based on analysis and theory.

Descriptive case studies would aim to understand a situation better. For example, identifying what happened and why by describing particular aspects of that situation and analysing it in terms of theoretical categories. This will help to make a choice about how to do things in a better way in future for another case having similar features.

Some indicative areas for the case studies are as follows.

Visit to a village to study the energy consumption pattern and suggest measures for efficient energy use and integration of renewable energy for different farm operations

After the visit, the students will submit a report to the institution on their observations. They may also be asked to present the report before the other faculty members and students for interaction.

REE 402/ EE 408	PHOTOVOLTAIC TECHNOLOGY AND SYSTEMS	3 (2+1)	SEM VIII

Objective

1. To enable the students to understand the basic elements of photovoltaics, working of PV cells, designs of PV systems
2. To know the installation of PV system both off grid and on grid

Theory

Solar PV Technology: advantages, limitations, current status of PV technology, SWOT analysis of PV technology; Types of solar cells: Wafer based silicon cell, Thin film amorphous silicon cell, Thin Cadmium Telluride (CdTe) Cell, Copper Indium Gallium Selenide (CiGS) Cell, Thin film crystalline silicon solar cell; Solar photo voltaic module: solar cell, solar module, solar array, series & parallel connections of cell, mismatch in cell, fill factor, effect of solar radiation and temperature on power output of module, I-V and power curve of module, balance of solar PV system; Solar PV system designing and cost estimation.

Introduction to batteries, battery classification, lead acid battery, Nicked Cadmium battery, comparison of batteries, battery parameters; Charge controller: types and function of charge controller, PWM (Pulse width modulation) type, MPPT (Maximum Power Point Tracking) type charge controller; Converters: DC to DC converter and DC to AC type converter.

Application of solar PV system, solar home lighting system, solar lantern, solar fencing, solar street light, solar water pumping system, roof top solar photovoltaic power plant and smart grid.

Practical

Study of V-I characteristics of solar PV system; Smart grid technology and application; Manufacturing technique of solar array; Different DC to DC and DC to AC converter; Domestic solar lighting system; Various solar module technologies; Safe measurement of PV modules electrical characteristics and commissioning of complete solar PV system.

Suggested Readings

1. Derrick, A., Francis, C. and Bokalders, V. 1991. Solar Photo-voltaic Products. Intermediate Technology Publications.
2. Meinel, A. B. and Meinel, M. P. 1976. Applied Solar Energy: An Introduction. Addison-Wesley Educational Publishers Inc.
3. Rai, G. D. 1998. Non-conventional Sources of Energy. Khanna Pub.
4. Rathore, N. S., Kurchania, A. K. and Panwar, N. L. 2006. Renewable Energy: Theory & Practice. Himanshu Publications.
5. Solanki, C. S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications. PHI Learning Private Ltd.

REE 404	WIND POWER TECHNOLOGY AND SYSTEMS	3 (2+1)	SEM VIII

Objective

To enable the students to calculate and analyse wind resource and energy production from a wind turbine, Understand the typical control methods for wind turbines and the modes of wind power generation

Theory

Aerodynamic operations of wind turbines; Wind energy extraction and wind turbine power generation; Design of wind turbine rotors, estimation of wind turbine power rating, selection of optimum wind energy generator; Types of wind energy systems, wind to electrical energy conversion alternatives, grid interfacing of a wind farm, grid connection, energy storage requirements with wind energy system.

Economics of wind energy system; Modes of wind power generation; standalone mode, wind diesel hybrid system, solar wind hybrid system; Control and monitoring system of a wind farm, wind farm sitting; Wind map of India, wind-electric energy stations in India.

Practical

Detailed design and drawing of wind turbine; Study of horizontal axis wind turbine; Study of vertical axis wind turbine; Study of variation of wind speed with elevation; Study of validation of Weibull probability density function; Study of wind power density duration curve; Electrical characteristics and commissioning of complete aero-generator wind power system; Visit to a wind farm.

Suggested Readings

1. Kothari, D. P., Singal, K. C. and Ranjan, R. 2012. Renewable energy sources and emerging technologies. PHI Learning Private Limited. New Delhi.
2. Powar, A. G. and Mohod, A. G. 2010. Fundamentals of wind energy utilization. Jain Brothers Publisher, Karol Bagh, New Delhi.
3. Rai, G. D. 1998. Non-conventional Sources of Energy. Khanna Publisher, New Delhi.
4. Rao, S. and Parulekar, B. B. 2007. Energy Technology. Khanna Publishers, New Delhi.
5. Rathore, N. S., Kurchania, A. K. and Panwar, N. L. 2006. Renewable Energy: Theory & Practice. Himanshu Publications, Udaipur.
6. Solanki, C. S. 2011. Solar Photovoltaic: Fundamentals, Technologies and Applications. PHI Learning Private Ltd, New Delhi.
7. Tiwari, G. N. and Ghosal, M. K. 2005. Renewable Energy Resources: Basic Principles and Applications. Narosa Publishing House, New Delhi.

REE 406	WASTE AND BY-PRODUCTS UTILIZATION	3 (2+1)	SEM VIII

Objectives

1. To enable the students to understand the nature of agricultural wastes and the physical, chemical and biological basis of agricultural waste treatment
2. To analyse and design systems for the collection, handling, treatment and utilization of wastes.

Theory

Types and formation of by-products and waste; Magnitude of waste generation in different food processing industries; Uses of different agricultural by-products from rice mill, sugarcane industry, oil mill etc.

Concept, scope and maintenance of waste management and effluent treatment; Waste parameters and their importance in waste management- temperature, pH, Oxygen demands (BOD, COD), fat, oil and grease content, metal content, forms of phosphorous and sulphur in waste waters, microbiology of waste, other ingredients like insecticide, pesticides and fungicides residues.

Waste utilization in various industries, furnaces and boilers run on agricultural wastes and by products, briquetting of biomass as fuel, production of charcoal briquette, generation of electricity using surplus biomass, producer gas generation and utilization; Waste treatment and disposal: Design, construction, operation and management of institutional community and family size biogas plants, vermi-composting.

Pre-treatment of waste: sedimentation, coagulation, flocculation and floatation; Secondary treatments: biological and chemical oxygen demand for different food plant waste– trickling filters, oxidation ditches, activated sludge process, rotating biological contractors, lagoons; Tertiary treatments: advanced waste water treatment process- sand, coal and activated carbon filters, phosphorous, sulphur, nitrogen and heavy metals removal; Assessment, treatment and disposal of solid waste.

Effluent treatment plants; Environmental performance of food industry to comply with ISO- 14001 standards.

Practical

Determination of temperature, pH, turbidity solids content, BOD and COD of waste water; Determination of ash content of agricultural wastes and determination of un-burnt carbon in ash; Study about briquetting of agricultural residues; Estimation of excess air for better combustion of briquettes; Study of extraction of oil from rice bran; Study on bioconversion of agricultural wastes; Recovery of germ and germ oil from by-products of cereals; Visit to various industries using waste and food by-products.

Suggested Readings

1. Bhatia, S. C. 2001. Environmental Pollution and Control in Chemical Process Industries. Khanna Publishers, New Delhi.
2. Garg, S. K. 1998. Environmental Engineering (Vol. II) – Sewage Disposal and Air Pollution Engineering. Khanna Publishers, New Delhi
3. Joshi, V. K. and Sharma, S. K. 2011. Food Processing Waste Management: Treatment & Utilization Technology. New India Publishing Agency.
4. Markel, I. A. 1981. Managing Livestock Waste. AVI Publishing Co.
5. Pantastico, E. C. B. 1975. Post-harvest Physiology, Handling and Utilization of Tropical and Sub- Tropical Fruits and Vegetables. AVI Pub. Co.
6. Prashar, A. and Bansal, P. 2008. Industrial Safety and Environment. S.K. Kataria and Sons, New Delhi.

7. Shewfelt, R. L. and Prussi, S. E. 1992. Post- arvest Handling - A Systems approach. Academic Press Inc.
8. USDA. 1992. Agricultural Waste Management Field Hand book. USDA, Washington DC.
9. Vasso, O. and Winfried, R. (Eds) 2007. Utilization of By-products and Treatment of Waste in the Food Industry. Springer Science & Business Media, LLC 233 New York.
10. Weichmann, J. 1987. Post-Harvest Physiology of Vegetables. Marcel and Dekker Verlag.

REE 408	SOLAR ENERGY UTILIZATION	3 (2+1)	SEM VIII

Objective

To enable the students to understand the solar energy utilisation, solar energy devices and storage of solar energy in the form of heat.

Theory

Solar radiation: sun and its characteristics; structure of the sun; extraterrestrial solar radiation; the solar constant; solar radiation on earth's surface; beam and scattered radiation; variation in the extraterrestrial radiations; diffuse radiation; attenuation of beam and diffused radiation at the ground; basic earth sun angles; solar time and equation of time; day length; solar radiation measurements and estimation: solar energy measuring instruments, estimation of average solar radiation; solar collectors: flat plate collector, material for flat plate collector and their properties; thermal analysis of flat-plate collectors; collector efficiency factor and heat removal factor; focusing collectors; types and applications of focusing collectors; solar energy application: introduction and principle of operation of solar cookers; solar air heaters; solar water heaters; solar distillation; solar pond; solar refrigeration and air-conditioning; solar thermal power generation; greenhouse etc.; solar thermal storage: types of energy-storage, thermal storage, material characteristics for thermal storage.

Practical

Measurement of solar radiation; solar energy measuring instruments; study of flat plate collector; performance testing of solar cooker; solar water heater; natural and forced convection solar dryer; solar tunnel dryer; solar green house; solar cooling systems; solar pond and visit to various sites of solar energy applications and solar power plants.

Suggested Readings

1. Rai G.D. 1998. Non-conventional sources of energy. Khanna publ.
2. Twindal JW & Anthony D Wier. 1986. Renewable Energy Sources. E&FN Spon Ltd.
3. Sukhatame SP 1996. Solar Energy, Tata McGraw-Hill Education. New Delhi.
4. Garg HP 1990. Advances in solar energy Technology, D.Publishing Company, Tokyo

REE 410	BIOGAS TECHNOLOGY AND MECHANISM	3 (2+1)	SEM VIII

Objective

To enable the students to understand the biogas generation mechanism, design of biogas plants and recycling of biomass released from various sources.

Theory

Biogas technology: introduction and potential of 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 requirements; 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 viability; 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 limitation; 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 biogas plant for distillery and sugar mills effluent; willow dust; agro-wastes; agro and processing industry wastes; repair and maintenance of biogas plants.

Practical

Study of different equipments in lab; study of different models of biogas plants; determination of N; P and K contents of the fresh and digested slurry by chemical analysis; material of biogas to determine its constituents (gas chromatography; Orsate gas Analyzer); study on constructional details of different designs of biogas plants; testing of biogas burner for heat transfer; thermal and cooking efficiency; testing of biogas lamp; determination of BOD/COD; determination of calorific value of biogas; visit to industrial biogas plants; BIS code for efficiency testing of biogas appliances.

Suggested Readings

1. Markel IA 1981. Managing Livestock Waste, AVI Publishing Co.
2. Khoiyangbam RS, Navindu Gupta, Kumar Sushil 2011. Biogas Technology: Towards Sustainable Development. TERI Press, New Delhi.
3. Nijaguna BT 2006. Biogas Technology. New Age International, New Delhi
4. Mathur AN and Rathore NS 1992. Biogas Production Management & Utilization. Himanshu Publications, Udaipur
5. Khandelwal KC and Mahdi SS 1990 Biogas Technology

SOIL AND WATER ENGINEERING

Course No.	Course Title	Credits	Semester
Core Courses			
AED 191[$]	Introduction to Agricultural Engineering	3 (2+1)	I
AET 192[§] (SEC)-SWE	Skill Enhancement	8 (0+8)	II
SWE 201	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	III
PFE 203/ SWE 203/ ABM 209	Protected Cultivation and Secondary Agriculture (For B.Sc. (Hons.) Agribusiness Management)	2 (1+1)	III
SWE 202	Watershed Hydrology	3 (2+1)	IV
SWE 204	Soil and Water Conservation Engineering	3 (2+1)	IV
SWE 301	Irrigation and Drainage Engineering	4 (3+1)	V
SWE 302	Groundwater, Wells and Pumps	3 (2+1)	VI
AET 392[§]-SWE	Case Study	1 (0+1)	VI
SWE 403	Watershed Planning and Management	3 (2+1)	VII
SWE 405	Sprinkler and Micro Irrigation Systems	2 (1+1)	VII
AED 491[♀]-SWE	Project I	3 (0+3)	VII
AED 492[♀]-SWE	Project II	4 (0+4)	VIII
	Total Credits	**42 (17+25)**	
Elective Courses (Any Three)**			
SWE 402	Management of Canal Irrigation System	3 (2+1)	VIII
SWE 404	Remote Sensing and GIS Applications	3 (2+1)	VIII
SWE 406	Precision Farming Techniques for Protected Cultivation	3 (2+1)	VIII
SWE 408	Landscape Irrigation Design and Management	3 (2+1)	VIII
SWE 410	Floods and Control Measures	3 (2+1)	VIII
SWE 412	Minor Irrigation and Command Area Development	3 (2+1)	VIII
	Total Credits	**18 (12+6)**	
	Grant Total	**60 (29+31)**	

[$] On sharing basis with other departments

AED 191[$]	INTRODUCTION TO AGRICULTURAL ENGINEERING	3 (2+1)	SEM I

Objective

To enable the students to have basic idea on different agricultural engineering applications and the machinery involved in different farm operations, post-harvest and allied activities

Theory

Importance of soil and water conservation; Different agronomic measures for control of water erosion, mixed cropping, crop rotation, tillage practices, mulching; Different engineering measures; gully control measures. Use of topographical survey and contour maps. Different types of water harvesting structures. Introduction to soil-plant-water relationship; Equipment for measurement of irrigation water, viz. weirs, notches, orifices; Introduction to different surface irrigation methods as border, furrow and check basin, sprinkler, drip irrigation and their different components; Underground water conveyance methods in pipes; Introduction to drainage systems; Introduction to centrifugal pumps and different components.

Practical

Study on various components of sprinkler and drip irrigation; Study on various components centrifugal pump

Suggested Readings

1. Mal B C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
2. Michael A M and Ojha T P. 2003. Principles of Agricultural Engineering. Jain Brothers, New Delhi.
3. Michael A M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
4. Suresh R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

AET 192 (SEC)-SWE	SKILL ENHANCEMENT	8 (0+8)	SEM II

Objective

To enable the students to acquire basic skills in agricultural engineering so that in case they exit with UG-certificate, they can work as operators and technicians in the fields of farm machinery, micro-irrigation, solar and wind energy or food processing, etc. or can go for self-employment or start their own agro-service centre, agro-processing centre or similar activities. Thus, the broad objective of this course is Skill for Employment and Entrepreneurship Development.

Indicative Modules

SWE 001	REPAIR AND MAINTENANCE OF PUMPS AND IRRIGATION SYSTEMS	4 (0+4)

- Acquaint with different pumps and motors used in irrigation system
- Study of various water lifting devices and their limitations
- Study of components of centrifugal pump and its function
- Study of components of submersible pump and its function
- Components of reciprocating pump and its function
- Dismantling and assembling of irrigation pumps
- Performance testing of centrifugal pumps
- Preparation of pump housing
- Pump alignment and troubleshooting
- Knowing different accessories for electric pump
- Winding of 3-phase and single-phase electric motor
- Causes of trouble shooting in electrical pump set and their remedial measures
- Dismantling and assembling of diesel pump set
- Causes of trouble shooting in diesel pump set and their remedial measures
- Regular maintenance and overhauling, lubrication of pumps
- Study of solar pump set, and its components
- Step-wise installation of solar pump set including earthing

SWE 002	INSTALLATION AND MAINTENANCE OF MICRO IRRIGATION SYSTEMS	4 (0+4)

- Acquaint with different components of micro irrigation
- Installing of micro irrigation (both drip and micro sprinkler) system
- Design of micro irrigation system (both drip and micro irrigation) in field
- Computation crop water requirement of crops
- Acquaint with fertigation equipment, their operation and maintenance
- Execution of fertigation with water soluble fertilizers
- Fixation of fertigation equipment with micro irrigation system
- Doing maintenance schedule in micro irrigation
- Operating automated micro irrigation system
- Operating IOT based irrigation system

SWE 003	APPLICATION OF REMOTE SENSING AND GIS FOR AGRICULTURAL WATER MANAGEMENT	4 (0+4)

- Basics of remote sensing
- Remote sensing sensors and platforms
- Introduction to GIS
- Types of projection systems
- Study of Image resolutions and coordinate system
- Source of remote sensing data and accessibility

- Operations in Google earth platform
- Georeferencing, rectification, digitization and shape file creation
- Basic raster/vector data operations
- Map projection and re-projection
- Preparation of contour maps and rainfall Thiessen polygons
- Map layout and styling
- Preparation of various vegetation index maps
- Preparation of various wetness index maps
- Delineation of watershed and derivation of morphological parameters

SWE 004	OPERATION AND MAINTENANCE OF HYDRO-METEOROLOGICAL INSTRUMENTS	4 (0+4)

- Study and operation of Weather Monitoring Instruments: Thermometer, Barometer,
- Hygrometer; Anemometer, Pyranometer and others
- Components of an automatic weather station (AWS)
- Installation of AWS and its maintenance
- Calibration and installation of Tipping bucket raingauge
- Installation of open pan evaporimeter and periodic maintenance
- Study of infiltration process using ring infiltrometer
- Measurement of flow in open channels using various methods
- Study of different weirs and flumes for flow measurement
- Installation of weirs and flumes in the channel
- Measurement of soil moisture using gravimetric method
- In-situ measurement of soil moisture using different soil moisture sensors
- Installation of water level recorder
- Measurement of groundwater level using ground water level recorder
- Study of multi-slot divisor and Coshocton wheel silt sampler for measurement of soil loss
- Measurement of flow velocity using digital current meter
- Procedure for recording field observations
- Troubleshooting of hydro-meteorological instruments

SWE 005	GEOPHYSICAL SURVEY AND INVESTIGATIONS FOR GROUNDWATER EXPLORATION AND INSTALLATION OF TUBE WELL/ BORE WELL	4 (0+4)

- Learn about different features of groundwater system
- Study of different types of geophysical survey
- Components of a resistivity meter
- Wenner-Schlumberger arrangement and comparison
- Process of geophysical survey in field
- Surveyed data analysis and interpretation
- Different types of well log and preparation of commonly used well log
- Study of different types of wells

- Study the components of a tube well/ bore well
- Study of different types of drilling methods/ equipment
- Installation of well assembly: types of casing, screen
- Study on gravel packing
- Study of well development process
- Sanitary protection of tube wells

SWE 006	INSTALLATION AND MAINTENANCE OF ROOFTOP RAINWATER HARVESTING SYSTEM	4 (0+4)

- Survey and site selection for RRWH
- Computation of rooftop RWH potential and runoff coefficient
- Study of components of RWH system
- Catchments: grading and plastering of rooftop
- Coarse mesh, gutters; roofing materials
- Conduit: material, size of conveyance pipe
- Types of filter system used in RWH system
- Study of storage tank: capacity, overflow pipe
- Study of suitable recharge structure for groundwater
- Study of constructional details of recharge pits, recharge trench
- Types of contaminants in RWH system
- Hand pumps and its application in RWH system
- Preparation of Detail Project Report

SWE 201	FLUID MECHANICS AND OPEN CHANNEL HYDRAULICS	3 (2+1)	SEM III

Objective

To make the students acquainted with the behaviour of fluids at rest and in motion and to enable them to apply the principles to design simple fluid mechanical systems in engineering

Theory

Properties of fluids: Ideal and real fluid, units; Pressure and its measurement, Pascal's law, application of hydrostatics in engineering structures; Buoyancy, Archimede's principle, condition of floatation and stability of submerged and floating bodies. Kinematics of fluid flow: Lagrangian and Eulerian description of fluid motion, continuity equation, path lines stream lines, stream function, velocity potential and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice meter and pitot tube, siphon. Flow through orifices (measurement of discharge, measurement of time), flow through mouthpieces; Flow over notches, flow over weirs, end contraction of rectangular weirs, ventilation of weirs, various types of nappe. Laminar and turbulent flow in pipes, general equation for head loss Darcy equation, Moody's diagram, minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient,

Chezy's formula for loss of head in pipes, flow through simple and compound pipes. Open channel design and hydraulics: Chezy'sformula, Manning's formula, best hydraulic section, velocity and pressure profiles in open channels, hydraulic jump; Discharge measurement in open channels: current meter.

Practical

Study of manometers and pressure gauges; Study of transmissibility of liquid pressure; Study of various types of flow such as laminar flow, uniform flow, steady flow, vertex flow, Verification of Bernoulli's theorem, determination of coefficient of discharge of venturi-meter and orifice meter; Determination of coefficient of friction in pipeline; Determination of coefficient of discharge for rectangular and triangular notch; Determination of coefficient of discharge, coefficient of velocity and coefficient of contraction for flow through orifice; Determination of coefficient of discharge for mouth piece; Determination of efficiency of hydraulic ram; Measurement of velocity by current meter; Study of open channel flow: velocity distribution in open channels and determination of Manning's coefficient and Chezy'sroughness coefficient; Study on non-dimensional constants such as Froude's number and Reynold's number.

Suggested Readings

1. Bansal, R. K. 2019. A Text book of Fluid Mechanics. Laxmi Publications, New Delhi.
2. Ramanuthan, S. 2011. Hydraulics, Fluid Mechanics & Hydraulic Machines. Dhanpat Rai & Sons, Delhi.
3. Khurmi, R. S. and Khurmi, N. 1987. Hydraulics, Fluid Mechanics and Hydraulic Machines. S. Chand & Co. Ltd., New Delhi.
4. Modi, P. N. and Seth, S. M. 2017. Hydraulics & Fluid Mechanics including Hydraulic Machines. Standard Book House, Delhi.

PFE 203/ SWE 203/ ABM 209	**PROTECTED CULTIVATION AND SECONDARY AGRICULTURE (For B.Sc. (Hons.) Agribusiness Management)**	**2 (1+1)**	**SEM III**

Objectives

1. Understand the principles and techniques of protected cultivation, such as greenhouse and polyhouse farming
2. Learn about secondary agriculture practices like value addition, processing, and post-harvest management
3. Explore methods to optimize production, quality, and profitability in controlled environments
4. Develop skills to integrate protected cultivation and secondary agriculture techniques to enhance yield, quality, and market value of agricultural products

Theory

Green house technology: Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipment, materials of

construction for traditional and low-cost green houses. Irrigation systems used in green houses, passive solar green house, hot air greenhouse heating systems, greenhouse drying. Cost estimation and economic analysis.

Important Engineering properties such as physical, thermal and aero and hydrodynamic properties of cereals, pulses and oilseeds. Drying and dehydration; moisture measurement, EMC, drying theory, various drying method, commercial grain dryer (deep bed dryer, flatbed dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer). Material handling equipment; conveyer and elevators, their principle, working and selection.

Practical

Study of different type of greenhouses based on shape. Determine the rate of air exchange in an active summer winter cooling system. Determination of drying rate of agricultural products inside green house. Study of greenhouse equipment. Visit to various Post-Harvest Laboratories. Determination of Moisture content of various grains by oven drying and infrared moisture methods. Determination of engineering properties (shape and size, bulk density and porosity of biomaterials). Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant.

Suggested Readings

1. Green house technology - Aruprathan Ghosh, Kalyani Publishers, New Delhi.
2. Green House Technology and Management - K. Radha Manohar, C. Igathinathane, BS Publications, Koti, Hyderabad, A.P.
3. Greenhouse Management for Horticultural Crops - S. Prasad and U. Kumar, Agrobios, AgroHouse, Jodhpur.
4. Principles and Practices of PostHarvest Technology - P. H. Pandey, Kalyani Publishing, Ludhiana.
5. Unit Operations of Agricultural Processing - K. M. Sahay and K.K. Singh, Vikas Publishing House Pvt Limited, New Delhi.

SWE 202	WATERSHED HYDROLOGY	3 (2+1)	SEM IV

Objective

To make the students acquainted with the different hydrological processes, their methods of analysis so as to enable them to apply these for watershed development, water harvesting, minor irrigation, drought and flood control, etc.

Theory

Hydrologic cycle, components; Precipitation and its forms, rainfall measurement and estimation of mean rainfall, estimation of missing rainfall, optimum number of rain gauges. Frequency analysis of point rainfall; Mass curve, hyetograph, depth-area-duration curves and intensity-duration-frequency relationship. Hydrologic processes-interception, infiltration -factors influencing, measurement and indices; Evaporation-estimation and measurement; Runoff- factors affecting, measurement, stage - discharge rating curve, estimation of peak runoff rate and volume, rational method and SCS curve number method. Geomorphology of watersheds – linear, aerial and

relief aspects of watersheds- stream order, drainage density and stream frequency; Hydrograph - components, base flow separation, unit hydrograph theory, s-curve, applications and limitations. Flood routing – channel and reservoir routing; Drought- classification, causes and impacts, drought management strategy

Practical

Visit to meteorological observatory and study of different instruments; Study of optimal rain gauge network; Study of intensity - frequency - duration curves; Study of depth - area –curve; Analysis of rainfall data and estimation of mean rainfall by different methods; Analysis of frequency of hydrologic data and estimation of missing data, test for consistency of rainfall records; Computation of infiltration indices; Computation of peak runoff and runoff volume by rational formula; Computation of runoff volume by SCS curve number method; Study of stream gauging instruments- current meter and stage level recorder; Study and determination of geomorphic parameters of watersheds; Study of runoff hydrograph and separation of base flow and surface flow ; Study of unit hydrograph; Study of flood routing; Study of various discharge measuring devices

Suggested Readings

1. Chow, V. T., Maidment, D. R. and Mays, L. W. 2010. Applied Hydrology. McGraw Hill, New York.
2. Das, G. 2000. Hydrology and Soil Conservation Engineering. PHI, New Delhi.
3. Garg, S. K. 1998. Hydrology and Water Resources Engineering. Khanna Publishers, Delhi.
4. Jaya Rami Reddy, P. 2011. A Text Book of Hydrology. University Science Press, New Delhi.
5. Linsley, R. K., Kohler, M. A., and Paulhus, J. L. H. 1984. Hydrology for Engineers. McGraw-Hill Publishing Co., Japan.
6. Mutreja, K. N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New Delhi.
7. Panigrahi, B. and Panigrahi, K. 2016. Engineering Hydrology. New India Publishing Agency, New Delhi.
8. Raghunath, H. M. 2006. Hydrology: Principles Analysis and Design. 2nd Edition, New Age International (P) Limited Publishers, New Delhi.
9. Subramanya, K. 2008. Engineering Hydrology. 3rd Edition, Tata McGraw-Hill, New Delhi.
10. Suresh, R. 2005. Watershed Hydrology. Standard Publishers and Distributors, Delhi.
11. Varshney, R. S. 1986. Engineering Hydrology. Nem Chand and Brothers, Roorkee, U.P.

SWE 204	SOIL AND WATER CONSERVATION ENGINEERING	3 (2+1)	SEM IV

Objective

To make the students acquainted with the different causes of soil erosion and water loss and the different measures for soil and water conservation.

Theory

Soil erosion: Introduction, causes and types - geological and accelerated erosion, agents, factors affecting and effects of erosion. Water erosion: Mechanics and forms- splash, sheet, rill, gully, ravine and stream bank erosion; Gullies: classification, stages of development; Soil loss estimation– Universal soil loss equation (USLE) and modified USLE. Rainfall erosivity- estimation by KE >25 and EI30 methods; Soil erodibility- topography, crop management and conservation practice factors; Measurement of soil erosion- Runoff plots, soil samples. Water erosion control measures: Agronomical measures, contour farming, strip cropping, conservation tillage and mulching; Engineering measures- bunds and terraces, bunds: contour andgraded bunds- design and surplussing arrangements; terraces: level and graded broad base terraces, bench terraces - planning, design and layout procedure, contour stone wall and trenching; Gully and ravine reclamation- principles of gully control, vegetative measures, temporary structures and diversion drains. Grassed waterways and design. Soil erosion control structures- Introduction, classification and functional requirements. Permanent structures for soil conservation and gully control- check dams, drop, chute and drop inlet spillways- design requirements, planning for design, design procedures- hydrologic, hydraulic and structural design and stability analysis. Wind erosion: Factors affecting, mechanics, soil loss estimation and control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.

Water harvesting techniques: Classification based on source, storage and use, runoff harvesting short-term and long-term techniques; Structures- farm ponds - dug-out and embankment reservoir types, tanks and subsurface dykes; Farm pond- components, site selection, design criteria, capacity, embankment, mechanical and emergency spillways, cost estimation and construction; Percolation pond - site selection, design and construction details. Design considerations of nala bunds.

Practical

Estimation of soil loss by USLE, computation of rainfall erosivity index, computation of soil erodibility index in soil loss estimation; Determination of length of slope (LS) and cropping practice (CP) factors; Determination of sediment concentration through oven drying method. Calculation of rate of sedimentation and storage loss in tanks; Study on sedimentation of reservoirs; Design and layout of contour bunds and graded bunds; Design and layout of broad base terraces and bench terraces; Design of vegetative waterways; Design of shelter belts and wind breaks for wind erosion control; Farm pond- design, capacity and estimation; Hydraulic design of drop spillway; Determination of uplift force and construction of uplift pressure diagram, structural design and stability analysis of drop spillway; Hydraulic and structural design of chute spillway; Design of drop inlet spillway; Study on components of earth embankments and its design; Design of water harvesting structures; Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures.

Suggested Readings

1. Chow, V. T. 1985. Open-Channel Hydraulics. McGraw- Hill Book Company, Inc.
2. Frevert, R. K., Schwab, G. O., Edminster, T. W. and Barnes, K. K. 2009. Soil and Water Conservation Engineering. 4th Edition, John Wiley and Sons, New York.
3. Mahnot, S. C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service, New Delhi. REPORT OF THE ICAR SIXTH DEANS' COMMIT TEE 175.
4. Mal, B. C. 2014. Introduction to Soil and Water Conservation Engineering. 2014. Kalyani Publishers.
5. Michael, A. M. and Ojha, T. P. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
6. Murthy, V. V. N. 2002. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
7. Norman Hudson. 1985. Soil Conservation. Cornell University Press, Ithaka, New York, USA.
8. Samra, J. S., Sharda, V. N. and Sikka, A. K. 2002. Water Harvesting and Recycling: Indian Experiences. CSWCR&TI, Dehradun, Allied Printers, Dehradun.
9. Sharda, V. N., Juyal, G. P., Prakash, C. and Joshi, B. P. 2007. Training Manual: Soil Conservation and Watershed Management (Vol.-II) – CSWCRTI Publication, Dehradun.
10. Singh, G., Venkataraman, C., Sastry, G. and Joshi, B. P. 1996. Manual of Soil and Water Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.
11. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.
12. Das, G. 2000. Hydrology and Soil Conservation Engineering. Prentice Hall of India Pvt. Ltd, New Delhi.
13. USDA. 1964. Engineering Hand Book on Drop Spillways (Section-11). USDA, Soil Conservation Service.

SWE 301	IRRIGATION AND DRAINAGE ENGINEERING	4 (3+1)	SEM V

Objective

To make the students acquainted with the different methods of irrigation depending on the crop water requirement and the different drainage solutions depending on specific situations.

Theory

Major and medium irrigation schemes of India, purpose of irrigation, merits and demerits of irrigation, source of irrigation water, present status of development and utilization of different water resources of the country; Measurement of irrigation water: weir, flumes and orifices and other methods. Design of irrigation field channels, on-farm structures for water conveyance, control and distribution; Underground pipe conveyance system: components and design.

Soil-water-plant relationship: Soil properties influencing irrigation management, soil water movement, infiltration, soil water potential, soil moisture characteristics, soil moisture constants, measurement of soil moisture, moisture stress and plant response; Water requirement of crops: concept of evapotranspiration (ET), measurement and estimation of ET, water and irrigation requirement of crops, depth of irrigation, frequency of irrigation, irrigation efficiencies. Surface methods of water application: Border, check basin and furrow irrigation- adaptability, specification and design considerations; Water logging-causes and impacts; Drainage, objectives of drainage, familiarization with the drainage problems of the state, drainage coefficient. Surface drainage, types and design; Sub-surface drainage: purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types and use of subsurface drainage system, interceptor and relief drains. Derivation of Hooghoudt's and Ernst's drain spacing equations; Design of subsurface drainage system, drainage materials, drainage pipes, drain envelope; Layout, construction and installation of drains; Drainage structures, vertical drainage, bio-drainage, tile drains, mole drain. Salt balance, reclamation of saline and alkaline soils, leaching requirements; Conjunctive use of fresh and saline waters.

Practical

Measurement of irrigation water; Measurement of infiltration characteristics; Determination of bulk density, field capacity and wilting point; Measurement of soil moisture by different instruments; Estimation of evapotranspiration and water requirement of crops; Study on scheduling of irrigation of field crops; Study of advance, recession and computation of infiltration opportunity time; infiltration by inflow-outflow method; Study on evaluation of border irrigation method; Study on insitu measurement of hydraulic conductivity by auger hole method; Study on drainage coefficients determination; Study of piezometer, observation well and measurement of water table; Preparation of iso-bath maps; Design of surface drainage systems; Design of subsurface drainage systems; Determination of various chemical properties of soil and water; Visit to a waterlogged area and study of a drainage project; Gypsum required exercise for reclamation of alkaline soil.

Suggested Readings

1. Allen, R. G., Pereira, L. S., Raes, D. and Smith, M. 1998. Crop Evapotranspiration Guidelines for Computing Crop Water Requirement. Irrigation and drainage paper 56, FAO of United Nations, Rome.
2. Bhattacharya, A. K. Drainage Engineering. ICAR Publications, New Delhi.
3. Bhattacharya, A. K. and Michael, A. M. 2013. Land Drainage, Principles, Methods and Applications. Vikas Publication House, Noida (UP).
4. Israelsen, O. W., Hansen, V. E. and Stringham, G. E. 1980. Irrigation Principles and Practices. John Wiley & Sons, Inc. USA.
5. Majumdar, D. K. 2013. Irrigation Water Management Principles. PHI learning Private Limited, New Delhi.
6. Michael, A. M. 2012. Irrigation: Theory and Practice. Vikas Publishing House, New Delhi.

7. Michael, A. M. and Ojha, T. P. 2014. Principles of Agricultural Engineering. Vol II. 5th Edition. REPORT OF THE ICAR SIXTH DEANS' COMMIT TEE 187 Jain Brothers Publication, New Delhi.
8. Murthy, V. V. N. 2013. Land and water Management Engineering. Kalyani Publishers, New Delhi.
9. Panigrahi, B. 2013. A Handbook on Irrigation and Drainage. New India Publishing Agency, New Delhi.
10. Ritzema, H. P. 1994. Drainage Principles and Applications. ILRI Publication 16.

SWE 302	GROUNDWATER,WELLS AND PUMP	3 (2+1)	SEM VI

Objective

To make the students acquainted with the quality of ground water, equipment and methods for construction of wells, and different types of water lifting devices.

Theory

Groundwater hydrology and hydrologic cycle, groundwater resources of World and India; Occurrence and movement of groundwater, aquifer and its types, aquifer properties, groundwater flow direction, flow in relation to groundwater contours; Classification of wells, fully penetrating tube wells and open wells, familiarization of various types of bore wells, design of open wells. Darcy's law, determination of hydraulic conductivity by laboratory and field method; Groundwater hydraulics-Dupit's assumptions and Dupit's method, Thiem's method; Well interference; determination of aquifer parameters by Theis, Chow's, Theis recovery method; Design of tube well and gravel pack. Groundwater exploration techniques; methods of drilling of wells: percussion, rotary, reverse rotary; DTH; Development of tube well; Basin wise groundwater development, safe yield, factors governing safe yield. Quality of groundwater, groundwater pollution; Artificial groundwater recharge techniques; different direct, indirect and combination of methods. Pumping systems: Water lifting devices; Classification of pumps, components of centrifugal pumps, priming, pump selection, installation and troubleshooting, performance curves, effect of speed on capacity, head and power, effect of change of impeller dimensions on performance characteristics; Hydraulic ram, deep well turbine pump and submersible pump.

Practical

Verification of Darcy's law; Determination of hydraulic conductivity by laboratory and field methods; Study of piezometer, observation well and measurement of water table; Study of groundwater flow direction, preparation of iso-bath maps and its application in the field; Study of different drilling equipment; Sieve analysis for gravel and well screens design; Estimation of specific yield and specific retention; Estimation of aquifer parameters by Theis method, Chow method and Theis Recovery method; Design of well; Study of well losses and well efficiency; Determination of various parameters on groundwater quality; Study on various types of wells; Estimation of groundwater balance; Study of various artificial ground-

water recharge structures; Study of centrifugal pumps, multistage centrifugal pumps, installation and testing of centrifugal pump; Visit to a drilling site.

Suggested Readings

1. Garg, S. P. 1987. Groundwater and Tube Wells. Oxford & IBH Publishing Co. Ltd., New Delhi.
2. Lal, R. 1993. Irrigation Hydraulics. Ajiwan Shiksha Sansthan, Allahabad.
3. Michael, A. M., Khepar, S. D. and Sondhi, S. K. 2008. Water Well & Pump Engineering. Tata Mc-Graw Hill.
4. Nagabhusaniah, H. S. 2020. Groundwater in Hydrosphere. CBS Publishers and Distributors, New Delhi.
5. Raghunath, H. M. 2007. Groundwater. New Age Publications, New Delhi.
6. Todd, D. K. and Mays, L. W. 2011. Groundwater Hydrology. John Wiley & Sons, New York.

AET 392-SWE	CASE STUDY	1 (0+1)	SEM VI

Objective

To enable the students to generate an in-depth, multi-faceted understanding of a specific case/ situation/ aspect related to the profession in its real-life context

Activities

The students will be assigned to visit to a nearby area/ entity to study and analyse any particular case.

The case study can be either problem-solving type or descriptive type. The problem-solving case studies would aim to investigate a problem or situation in a particular individual or group, and recommend solution to the problem(s) based on analysis and theory.

Descriptive case studies would aim to understand a situation better. For example, identifying what happened and why by describing particular aspects of that situation and analysing it in terms of theoretical categories. This will help to make a choice about how to do things in a better way in future for another case having similar features.

Some indicative areas for the case studies are as follows.

- Study a specific watershed and suggest measures for rejuvenating the watershed
- Visit to an orchard and suggest measures for optimized water use

After the visit, the students will submit a report to the institution on their observations. They may also be asked to present the report before the other faculty members and students for interaction.

SWE 402	MANAGEMENT OF CANAL IRRIGATION SYSTEM	3 (2+1)	SEM VIII

Objective

To enable the students to analyse water requirement and availability in a canal command, to take up design of lined and unlined canals and enable to control of

losses of water in canal commands and for design and layout of different canal outlet structures.

Theory

Typical network of canal irrigation system and its physical components; Canal classifications based on source of water, financial output, purpose, discharge and alignment; Canal alignment: general considerations; Different parts of canal sections, performance indicators for canal irrigation system evaluation; Estimation of water requirements for canal command areas and determination of canal capacity; Base period, water duty and delta, relationship between base period, duty and delta; factors affecting duty and method to improve duty; Silt theory: Kennedy's theory, design of channels by Kennedy's theory, Lacey's regime theory and basic regime equations, design of channels by Lacey's theory; Maintenance of unlined irrigation canals, measurement of discharge in canals; Rostering (canal running schedule) and warabandi, rotational irrigation, pre-requisite of warabandi; Necessity of canal lining: advantages and disadvantages, types of canal lining and desirable characteristics for the suitability of lining materials, design of lined canals; Functions of distributary head and cross regulators; Canal falls, their necessity and factors affecting canal fall, types of canal falls; Sources of surplus water in canals and types of canal escapes; Requirements of a good canal outlet and types of outlet; water user's association: necessity, structure, function and duties.

Practical

Estimation of water requirement of canal commands; Determination of canal capacity; Layout of canal alignments on topographic maps; Drawing of canal sections in cutting; Design of canal by full banking and partial cutting; Determination of longitudinal section (L-section) of canals; Design of irrigation canals based on silt theories (unlined canal); Design of lined canals; Formulation of warabandi system in canal command areas; Study of various types of canal outlet; Study of various types of canal regulators; Study of canal escapes; Study of various types of canal falls; Visit to a canal off taking site; Visit to a canal command area; Visit and discussion with functionaries of water user association.

Suggested Readings

1. Arora, K. R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.
2. Garg, S. K. 2014. Irrigation Engineering and Hydraulic Structures. Khanna Publishers New Delhi.
3. Sahasrabudhe, S. R. 2011. Irrigation Engineering and Hydraulic Structures. S K Kataria& Sons. Reprint 2015.

SWE 403	WATERSHED PLANNING AND MANAGEMENT	3 (2+1)	SEM VII

Objective

To acquaint the students with different aspects of watershed planning and management including participatory approaches and also on the integrated watershed management practices

Theory

Watershed- introduction and characteristics; Watershed management- concept, objectives, factors affecting watershed planning based on land capability classes, hydrologic data for watershed planning, watershed codification, delineation and prioritization of watersheds – sediment yield index. Community mobilization and participatory institution building: participatory watershed management, role of watershed associations, user groups and self-help groups; Participatory Rural Appraisal, understanding gender in relation to agriculture. Water budgeting in a watershed; Management measures - rainwater conservation technologies in-situ and ex-situ storage, water harvesting and recycling; Integrated watershed management-concept, components, arable lands - agriculture and horticulture, non-arable lands-forestry, fishery and animal husbandry; Effect of cropping systems, land management and cultural practices on watershed hydrology. Application of remote sensing and GIS in watershed planning and management. Delineation of watersheds and generation of stream network; Preparation of various thematic maps in watershed; Prioritization of watersheds; Watershed characterization; Watershed action plan; Analytical Hierarchy Process; Watershed evaluation and impact assessment; Quantification of surface and groundwater resources in watersheds; Computer models used for hydrologic and watershed modelling.

Watershed programme- execution, follow-up practices, maintenance, monitoring and evaluation; Planning and formulation of project proposal for watershed management programme including cost-benefit analysis; Financial management and accounting procedure**.**

Practical

Delineation of watersheds using toposheets; Surveying and preparation of watershed map; Quantitative analysis of watershed characteristics and parameters; Investigations on watershed for planning and development including PRA; Analysis of hydrologic data for planning watershed management; Measurement of discharge and sediment in a watershed; Water budgeting of watersheds; Study of thematic maps using remote sensing; Prioritization of watersheds based on sediment yield index; Study of functional requirement of watershed development structures; Study of watershed management technologies; Study of role of various functionaries in watershed development programs; Visit to watershed development project areas

Suggested Readings

1. Das, G. 2008. Hydrology and Soil Conservation Engineering: Including Watershed Management. 2nd edn. Prentice-Hall of India Learning Pvt. Ltd., New Delhi.

2. Katyal, J. C., Singh, R. P., Sharma, S., Das, S. K., Padmanabhan, M. V. and Mishra, P. K. 1995. Field Manual on Watershed Management. CRIDA, Hyderabad.
3. Mahnot, S. C. 2014. Soil and Water Conservation and Watershed Management. International Books and Periodicals Supply Service. New Delhi.
4. Rajora, R. 2019.Integrated Watershed Management. Rawat Publications, New Delhi.
5. Sharda, V. N., Sikka, A. K. and Juyal, G. P. 2006. Participatory Integrated Watershed Management: A Field Manual. Central Soil and Water Conservation Research and Training Institute, Dehradun.
6. Singh, G. D. and Poonia, T. C. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner.
7. Thomas, C. G. 2010. Land Husbandry and Watershed Management. Kalyani Publishers, Ludhiana.

SWE 404	REMOTE SENSING AND GIS APPLICATIONS	3 (2+1)	SEM VIII

Objective

To enable the students to know about the remote sensing methods and applications in NRM, digital image processing and concepts of GIS and data management.

Theory

Basic component of remote sensing (RS), advantages and limitations of RS, possible use of RS techniques in assessment and monitoring of land and water resources; Electromagnetic spectrum, energy interactions in the atmosphere and with the Earth's surface; Major atmospheric windows, principal applications of different wavelength regions, typical spectral reflectance curve for vegetation, soil and water; Spectral signatures, different types of sensors and platforms, contrast ratio and possible causes of low contrast, aerial photography; Types of aerial photographs, scale of aerial photographs, planning aerial photography- end lap and side lap, stereoscopic vision, requirements of stereoscopic photographs; Air-photo interpretation- interpretation elements; Photogrammetry- measurements on a single vertical aerial photograph, measurements on a stereopair- vertical measurement by the parallax method; Ground control for aerial photography; satellite remote sensing, multispectral scanner-whiskbroom and push-broom scanner; Different types of resolutions; analysis of digital data- image restoration; image enhancement; Information extraction, image classification, unsupervised classification, supervised classification, important consideration in the identification of training areas, vegetation indices; Microwave remote sensing, GIS and basic components, different sources of spatial data, basic spatial entities, major components of spatial data; Basic classes of map projections and their properties; Methods of data input into GIS, data editing, spatial data models and structures, attribute data management, integrating data (map overlay) in GIS; Application of remote sensing and GIS for the management of land and water resources.

Practical

Familiarization with remote sensing and GIS hardware; Use of software for image interpretation; Interpretation of aerial photographs and satellite imagery; Basic GIS

operations such as image display; Study of various features of GIS software package; Scanning, digitization of maps and data editing; Data base query and map algebra; GIS supported case studies in water resources management.

Suggested Readings

1. Elangovan, K. 2006. GIS Fundamentals Applications and Implementations. New India Publication Agency, New Delhi.
2. George, J. 2005. Fundamentals of Remote Sensing. 2nd Edn. Universities Press (India) Private Limited, Hyderabad.
3. Jensen, J. R. 2013. Remote Sensing of the Environment: An Earth Resource Perspective. Pearson Education Limited, UK.
4. Lillesand, T., Kiefer, R. W. and Chipman, J. 2015. Remote Sensing and Image Interpretation. 7th Edition, John Wiley and Sons Singapore Pvt. Ltd., Singapore.
5. Reddy, A. M. 2006. Textbook of Remote Sensing and Geographical Information Systems. BS Publications, Hyderabad.
6. Sabins, F. F. 2007. Remote Sensing: Principles and Interpretation. Third Edition, Waveland Press Inc., Illinois, USA.
7. Sahu, K. C. 2008. Text Book of Remote Sensing and Geographic Information Systems. Atlantic Publishers and Distributors (P) Ltd., New Delhi.
8. Shultz, G. A. and Engman, E. T. 2000. Remote Sensing in Hydrology and Water Management. Springer, New York.

SWE 405	SPRINKLER AND MICRO IRRIGATION SYSTEMS	2 (1+1)	SEM VII

Objective

To make the students acquainted with the importance of micro irrigation systems, their design and lay out for efficient water, fertilizer and pesticides applications.

Theory

Sprinkler irrigation: adaptability, problems and prospects, types of sprinkler irrigation systems; Design of sprinkler irrigation system: layout selection, hydraulic design of lateral, sub-main and main pipe line, design steps; Selection of pump and power unit for sprinkler irrigation system; Performance evaluation of sprinkler irrigation system: water distribution pattern and overlapping of sprinklers and laterals, uniformity coefficient.

Micro Irrigation systems: types- drip, spray, and bubbler systems, merits and demerits, different components; Design of drip irrigation system: general considerations, wetting patterns, irrigation requirement, emitter selection; Hydraulics of drip irrigation system, design steps; Necessary steps for proper operation of a drip irrigation system, maintenance of micro irrigation system: clogging problems, filter cleaning, flushing and chemical treatment. Fertigation: advantages and limitations of fertigation, fertigation frequency, duration and injection rate, methods of fertigation.

Practical

Study of different components of sprinkler irrigation system; Study of wetting pattern of a sprinkler and requirement for overlapping of sprinkler; Study of discharge and

uniformity coefficient; Design and installation of sprinkler irrigation system; Study on maintenance of sprinkler irrigation system; Field visit to a sprinkler irrigation project; Study of different components of drip irrigation; Design and installation of drip irrigation system; Determination of pressure discharge relationship and emission uniformity for given emitter; Study of different types of filters and determination of filtration efficiency; Study of fertigation, types of liquid fertilisers, determination of rate of injection and calibration for chemigation/ fertigation; Design of irrigation and fertigation schedule for crops; Study on removal of clogging of emitters; Study on maintenance of drip irrigation system; Field visit to micro irrigation system and evaluation of drip system; Field visit to study foggers.

Suggested Readings

1. Jain, S. C. and Philip, G. 2003. Farm Machinery - An Approach. Standard Publishers and Distributors, Delhi.
2. Mane, M. S. and Ayare, B. L. 2007. Principles of Sprinkler Irrigation system. Jain Brothers, New Delhi.
3. Mane, M. S. and Ayare, B. L. and Magar, S. S. 2006. Principles of Drip Irrigation systems. Jain Brothers, New Delhi.
4. Michael, A. M., Shrimohan and Swaminathan, K. R. 1972. Design and evaluation of irrigation methods (IARI Monograph No.1). Water Technology Center, IARI New Delhi.
5. Michael, A. M. 2012. Irrigation: Theory and Practice. Vikas Publishing, New Delhi.
6. Sivanappan, R. K. 1992. Sprinkler Irrigation. Oxford & IBH Publishing House, New Delhi.
7. Suresh, R. 2010. Micro Irrigation - Theory and Practices. Standard Publishers Distributors, Delhi.

SWE 406	PRECISION FARMING TECHNIQUES FOR PROTECTED CULTIVATION	3 (2+1)	SEM VIII

Objectives

1. To enable the students to design and construction of green houses in different agro-climatic zones, greenhouse cooling and heating systems, environmental parameter and control, ventilation systems
2. To assess different root media, micro-irrigation, fertigation, planting techniques in green house cultivation and to know about hydroponics, post-harvest management, pest management and economic aspects of a green house

Theory

Protected cultivation: introduction, development, national and international scenario.

Types of green houses, components of green house, cladding materials, plant environment interactions, principles of limiting factors, solar radiation and transpiration, greenhouse effect, light, temperature, relative humidity, carbon dioxide enrichment; Design and construction of greenhousessite selection, orientation, design, construction, design for ventilation requirement using exhaust fan system,

selection of equipment; Greenhouse cooling system- methods, ventilation with roof and side ventilators, evaporative cooling, different shading materials, fogging, combined fogging and fan-pad cooling system, design of cooling system, maintenance of cooling and ventilation systems, pad care, etc.; Greenhouse heating- components, methods, design of heating system.

Irrigation in greenhouse and net house- water quality, types of irrigation system, components, design, installation and material requirement; Fogging system for greenhouses and net houses- introduction, benefits, design, installation and material requirement; Maintenance of irrigation and fogging systems.

Fertilization- nutrient deficiency symptoms and functions of essential nutrient elements, principles of selection of proper application of fertilizers, fertilizer scheduling, rate of application of fertilizers, methods, automated fertilizer application.

Greenhouse climate measurement, control and management; major crops in greenhouse- irrigation requirement, fertilizer management.

Practical

Estimation of material requirement for construction of greenhouse; Determination of fertilization schedule and rate of application for various crops; Design and installation of irrigation system; Design and installation of fogging system; Study of different greenhouse environment control instruments; Study of operation, maintenance and fault detection in irrigation system; Study of operation, maintenance and fault detection in fogging system; Visit to greenhouses.

Suggested Readings

1. Sharma, P. 2007. Precision Farming. Daya Publishing House New Delhi.
2. Singh, B. and Singh, B. 2014. Advances in Protected Cultivation. New India Publishing Company.

SWE 408	LANDSCAPE IRRIGATION DESIGN AND MANAGEMENT	3 (2+1)	SEM VIII

Objective

To enable the students to know about the different conventional and modern methods of landscape irrigation, various types of landscapes and their suitability with regard to different irrigation methods, design the modern landscape irrigation systems, automation of the landscape irrigation system and irrigation scheduling with proper methods of irrigation for different landscapes

Theory

Conventional method of landscape irrigation- hose irrigation system, and portable sprinkler with hose pipes; Modern methods of landscape irrigation- pop-up sprinklers, spray pop-up sprinkler, drip irrigation and bubblers; Merits and demerits of conventional and modern irrigation systems; Types of landscapes and suitability of different irrigation methods, water requirement for different landscapes; Segments of landscape irrigation systems, main components of modern landscape irrigation systems and their selection criteria; Types of pipes, pressure ratings, sizing and

selection criteria; Automation system for landscape irrigation- main components, types of controllers and their application;

Use of sensors for irrigation automation and use of IOT in landscape irrigation. Use of AutoCAD in irrigation design; Design of modern landscape irrigation systems, operation and maintenance of landscape irrigation systems**.**

Practical

Study of irrigation equipment for landscapes; Design and installation of irrigation system for landscape; Determination of water requirement; Determination of power requirement, pump selection; Irrigation scheduling of landscapes; Study of irrigation controllers and other equipment; Use of AutoCAD in irrigation design; Study of blocks and symbols, head layout, zoning and valves layout, pipe sizing, pressure calculations, etc.; Study of various types of sensors for irrigation automation; Study of IoT in landscape irrigation; Visit to landscape irrigation system and its evaluation.

Suggested Readings

1. Michael, A. M. 2012. Irrigation: Theory and Practice. Vikas Publishing House, New Delhi.
2. Singh, N. P. 2010. Landscape Irrigation and Floriculture Terminology. Bangalore.
3. Smith, S. W. 1996. Landscape Irrigation: Design and Management. John Wiley and Sons, Inc.,New York, United States.

SWE 410	FLOODS AND CONTROL MEASURES	3 (2+1)	SEM VIII

Objective

To enable the students to Understand the flood forecasting and warning systems, different permanent and temporary control measures of flood, and to design of storage structures and dam.

Theory

Floods- causes of occurrence, flood classification- probable maximum flood, standard project flood, design flood, flood estimation- methods of estimation; Estimation of flood peak- rational method, empirical methods, unit hydrograph method; Statistics in hydrology, flood frequency methods- log normal, Gumbel's extreme value, log-Pearson type-III distribution; depth-areaduration analysis, flood forecasting; Flood routing- channel routing, Muskingum method, reservoir routing, modified Pul's method; Flood control- history of flood control, structural and non-structural measures of flood control, storage and detention reservoirs, levees, channel improvement.

Gully erosion and its control structures- design and implementation; Earthen embankments functions, classification, hydraulic fill and rolled fill dams, homogeneous, zoned and diaphragm type, foundation requirements, grouting, seepage through dams, flow net and its properties, seepage pressure, seepage line in composite earth embankments, drainage filters, piping and its causes.

Design and construction of earthen dam, stability of earthen embankments against failure by tension, overturning, sliding, etc., stability of slopes- analysis of failure by different methods; Planning of flood control projects and their economics.

Practical

Determination of flood stage-discharge relationship in a watershed; Determination of flood peak-area relationships; Determination of frequency distribution functions for extreme flood values using Gumbel's method; Determination of confidence limits of the flood peak estimates for Gumbel's extreme value distribution; Determination of frequency distribution functions for extreme flood values using log-Pearson Type-III distribution; Determination of probable maximum flood, standard project flood and spillway design flood; Design of levees for flood control; Designing, planning and cost- benefit analysis of a flood control project; Design of earthen dams; Determination of the position of phreatic line in earth dams for various conditions, stability analysis of earthen dams against head water pressure, foundation shear, sudden draw down condition; Stability of slopes of earth dams by friction circle and other methods; Construction of flow net for isotropic and anisotropic media; Computation of seepage by different methods; Determination of settlement of earth dam; Input-output-storage relationships by reservoir routing; Study of reservoir rule curve; Visit to earthen dam and flood control reservoir.

Suggested Readings

1. Arora, K. R. 2014. Soil Mechanics and Foundation Engineering (Geotechnical Engineering). Standard Publishers Distributors, Delhi.
2. Bureau of Reclamation. 1987. Design of Small Dams. US Department of Interior, Washington DC, USA.
3. Garg, S. K. 2014. Soil Mechanics and Foundation Engineering. Khanna Publishers, Delhi.
4. Garg, S. K. 2018. Irrigation Engineering and Hydraulic Structures. Khanna Publishers, Delhi
5. Michael, A, M. and Ojha, T. P. 2003. Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi.
6. Modi, P. N. 2010. Irrigation and Water Power Engineering. Standard Publishers Distributors, Delhi.
7. Murthy, V. V. N. 2010. Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi.
8. Mutreja, K. N. 1990. Applied Hydrology. Tata McGraw-Hill Publishing Co., New York, Delhi.
9. Stephens, Tim. 2010. Manual on Small Earth Dams - A Guide to Siting, Design and Construction. Food and Agriculture Organization of the United Nations, Rome.

10. Subramanya, K. 2008. Engineering Hydrology. 3rd edn, Tata McGraw-Hill Publishing Co., New Delhi.
11. Suresh, R. 2014. Soil and Water Conservation Engineering. Standard Publisher Distributors, New Delhi.

SWE 412	MINOR IRRIGATION AND COMMAND AREA DEVELOPMENT	3 (2+1)	SEM VIII

Objective

To enable the students to importance of command area development programs in irrigation projects and to plan, design, execute and evaluate on-farm development works.

Theory

Major, medium and minor irrigation projects, factors affecting performance of irrigation projects; Types of minor irrigation systems in India, surface water and groundwater projects; Lift irrigation systems: feasibility, type of pumping stations and their site selection, design of lift irrigation systems; Tank irrigation: grouping of tanks, storage capacity, supply works and sluices; Earthen dams: components, types, methods of construction, causes of failure of earthen dams, seepage control in earthen dams.

Command area development (CAD) programme- components, need, scope, and development approaches, historical perspective, command area development authorities- objectives, functions and responsibilities; On farm development works, design of lined and un-lined field channel and its cost estimation; Farmers' participation in command area development, PIM, water user's association; Reclamation works, cross drainage works; Use of remote sensing techniques for CAD works; Rotational irrigation system, Warabandi, pre-requisites for warabandi; Conjunctive use of water, optimum utilization of water; Water productivity: concepts and measures for enhancing water productivity.

Practical

Preparation of command area development layout plan; Irrigation water requirement of crops of command area; Preparation of irrigation schedules; Planning and layout of water conveyance system; Design of surplus weir of tanks; Determination of storage capacity of tanks; Design of intake pipe and pump house; Planning and design of OFD works; Cost estimation of OFD work; Study of cross-drainage works; Design and cost estimation of earthen dams for minor irrigation project; Estimation of seepage in field channels; Visit to a minor irrigation project; Visit to a command area and study of OFD works; Study of reclamation of waterlogged areas inside command area.

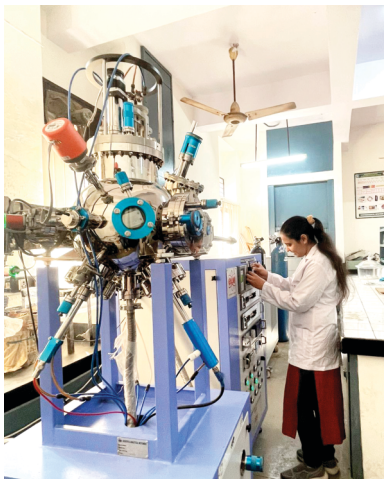
Suggested Readings

1. Arora, K. R. 2001. Irrigation, Water Power and Water Resources Engineering. Standard Publishers Distributors, Delhi.

2. Garg, S. K. 2014. Irrigation Engineering and Hydraulic Structures. Khanna Publishers, New Delhi.
3. Michael, A. M. 2012. Irrigation: Theory and Practice. Vikas Publishing House New Delhi.
4. Reddi, G. H. S. and Reddy, T. Y. 2005. Efficient use of Irrigation Water. Kalyani Publishers, Ludhiana.
5. Sahasrabudhe, S. R. 2011. Irrigation Engineering and Hydraulic structures. SK Kataria& Sons, Reprint 2015.

COLLEGE OF BASIC SCIENCES & HUMANITIES


National Science Day-2025
Harnessing Science for a Self-Reliant and Sustainable Viksit Bharat-2047
Keynote Speaker
Dr. Devinder Kumar
Chief Guest
Prof. B. R. Kamboj
Vice-Chancellor




WESTERN SYDNEY
UNIVERSITY

COLLEGE OF BASIC SCIENCES & HUMANITIES

SUPPORTING COURSES FOR B.SC. (HONS.) AGRICULTURE, B.SC. (HONS.) AGRIBUSINESS MANAGEMENT, B.SC. (HONS.) COMMUNITY SCIENCE, B.F.Sc., B.TECH (AGRICULTURAL ENGINEERING) AND B.TECH. BIOTECHNOLOGY

Course No.	Course Title	Credits	Semester
	Biochemistry		
BIOCHEM 202	Basic Biochemistry (For B.Tech. Biotechnology)	4 (3+1)	IV
BIOCHEM 302	Essentials of Plant Biochemistry (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
	Total Credits	**7 (5+2)**	
	Botany and Plant Physiology		
BIO 101	Introductory Biology (Need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
BIO 103	Basic Biology (For B.Tech. Biotechnology)	2 (2+0)	I
PL PHY 201	Fundamentals of Crop Physiology (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)	3 (2+1)	Agri.: V Biotech: III
	Total Credits	**5 (4+1)**	
	Chemistry		
CHEM 201	Engineering Chemistry (For B. Tech. (Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	
	Computer Section		
COMP 101 (SEC I)	Computer Applications in Agriculture (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)	3 (2+1)	Agri: III AM: III CS: IV FS: IV Biotech: IV
	Total Credits	**5 (2+3)**	
	Languages and Haryanavi Culture		
ENG 101 (AEC)	Communication Skills (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. (Agricultural Engineering) and B.Tech. Biotechnology)	2 (1+1)	Agri: I AM: I FS: I Biotech: I CS: II AE: II

ENG 301 (AEC)	Human Values and Personality Development (For B. Tech. Agricultural Engineering)	2 (1+1)	V
	Total Credits	**4 (2+2)**	
Mathematics and Statistics			
MATH 101	Introductory Mathematics (Need based) (For B.Sc. (Hons.) Agriculture & B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
MATH 103	Basic Mathematics (For B.Tech. Biotechnology)	2 (2+0)	I
MATH 201	Engineering Mathematics I (For B. Tech. Agricultural Engineering)	3 (3+0)	III
MATH 203	Biomathematics (For B.Tech. Biotechnology)	2 (2+0)	III
MATH 202	Engineering Mathematics II (For B. Tech. Agricultural Engineering)	3 (3+0)	IV
STAT 301	Biostatistics (For B.Tech. Biotechnology)	2 (1+1)	VI
STAT 302	Basic and Applied Agril Statistics (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
STAT 401	Agricultural Statistics and Data Analysis (for B. Tech. Agricultural Engineering)	2 (1+1)	VII
STAT 402	Statistical Methods (For B.Sc. (Hons.) Community Science)	2 (1+1)	VII
	Total Credits	**19 (15+4)**	
Microbiology			
MICRO 101 (SEC II)	Production Technology for Bio-agents and Bio-fertilizers (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
MICRO 102	Elementary Microbiology (For B.Tech. Biotechnology)	2 (1+1)	II
MICRO 302	Agricultural Microbiology and Phyto-remediation (For B.Sc. (Hons.) Agriculture)	2 (1+1)	VI
	Total Credits	**6 (2+4)**	
Physics			
PHY 203	Engineering Physics (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	
Sociology			
SOC 101	Rural Sociology and Educational Psychology (For B.Sc. (H) Agriculture)	2 (2+0)	I
SOC 201	Rural Sociology (For B.Sc. (Hons.) Community Science)	2 (2+0)	III
SOC 202	Human Ethics (For B.Tech. Biotechnology)	1 (1+0)	IV
	Total Credits	**5 (5+0)**	

COURSE CONTENTS: DEAPRTMENT-WISE
BIOCHEMISTRY

Course No.	Course Title	Credits	Semester
BIOCHEM 202	Basic Biochemistry (For B.Tech. Biotechnology)	4 (3+1)	IV
BIOCHEM 302	Essentials of Plant Biochemistry (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
	Total Credits	**7 (5+2)**	

BIOCHEM 202	BASIC BIOCHEMISTRY (For B.Tech. Biotechnology)	4 (3+1)	SEM IV

Objectives

1. To study the structure and functions of biomolecules of living organisms
2. To study metabolism and bioenergetics
3. To study secondary metabolites and their applications

Theory

Introduction and importance. Acids, bases and buffers of living systems. Biomolecules: carbohydrates, lipids, proteins and nucleic acids – structure, functions and properties, Vitamins and animal hormones.

Bioenergetics. Metabolism – basic concept: glycolysis, citric acid cycle, gluconeogenesis, HMP pathway, oxidative phosphorylation, fatty acid oxidation; ketone bodies.

Overview & significance of secondary metabolites: alkaloids, phenolics and their applications in food and pharmaceutical industries. Role of phytohormones: Auxin, Gibberellins, Cytokinin, Ethylene and Abscisic acid.

Practical

Qualitative tests for carbohydrates, amino acids, proteins and lipids. Extraction and characterization of lipids by TLC. Determination of acid, iodine and saponification values of oil. Extraction, quantitative estimation and separation of sugars by paper chromatography.

Suggested Readings

1. Nelson DL and Cox MM, 2017, Lehninger principles of biochemistry, 7th edn, W. H. Freeman.
2. Satyanarayana U and Chakrapani U, 2021, Essentials of Biochemistry, Elsevier.

BIOCHEM 302	ESSENTIALS OF PLANT BIOCHEMISTRY (For B.Sc. (Hons.) Agriculture)	3 (2+1)	SEM VI

Objectives

To impart the fundamental knowledge on structure and function of cellular components, biomolecules and the biological processes in plants

Theory

Biochemistry − Introduction and importance, Properties of water, pH and buffer, plant cell and its components. Bio-molecules − Structure, classification, properties and function of carbohydrates, amino acids, proteins, lipids and nucleic acids. Vitamins − physiological and metabolic role. Enzymes: General properties; Classification; Mechanism of action; Michaelis and Menten and Line Weaver Burk equation and plots; Introduction to allosteric enzymes, use of enzymes. Metabolic energy and its generation − Metabolism − Basic concepts, Glycolysis, Citric acid Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. Biosynthetic Pathways −Photosynthesis, Gluconeogenesis, nitrogen fixation, fatty acid and starch formation. Regulation of metabolic pathways. Secondary metabolites, Terpenoids, Alkaloids, Phenolic and their applications in food and pharmaceutical industries.

Practical

Preparation of standard solutions and reagents, Determination of pH, Qualitative tests of carbohydrates and amino acids, Quantitative estimation of soluble sugars and starch, Estimation of protein by Kjeldhal method and Lowry’ s method, Preparation of mineral solution from ash, Estimation of fat by Soxhlet method, Determination of acid value, saponification value and iodine number, Estimation of ascorbic acid, Qualitative/quantitative tests of secondary metabolites.

Suggested Readings

1. Nelson and Cox. 2008. Lehninger Principles of Biochemistry. Fourth/Fifth edition. Freeman (Can be downloaded)
2. Conn, Stumpf, Bruening and Doi. 2006. Outlines of Biochemistry. Fifth Edition. Wiley
3. Horton, Moran, Rawn, Scrimgeour, Perry. 2011. Principles of Biochemistry. Fifth Edition. Pearson/Prentice Hall (Can be downloaded)
4. Heldt. 2005. Plant Biochemistry. Elsevier (Can be downloaded)
5. Goodwin and Mercer. 2005. Introduction to Plant Biochemistry. 2nd edition. CBS.

BOTANY AND PLANT PHYSIOLOGY

Course No.	Course Title	Credits	Semester
BIO 101	Introductory Biology (need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
BIO 103	Basic Biology (For B.Tech. Biotechnology)	2 (2+0)	I
PL PHY 201	Fundamentals of Crop Physiology (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)	3 (2+1)	Agri.: V Biotech: III
	Total Credits	**5 (4+1)**	

BIO 101	INTRODUCTORY BIOLOGY (NEED BASED) NON-GRADIAL (For B.Sc. (Hons.) Agriculture & B.Sc. (Hons.) Agribusiness)	1 (1+0) NG	SEM I

Objectives

To impart the basics of plant cell and structure of flowers to non-biology background students.

Theory

Introduction to the living world, diversity and characteristics of life, origin of life, Evolution and Eugenics. Binomial nomenclature and classification Cell and cell division. Morphology and anatomy of flowering plants. Seed and seed germination. Plant systematics viz; Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

Suggested Readings

1. Biology- Text Book of class XI, NCERT, New Delhi
2. Biology- Text Book of class XII, NCERT, New Delhi

BIO 103	BASIC BIOLOGY (For B.Tech. Biotechnology)	2 (2+0)	SEM I

Objectives

1. To study the basic taxonomy and classification of plants
2. To study the features of the plant kingdom and morphology
3. To study the internal structure of plants
4. To study cells and biomolecules
5. To study the animal kingdom and nomenclature
6. To study the organisation of mammalian systems

Theory

The plant kingdom and features of each group. Morphology, modifications and functions of root, stem, leaf, flower and inflorescence. Pollination and fertilisation. Fruit types. Structure of dicot and monocot seeds, and seed germination.

Cell structure. DNA, chromosomes and genes. Cell and tissue types. Internal structure of root, stem and leaf.

Plant taxonomy, systems of classification. Characteristics and economic importance of Poaceae, Brassicaceae, Fabaceae, Malvaceae, Rutaceae, Rosaceae, Asteraceae and Solanaceae families.

Introduction to Zoology. Structure and functions of the cell and cell organelles. The difference between prokaryotic and eukaryotic cells. Structure and function of biomolecules. Types of simple and compound tissues.

Binomial nomenclature. Classification and general survey of the animal kingdom. Functional organisation of various systems of a mammal: digestive, circulatory, respiratory, excretory, nervous and reproductive. Laws of inheritance. Multiple allelism - blood groups. Genetic disorders in human and their inheritance.

Suggested Readings

1. Bendre AM and Kumar A, 1999, Textbook of Practical Botany. Vol. 2, 7th edn, Rastogi Publications.
2. Bendre AM and Pande PC, 2009, Introduction to Botany, Rastogi publications.
3. Bhatia K.N. and Tyagi M.P. 2020 Elementary Biology. A Truemen publication
4. David M Hillis; H Craig Heller; Sally D Hacker; David W Hall; David E Sadava. 2020. Life: the science of biology, 12th edn, Sunderland publication. eBook
5. Dutta AC, 1995, A Class Book of Botany, 16th edn, Oxford University Press.
6. NCERT 2021. Biology of Class XI. NCERT, India.
7. Pande PC and Jain DK, 2022, A textbook of Botany, Angiosperm. S. Chand publications.
8. Bhatia KN and Tyagi MP, 2020, Elementary Biology, A Truemen Publication.
9. Chopra G and Dhami PS, 2021, A Textbook of Biology, Pradeep Publications.
10. David MH, Craig HH, Sally DH, David WH and David ES, 2020, Life: the science of biology, 12th Ed, Sunderland Publication.
11. NCERT, 2022, Biology of Class XI, 2022-23. NCERT, India.

PL PHY 201	**FUNDAMENTALS OF CROP PHYSIOLOGY (For B.Sc. (Hons.) Agriculture and B.Tech. Biotechnology)**	**3 (2+1)**	**SEM Agri.: V Biotech: III**

Objectives

To explain about the basic physiological process of plant viz. plant cell and water relations, mineral nutrition, carbon metabolism, reproductive physiology and plant growth and development

Theory

Definitions of plant physiology and crop physiology; Importance of crop physiology; Relationship of crop physiology with other branches of crop science; Diffusion and osmosis; Physiological roles of water to crop plants; Definition of water potential and components of water potential; Water absorption by plants: Concept of active and passive absorption; Water loss by plants: Types of water loss: transpiration, stomatal physiology and guttation; Water use efficiency; Essential and beneficial elements; Passive and active transport of mineral element; Functions of essential elements; Criteria of essentiality of nutrients; Correction measures for nutrient deficiency symptoms; Foliar nutrition and root feeding − significance; Aeroponics Imbibition; Field capacity, permanent wilting point and available soil moisture; Apoplast, symplast and transmembrane, Ascent of sap − theories and mechanism; Soil-plant-atmospheric continuum. Significance of transpiration. Stomatal opening and closing mechanisms. Definition of Cavitation and embolism. Antitranspirants - types and examples. Hydroponics and sand culture. Overview of plant cell - organelle and their functions. Brief outline of: Photosynthetic apparatus, pigment system, quantum requirement and quantum yield; Structure of chloroplast, Examples of different photosynthetic pigments (chlorophyll, carotenoids, phycobilins etc.), Difference between chlorophyll a and chlorophyll b, Structure of chlorophyll a and chlorophyll b, Short discussion on quantum requirement and quantum yield, Red drop and Emerson enhancement effect, Pigment system I and II.

Introduction to light reaction of photosynthesis, Light absorption by photosynthetic pigments and transfer of energy. Source of O2 during photosynthesis: Hill reaction; Brief introduction to cyclic and non-cyclic photo-phosphorylation: production of assimilatory powers; Introduction to C3, C4 and CAM pathways: Calvin Cycle, Hatch and Slack Cycle, CAM Cycle; Significance of these pathways (concept of photorespiration, absence of photorespiration in C4 plant: Productivity of C4 plant, CAM: an adaptive mechanism); Factors affecting photosynthesis (light, temperature, CO2, O2 etc.). Outline of the process of respiration: Definition and importance, Glycolysis, Kreb Cycle and ETC, Factors affecting respiration (O2, temperature, CO2 etc.). Terminologies / Definitions: Growth, Development and Differentiation. Measurement of plant growth (fresh weight, dry weight, linear dimension, area etc.). Introduction to CGR, RGR, NAR etc. Photoperiodism: Photoperiodic Classification of plants: Short Day Plant, Long Day Plant, Day Neutral plant etc. Introduction to Photoperiodic induction site of photo-inductive perception, Role of Phytochrome Introduction to Vernalization (What is vernalization, devernalization etc.), Meaning, classification (seasonal, sequential etc), relation with abscission. Physiological and biochemical changes during senescence, Abscission and its significance, Concept of stay green, Hormonal regulation of senescence. Terminologies / Definitions: Plant hormone, Plant growth regulators (PGR), Plant growth inhibitor. Recognized classes of PGR (Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid) and their major physiological roles, Agricultural uses of PGRs (IBA, NAA, 2, 4 −D, GAs, Kinetin etc).

Practical

Study on structure and distribution of stomata; Demonstration of imbibition, osmosis, plasmolysis, estimation of water potential, relative water content; Tissue test for mineral nutrients, identification of nutrient deficiency and toxicity symptoms in plant; Identification of nutrients by hydroponics; Estimation of photosynthetic pigments, rate of photosynthesis, respiration and transpiration; Plant growth analysis; Study on senescence and abscission, hormonal regulation of senescence; Demonstration of the effects of different PGRs on plants, Leaf anatomy of C3 and C4 plants.

Suggested Readings

1. Devlin's Exercises in Plant Physiology by Robert Devlin, Francis H. Witham and David F. Blaydes
2. Fundamentals of Plant Physiology by Lincoln Taiz, Eduardo Zeiger, Ian Max Molle and Angus Murphy
3. Plant Physiology by Robert M. Devlin and Francis H. Witham
4. Plant Physiology by Lincoln Taiz and Eduardo Zeiger
5. Plant Physiology by Frank B. Salisbury and Cleon W. Ross

CHEMISTRY

Course No.	Course Title	Credits	Semester
CHEM 201	Engineering Chemistry (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	

CHEM 201	ENGINEERING CHEMISTRY (For B. Tech. Agricultural Engineering)	3 (2+1)	SEM III

Objectives

To make the students acquainted with applications of chemistry in engineering and different chemical processes in agricultural and food engineering

Theory

Phase rule**:** Phase, component, degree of freedom, application to one component system, viz. water system, sulphur system, two component system, viz. pb-Ag system, desilverisation of Pb.

Colloids**:** Classification, properties like optical activity-Tyndall effect, Brownian movement, electrical properties –electrophoresis.

Corrosion**:** causes, types and methods of prevention- proper designing. Cathodic protection using pure metal and metal alloys, use of inhibitors.

Water**:** Temporary and permanent hardness, disadvantages of hard water, scale and sludge formation of boilers, boiler corrosion.

Basic idea on thermo-gravimetric analysis, polarographic analysis, nuclear radiation, detectors and analytical applications of radio-active materials, discovery of isotopes and new elements, release of atomic energy, radio-active tracer and carbon dating.

Fuels**:** Classifications, calorific value and its determination by bomb calorimeter.

Principles of food chemistry**:** Lipids, proteins, carbohydrates and their classifications, vitamins and their importance.

Enzymes and co-enzymes important in food processing and storage, their use in manufacturing of ethanol and acetic acid by fermentation method.

Introduction to food preservatives, definition, types natural and artificial preservative and its use, colouring and flavouring reagents of foods.

Lubricants**:** Classifications, properties-viscosity, flash point and fire point mechanism, thick film, thin film and extreme pressure, neutralization point, saponification number and mechanical stability.

Polymers**:** Type of polymerization with examples (addition, free radical); Different properties of polymers chemical resistance, crystallinity. Effect of heat on polymers, general use, molecular weight determination.

Introduction to IR spectroscopy**:** Basic principles of spectroscopy, Beer-Lambarts law, types of vibration, symmetric, asymmetric vibration and it type, absorbances of different functional group in IR.

Practical

To separate colored components by using Paper Chromatography.To determine of temporary and permanent hardness of water by EDTA method; To study the different types of fuels and compare their characteristics; To study different types of foods and their ingredients; Determination of alkalinity in the given water sample; Determination of available chlorine in bleaching powder; To estimate chloride in water sample; To estimate dissolved oxygen in water sample; Determination of viscosity of lubricant by REDWOOD Viscometer; To determine flash and fire point of an oil by PENSKY MARTEN's flash point apparatus; To determine λ max and verification of Beer-Lambert law.

Suggested Readings

1. Bahl, B. S., Bahl, A. and Tuli, B. D. 2007. *Essentials of Physical Chemistry*. S. Chand and Co. Ltd, Delhi.
2. Finar, I. L. 2002. *Organic Chemistry*. Vol I and II. Pearson.
3. Glasstone, S. *Elements of Physical Chemistry*. The Macmillan Company of India Limited.
4. Jain and Jain. 2016. *Engineering Chemistry*. Dhanpat Rai Publication.
5. Jain, P. L. and Jain, M. 1994. *Engineering Chemistry*. Dhanpat Rai publishing company Pvt. Ltd, Delhi.
6. Morrison, R. T., Boyd, R. N. and Bhattacharjee, S. K. 2010. *Organic Chemistry*. Pearson.
7. Sharam, Y. R. 2013. *Elementary Organic Spectroscopy*. S Chand.

COMPUTER SECTION

Course No.	Course Title	Credits	Semester
COMP 101 (SEC I)	Computer Applications in Agriculture (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
COMP 202 (VAC)	Agricultural Informatics and Artificial Intelligence (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)	3 (2+1)	Agri: III AM: III CS: IV FS :IV Biotech: IV
	Total Credits	**5 (2+3)**	

COMP 101 (SEC I)	**COMPUTER APPLICATIONS IN AGRICULTURE (For B.Sc. (Hons.) Agribusiness Management)**	**2 (0+2)**	**SEM I**

Objectives

1. To understand the role of computer applications in modern agricultural practices.
2. To learn to use agricultural software and tools for data analysis, modeling, and decision- making.
3. To explore the application of Geographic Information Systems (GIS) and remote sensing in precision agriculture.
4. To develop skills in utilizing technology to optimize farm management, improve productivity, and reduce environmental impact.

Practical

Working with MS-DOS/Windows. Database concept and type. Database design. Data entry operation. Word processing: MS Office. Database management program. Use of electronic spreadsheet and graphics. Statistical and mathematical functions. Advanced statistical analysis Toolpak in MS Excel. Use of SPSS/SAS statistical packages. Basics of computer networking – LAN, SAN, Network topologies, Internet and Intranet – Basics of Email – Exposure to web browsing (structure of URL), Types of websites – Internet service provider – using internet news. Application of Geographic Information System (GIS) and remote sensing in agriculture

Suggested Readings

1. Computers in Agriculture: Fundamentals and Applications (Hardcover – 20 October 2016) by Sharma Manish, Anil Bhatt
2. Computer Applications in Agriculture By William Otto Rasmussen.
3. Computer Applications in Agriculture and Agribusiness (Paperback – Import, 1 June 1994) by Michael E. Newman (Author).

COMP 202 (VAC)	**AGRICULTURAL INFORMATICS AND ARTIFICIAL INTELLIGENCE (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Management, B.Sc. (Hons.) Community Science, B.F.Sc. and B.Tech. Biotechnology)**	**3 (2+1)**	**SEM Agri: III AM: III CS: IV FS: IV Biotech: IV**

Objectives

1. To acquaint student with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision-making processes, etc.
2. To provide basic knowledge of computer with applications in Agriculture
3. To make students familiar with Agricultural-Informatics, its components and applications in agriculture

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System: Definition and types, Applications of MS-Office for creating, Editing and Formatting a document, Data presentation, Tabulation and graph creation, Statistical analysis, Mathematical expressions, Database, concepts and types, creating data base, Uses of DBMS in Agriculture. Internet and World Wide Web (WWW): Concepts and components.

Computer programming: General concepts, Introduction general programming concepts. Concepts and standard input/output operations. e-Agriculture, Concepts, design and development, Application of innovative ways to use information and communication technologies (IT) in Agriculture. Computer Models in Agriculture: Statistical, weather analysis and crop simulation models, concepts, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation, IT applications for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management. Smartphone mobile apps in agriculture for farm advice: Market price, post-harvest management etc. Geospatial technology: Concepts, techniques, components and uses for generating valuable agri-information. Decision support systems: Concepts, components and applications in Agriculture. Agriculture Expert System, Soil Information Systems etc., for supporting farm decisions. Preparation of contingent crop planning and crop calendars using IT tools. Digital India and schemes to promote digitalization of agriculture in India.

Introduction to artificial intelligence, background and applications, Turing test. Control strategies, Breadth-first search, Depth-first search, Heuristics search techniques: Best-first search, A* algorithm, IoT and Big Data; Use of AI in agriculture for autonomous crop management, and health, monitoring livestock health, intelligent pesticide application, yield mapping and predictive analysis, automatic weeding and harvesting, sorting of produce, and other food processing applications; Concepts of smart agriculture, use of AI in food and nutrition science etc.

Practical

Study of computer components, accessories, practice of important DoS Commands, Introduction of different operating systems such as Windows, Unix/Linux, creating files and folders, File Management .Use of MS-Word and MS Power-point for creating, editing and presenting a scientific documents, MS-EXCEL-Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data, MS-ACCESS: Creating Database, preparing queries and reports, Demonstration of Agri- information system, Introduction to World Wide Web (WWW) and its components, Introduction of programming languages such as Visual Basic, Java, Fortran, C, C++, Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost, Preparation of inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools, Use of smartphones and other devices in agro-advisory and dissemination of market information, Introduction of Geospatial technology, AR/ VR demonstration, Preparation of contingent crop planning, India Digital Ecosystem of Agriculture (IDEA).

Suggested Readings

1. Concepts and Techniques of Programming in C by Dhabal Prasad Sethi and Manoranjan, Wiley India.
2. Fundamentals of Computer by V. Rajaroman.
3. Introduction to Information Technology by Pearson.
4. Introduction to Database Management System by C. J. Date.
5. Introductory Agri-Informatics by Mahapatra, Subrat K et al, Jain Brothers Publication.

LANGUAGES AND HARYANAVI CULTURE

Course No.	Course Title	Credits	Semester
ENG 101 (AEC)	Communication Skills (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. (Agricultural Engineering) and B.Tech. Biotechnology)	2 (1+1)	Agri: I AM: I FS: I Biotech: I CS: II AE: II
ENG 301	Human Values and Personality Development (for B. Tech. Agriculture Engineering)	2 (1+1)	V
	Total Credits	**4 (2+2)**	

ENG 101 (AEC)	**COMMUNICATION SKILLS (For B.Sc. (Hons.) Agriculture, B.Sc. (Hons.) Agribusiness Mangement, B.Sc. (Hons.) Community Science, B.F.Sc., B.Tech. Agricultural Engineering and B.Tech. Biotechnology)**	**2 (1+1)**	**SEM Agri: I AM: I FS: I Biotech: I CS: II AE: II**

Objectives

To acquire competence in oral, written and non-verbal communication, develop strong personal and professional communication and demonstrate positive group communication.

Theory

Communication Process**:** The magic of effective communication; Building self-esteem and overcoming fears; Concept, nature and significance of communication process; Meaning, types and models of communication; Verbal and non-verbal communication; Linguistic and non-linguistic barriers to communication and reasons behind communication gap/ miscommunication.

Basic Communication Skills: Listening, Speaking, Reading and Writing Skills; Precis writing/ Abstracting/Summarizing; Style of technical communication Curriculum vitae/resume writing; Innovative methods to enhance vocabulary, analogy questions.

Structural and Functional Grammar**:** Sentence structure, modifiers, connecting words and verbal; phrases and clauses; Case: subjective case, possessive case; objective case; Correct usage of nouns, pronouns and antecedents, adjectives, adverbs and articles; Agreement of verb with the subject: tense, mood, voice; Writing effective sentences; Basic sentence faults;

Practical

Listening and note taking; Writing skills: precis writing, summarizing and abstracting; Reading and comprehension (written and oral) of general and technical articles; Micro-presentations and Impromptu Presentations: Feedback on presentations; Stage manners: grooming, body language, voice modulation, speed;

Group discussions; Public speaking exercises; vocabulary building exercises; Interview Techniques; organization of events.

Suggested Readings

1. Allport, G. W.1937. Personality: A Psychological Interpretation. Holt, New York.
2. Brown Michele and Gyles Brandreth. 1994. How to Interview and be Interviewed. Sheldon Press, London.
3. Carnegie Dale. 1997. The Quick and Easy Way to Effective Speaking. Pocket Books, New York.
4. Francis Peter S J. 2012. Soft Skills and Professional Communication. Tata McGraw Hill, New Delhi.
5. Kumar S and Pushpa Lata. 2011. Communication Skills. Oxford University Press.
6. Neuliep James W. 2003. Intercultural Communication A Contextual Approach. Houghton Mifflin Co Boston.
7. Pease, Allan. 1998. Body Language. Sudha Publications, Delhi.
8. Raman M and Singh P. 2000. Business Communication. Oxford University Press.
9. Seely J. 2013. Oxford Guide to Effective Writing and Speaking. Oxford University Press.
10. Thomson A J and Martinet A V. 1977. A Practical English Grammar. Oxford University

ENG 301	**HUMAN VALUES AND PERSONALITY DEVELOPMENT (For B. Tech. Agricultural Engineering)**	**2 (1+1)**	**SEM V**

Objectives

1. To make students realize their potential strengths, cultivate their inter-personal skills and improve employability
2. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
3. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
4. Strengthening of self-reflection.
5. Development of commitment and courage to act.

Theory

Personality definition, Nature of personality, theories of personality and its types. The humanistic approach - Maslow's self-actualization theory, shaping of personality, determinants of personality, Type A and Type B Behaviours, personality and Organizational Behaviour. Technical Writing: Reports & its types, Letters & its types. Foundations of individual behaviour and factors influencing individual behaviour, Models of individual behaviour, Perception and attributes and factors affecting perception. Learning: Meaning and definition, theories and principles of learning,

Learning and organizational behaviour, Learning and training, learning feedback. Speaking on given topics.

Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behaviour, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics. Comprehension Passages (General & Technical articles).

Practical

Learning Styles and Strategies, Motivational needs, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behaviour. Introduction to Phonetics and spoken English, Phonemic symbols, Syllable, Word Accent.

Suggested Readings

1. Andrews, Sudhir. 1988. How to Succeed at Interviews. Tata McGraw-Hill.
2. Heller, Robert. 2002. Effective Leadership. Essential Manager series. Dk Publishing.
3. Hindle, Tim. 2003. Reducing Stress. Essential Manager series. Dk Publishing.
4. Lucas, Stephen. 2001. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill.
5. Mile, D.J. 2004. Power of Positive Thinking. Delhi. Rohan Book Company.
6. Kumar, Pravesh. 2005. All about Self- Motivation. New Delhi. Goodwill Publishing House.
7. Smith, B. 2004. Body Language. Delhi: Rohan Book Company.
8. Shaffer, D. R. 2009. Social and Personality Development (6th Edition). Belmont, CA: Wadswor.
9. Human Values and Professional Ethics by R R Gaur, R Sangal, G P
10. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
11. The Story of Stuff (Book).
12. Rediscovering India - by Dharampal
13. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
14. India Wins Freedom - Maulana Abdul Kalam Azad
15. Vivekananda - Romain Rolland (English)

MATHEMATICS AND STATISTICS

Course No.	Course Title	Credits	Semester
MATH 101	Introductory Mathematics (Need based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	I
MATH 103	Basic Mathematics (For B.Tech. Biotechnology)	2 (2+0)	I
MATH 201	Engineering Mathematics I (For B. Tech. Agricultural Engineering)	3 (3+0)	III
MATH 203	Biomathematics (For B.Tech. Biotechnology)	2 (2+0)	III
MATH 202	Engineering Mathematics II (For B. Tech. Agricultural Engineering)	3 (3+0)	IV
STAT 301	Biostatistics (For B.Tech. Biotechnology)	2 (1+1)	VI
STAT 302	Basic and Applied Agril Statistics (For B.Sc. (Hons.) Agriculture)	3 (2+1)	VI
STAT 401	Agricultural Statistics and Data Analysis (For B. Tech. Agricultural Engineering)	2 (1+1)	VII
STAT 402	Statistical Methods (For B.Sc. (Hons.) Community Science)	2 (1+1)	VII
	Total Credits	**19 (15+4)**	

MATH 101	INTRODUCTORY MATHEMATICS (Need Based) (For B.Sc. (Hons.) Agriculture and B.Sc. (Hons.) Agribusiness Management)	1 (1+0) NG	SEM I

Objectives

To make the students acquainted with the basic mathematics applied in agriculture and their applications

Theory

Algebra: Progressions- Arithmetic, Geometric and Harmonic Progressions. Matrices: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order by adjoint method, Properties of determinants up to 3rd order and their evaluation.

Differential Calculus: Definition - Differentiation of function using first principle, Derivatives of sum, difference, product and quotient of two functions, Methods, Increasing and Decreasing Functions. Application of Differentiation- Growth rate, Average Cost, and Marginal cost, Marginal Cost, Marginal Revenue. Partial

differentiation: Homogeneous function, Euler's theorem, Maxima and Minima of the functions of the form y = f (x) and y = f (x1, x2).

Integral Calculus: Integration -Definite and Indefinite Integrals-Methods- Integration by substitution, Integration by parts. Area under simple well-known curves.

Mathematical Models: Agricultural systems - Mathematical models - classification of mathematical models- Fitting of Linear, quadratic and exponential models to experimental data.

Suggested Readings

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.
3. Narayan, S. 2004. *Differential Calculus*. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. *Integral Calculus*. S. Chand and Co. Ltd. New Delhi.

MATH 103	**BASIC MATHEMATICS (For B.Tech. Biotechnology)**	**2 (2+0)**	**SEM I**

Objectives

1. To study the basic principles and functions in mathematics, like limits and continuity
2. To study differentiation and integration
3. To study matrices and determinants

Theory

Functions: Defination, types of functions. Limit: Introduction, left-handed and right-handed limits, general rules for calculating limits, Standard limits. Continuity: Definition of continuity, continuity of algebraic functions, continuity of trigonometric and exponential functions. Types of discontinuity

Differentiation: Differentiation by the first principle, sum, difference, product and quotient formulae, differentiation using the chain rule, differentiation of functions in parametric and implicit form, logarithmic differentiation, geometrical interpretation of derivative. Successive differentiation, geometrical interpretation of derivative, maxima and minima, tangent and normal.

Integration: Integration of simple functions, Integration by substitution, integration by partial fractions, integration by parts, integration by trigonometric substitution.

Matrices and Determinants: Definition of matrix, addition, subtraction and multiplication, inverse of matrix. Properties of determinants Solution of linear equations by Cramer's rule and the inverse of a matrix.

Suggested Readings

1. NCERT, 2012, Mathematics of Class XII, NCERT, India.
2. Sharma RD, 2014, Mathematics of Class XII, Dhanpat Rai Publisher.

MATH 201	ENGINEERING MATHEMATICS I (For B. Tech. Agricultural Engineering)	3 (3+0)	SEM III

Objectives

To make the students acquainted with the basic mathematics, including calculus, Matrices and complex analysis applied in engineering and their applications in solving engineering problems

Theory

Differential calculus: Functions of two or more variables, Taylor's and Maclaurin's expansions, Maxima and minima.

Integral calculus: Double integrals, change of order of integration, triple integrals, application of double and triple integrals to find area and volume.

Vector calculus: Scalar and vector point functions, vector differential operator Del, gradient of scalar point function, divergent and curl of vector point function and their physical interpretations, line, surface and volume integrals, Green's, Stock's and Divergence theorem (without proofs).

Fourier series: Periodic functions, Euler's formulae, functions having arbitrary period, even and odd functions, half-range series expansion, series expansion of functions with finite discontinuity.

Complex Analysis: Functions of a complex variable, limit, continuity and analytic function, Cauchy-Reimann equations, harmonic functions.

Matrices: Elementary transformations, Gauss elimination, Gauss-Jordan method to find the inverse of a matrix. rank of a matrix, solution of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem-its use to find the inverse of a matrix, linear transformation, diagonalization of matrices.

Suggested Readings

1. Grewal, B. S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. A Text Book of Vector. S. Chand and Co. Ltd. New Delhi.
3. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd. New Delhi.
4. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.

MATH 203	BIOMATHEMATICS (For B.Tech. Biotechnology)	2 (2+0)	SEM III

Objectives

1. To study the basic theories of mathematics
2. To study factor reduction and eigenvalues
3. To study the applications of biomathematics

Theory

Rolle's theorem, Lagrange's theorem, Taylor's and Maclaurin's series. Partial differentiation, Euler's theorem on homogeneous functions, and change of variable. Jacobian, maxima and minima of two or more than two variables, Elementary transformations, Rank of matrix, Echelon form, Solution of system of linear

equations, eigenvalues and eigenvectors of a matrix. Reduction formulae, definite integrals and their properties, Area under simple, well known curves.

Solution of ordinary differential equation of first degree and first order and their application for the determination of the volume of blood and drug distribution. Epidemic models, simultaneous differential equation of first order and their applications to predator models. Linear differential equations of higher order and their applications to the simple biological problem. Numerical methods for solving algebraic and transcendental equations.

Suggested Readings

1. Grewal BS, 2013, Higher Engineering Mathematics, Khanna Publishers.
2. Rastogi SK, 2008, Biomathematics, Krishna Prakashan Media Pvt. Ltd.
3. Srivastava AC and Srivastava PK, 2011, Engineering Mathematics, Vol. I, PHI Learning Pvt. Ltd.
4. Srivastava AC and Srivastava PK, 2011, Engineering Mathematics, Vol.III, PHI Learning Pvt. Ltd.

MATH 202	ENGINEERING MATHEMATICS II (For B. Tech. Agricultural Engineering)	3 (3+0)	SEM IV

Objectives

To make the students acquainted with the application of various advanced mathematics such as differential equations, Laplace transform and applications of numerical methods in engineering.

Theory

Ordinary Differential Equations: First order differential equations, exact and reducible to exact form by integrating factors, linear differential equation and Bernoulli's equation, equations of first order and higher degree, Clairaut's equation. Higher order differential equations: Methods of finding complementary functions and particular integrals, methods of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients.

Partial Differential Equations: Partial derivative and total derivative, homogeneous functions and Euler's theorem. Formation of PDE, higher order linear PDE with constant coefficients, solution of non-linear PDE, Charpit's method.

Laplace Transform: rules for Laplace transform and inverse Laplace transform, applications to find solutions of ordinary and simultaneous differential equations.

Numerical Methods: Finite difference operators and their relationship, factorial notation. Newton's forward and backward interpolation formula, Newton's divide difference interpolation and Lagrange's interpolation formula, numerical differentiation and integration rule, numerical solutions of ODE by Taylor's series, Euler's and modified Euler's method, Runge-Kutta method of order four.

Suggested Readings

1. Grewal, B S. 2004. Higher Engineering Mathematics. Khanna Publishers Delhi.
2. Narayan, S. 2004. A Text Book of Vector. S. Chand and Co. Ltd., New Delhi.
3. Narayan, S. 2004. Differential Calculus. S. Chand and Co. Ltd., New Delhi.
4. Narayan, S. 2004. Integral Calculus. S. Chand and Co. Ltd. New Delhi.
5. Ramana, B. V. 2008. Engineering Mathematics. Tata McGraw-Hill, New Delhi.

STAT 301	BIOSTATISTICS (For B.Tech. Biotechnology)	2 (1+1)	SEM VI

Objectives

1. To study the variables and descriptive statistics
2. To study various distributions
3. To study experimental data analysis and interpretation

Theory

Random variables: expected value and its variance; probability distribution of random variables; conditional probability; Bayes' theorem and its applications; introduction to uniform, binomial, Poisson, normal, exponential, and gamma probability distributions.

Random mating populations, Hardy-Weinberg Law. Introduction to Poisson process and Markov chains. Transition probability matrix, n-step transition probabilities, steady state. Random walk models. Sensitivity and specificity. Positive and negative predictive values.

Chi-square test: testing heterogeneity, use in the genetic experiment, detection of linkage, linkage ratios and their estimation. Analysis of variance. One-way and two-way classification with interaction. Analysis of covariance. Incomplete block designs. Estimation and significance of genotypic and phenotypic variation.

Practical

Expected value and variance of discrete and continuous distributions. Uniform, binomial, Poisson, normal, exponential and gamma probability distributions. Hardy-Weinberg Law. Construction of the transition probability matrix in Markov Chains. Calculation of sensitivity and specificity. Positive and negative predictive values. Detection and linkage using chi-square test; one-way and two-way analysis of variance. Analysis of covariance. Incomplete block designs. Estimation of heritability.

Suggested Readings

1. Gupta SC, Kapoor VK, 2007, Fundamentals of applied statistics, 4th edn, S Chand and Sons.
2. Kaps M and Lamberson WR, 2017, Biostatistics for Animal Science, 3rd edn, CABI.
3. Triola MM, Triola MF and Roy J, 2017, Biostatistics for the Biological and Health Sciences, 2nd edn, Pearson.

STAT 302	BASIC AND APPLIED AGRIL STATISTICS (For B.Sc. (Hons.) Agriculture)	3 (2+1)	SEM VI

Objectives

To provide an idea on statistical concepts of both descriptive and inference Statistics which will be useful to do statistical analysis

Theory

Introduction to Statistics and its Applications in Agriculture: Types of Data. Scales of measurements of Data. Summarization of Data. Classification of Data. Frequency Distribution. Methods of Classification. Definition of Grouped and Ungrouped Data. Definition of Class Interval (formula for determining the no. of class interval), Width of CI, Class Limits (Boundaries), Mid Points. Types of Frequency Distribution. Diagrammatic Presentation of Data. Bar Diagrams −Simple, Multiple, Sub-divided and Percentage Bar Diagrams. Pie-diagram. Graphical Presentation of Data − Histogram, Frequency Polygon and Ogives.

Measures of Central Tendency: Requisites for an Ideal Measure of Central Tendency. Different Types of Measure. Arithmetic Mean− Definition, Properties, Merits, Demerits and Uses. A.M. (examples) for Grouped and Ungrouped Data. Step-deviation Method. Weighted Mean. Definition of Geometric Mean and Harmonic Mean. Relationship between A.M., G.M. and H.M. Median-Definition, Merits, Demerits and Uses. Graphical Location of Median. Mode- Definition, Merits, Demerits and Uses. Graphical Location of Mode. Relationship between Mean, Median and Mode.

Measures of Dispersion: Characteristics for an Ideal Measure of Dispersion. Different Types of Measures of Dispersions. Definition of Range, Interquartile Range, Quartile Deviation and Mean Deviation. Standard Deviation- Definition, Properties. S.D. and Variance for Grouped and Ungrouped Data. Variance of Combined Series. Co-efficient of Dispersions. Co-efficient of Variation.

Measures of Skewness and Kurtosis: Definition of Symmetrical Distribution. Definition of Skewness, Measures of Skewness. Definition of Kurtosis. Measure of Kurtosis. Relationship between Mean, Median and Mode for Symmetrical and Skewed Distribution.

Probability Theory and Normal Distribution: Introduction to Probability. Basic Terminologies. Classical Probability-Definition and Limitations. Empirical Probability- Definition and Limitations. Axiomatic Probability.

Addition and Multiplication Theorem (without proof): Conditional Probability. Independent Events. Simple Problems based on Probability. Definition of Random Variable. Discrete and Continuous Random Variable. Normal Distribution-Definition, Prob. Distribution, Mean and Variance. Assumptions of Normal Distribution. Normal Probability Curve. Correlation and Regression. Definition of Correlation. Scatter Diagram. Karl Pearson's Coefficient of Correlation. Types of Correlation Coefficient. Properties of Correlation Coefficient. Definition of Linear Regression. Regression Equations. Regression Coefficients. Properties of Regression Coefficients. Tests of Significance. Definition. Null and Alternative Hypothesis. Type

I and Type II Error. Critical Region and Level of Significance. One Tailed and Two Tailed Tests. Test Statistic. One Sample, Two Sample and Paired t-test with Examples: F-test for Variance. ANOVA and Experimental Designs. Definition of ANOVA. Assignable and Non assignable Factors. Analysis of One-way Classified Data. Basic Examples of Experimental Designs. Terminologies. Completely Randomized Design (CRD). Sampling Theory. Introduction. Definition of Population, Sample, Parameter and Statistic. Sampling Vs Complete Enumeration. Sampling Methods. Simple Random Sampling with Replacement and without Replacement. Use of Random Number Table.

Practical

Diagrammatic and Graphical representation of data. Calculation of A.M., Median and Mode (Ungrouped and Grouped data). Calculation of S.D. and C.V. (Ungrouped and Grouped data). Correlation and Regression analysis. Application of t-test (one sample, two sample independent and dependent). Analysis of variance one-way classification. CRD. Selection of random sample using simple random sampling.

Suggested Readings

1. Fundamentals of Statistics by D. N. Elhance, Kitab Mahal Publishers.
2. Fundamentals of Applied Statistics by S.C. Gupta and V. K. Kapoor, Sultan Chand and Sons.
3. Basic Statistics by B. L. Agarwal, New Age International Publishers.
4. Agricultural Statistics by S.P. Singh and R.P.S. Verma, Rama Publishing House.
5. Agriculture and Applied Statistics-I by P.K. Sahu, Kalyani Publishers.
6. Agriculture and Applied Statistics-II by P. K. Sahu and A. K. Das, Kalyani Publishers.

STAT 401	**AGRICULTURAL STATISTICS AND DATA ANALYSIS (For B. Tech. Agricultural Engineering)**	**2 (1+1)**	**SEM VII**

Objectives

To make the students acquainted with important statistical data analysis tools and application of these for research in agricultural engineering

Theory

Introduction to statistics: Definition, advantages and limitations; Data- types of data, quantitative and qualitative; variable - discrete and continuous; Frequency distribution table: construction of frequency distribution table (inclusive and exclusive)- number of classes, length of class, tally marks, frequency, class midpoint, cumulative frequencies, frequency curves, graphs and charts. Measures of central tendency: Definition, characteristics of ideal average, different measures; arithmetic mean, median, mode, geometric mean and harmonic mean for grouped and ungrouped data, merits and demerits; Measures of dispersion: definition, different measures (absolute and relative); range, quartile deviation, mean deviation, standard deviation (SD), variance and coefficient of variation. Probability: Definition and

concept of probability; Random variable: concept of random variable and expectation; Simple linear correlation: concept, definition, types and its properties; Simple linear regression: concept, definition and its properties; Normal distribution: definition, density function, curve, properties, standard normal distribution (SND), properties including area under the curve (without proof); Binomial distribution: definition, density function and properties; Poisson distribution: definition, density function and properties; Introduction to sampling: definition of statistical population, sample, random sampling, parameter, statistic, sampling distribution, concept of standard error of mean. Testing of hypothesis – hypothesis, null hypothesis, types of hypotheses, level of significance, degrees of freedom – statistical errors; Large Sample test (Z-test), small sample t-test (one tailed, two tailed and paired tests); Testing of significance through variance (F-test), Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table)

Practical

Construction of frequency distribution tables and frequency curves; Computation of arithmetic mean, median and mode for un-grouped and grouped data; Computation of harmonic and geometric mean; Computation of standard deviation (SD); Variance and coefficient of variation for un-grouped and grouped data; Computation of skewness, kurtosis; Standard normal distribution test for single sample mean (population SD known and unknown); SND test for two samples means (population SD known and unknown); Computation of binomial distribution; Computation of Poisson distribution; Calculation of correlation coefficient and its testing; Calculation of regression coefficient, regression line; Student's t-test for single sample mean; t-test for two samples means; Paired t test; F– test for equality for two sample variance test; Computation of Chi-square test: goodness of fit and testing of independence of attributes (2 × 2 contingency table) and m × n.

Suggested Readings

1. Agrawal, B. L. 1991. Basic Statistics. Wiley Eastern Ltd. New Age International Ltd.
2. Chandel, S. R. S. 1999. A Handbook of Agricultural Statistics. Achal Prakasan Mandir, Kanpur
3. Gupta, S. C. and Kapoor, V. K. 1970. Fundamentals of Mathematical Statistics. Sultan Chand & Sons. Gupta, S. C. and Kapoor, V. K. 2019. Fundamental Applied Statistics. Sultan Chand & Sons.
4. Nageswara Rao, G. 2007. Statistics for Agricultural Sciences. BS Publications.
5. Rangaswamy, R. 2018. A Text Book of Agricultural Statistics. New Age Int. Publications Ltd.

STAT 402	**STATISTICAL METHODS (For B.Sc. (Hons.) Community Science)**	**2 (1+1)**	**SEM VII**

Objectives

To develop understanding among students about sampling and data analysis techniques, methods of data analysis using various statistics.

Theory

Introduction to statistics and its applications in agriculture, graphical representation of data, measures of central tendency. Dispersion and their merits and demerits. Probability and distribution: definition of probability, addition and multiplication theorem (without proof). Simple problems based on probability. Binomial and Poisson Distributions. Correlation and regression: definition of correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation, Spearman correlation coefficient and their properties. Linear Regression Equations. Introduction to Test of Significance, One sample; two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. Introduction to various statistical packages.

Practical

Graphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2 ×2 contingency table. Selection of random sample using Simple Random Sampling. Use of software packages.

Suggested Readings

1. Agarwal, B. L. 2006. Basic Statistics. New Age International Publisher.
2. Gupta SC. 2006. *Fundamentals of Statistics.* Himalaya Publ. House.
3. Panse VG & Sukhatme PV. 1985. *Statistical Methods for Agricultural Workers.* ICAR. Rao GN. 2007. *Statistics for Agricultural Science.* Oxford & IBH.
4. Snedecor GW & Cochran WG. 1968. *Statistical Methods.* Oxford & IBH.
5. Sprent P. 1993. Applied Non-parametric Statistical Methods. 2nd Ed. Chapman & Hall.
6. Sukthame & Ashok C. 1984. *Sampling Theories and Surveys with Application.* 3rd Ed. ICAR.
7. Wetherill GB. 1982. Elementary Statistical Methods. Chapman & Hall.
8. William S. Cleveland (1994) The Elements of Graphing Data, 2ndEd., Chapman & Hall

MICROBIOLOGY

Course No.	Course Title	Credits	Semester
MICRO 101 (SEC II)	Production Technology for Bio-agents and Bio-fertilizers (For B.Sc. (Hons.) Agribusiness Management)	2 (0+2)	I
MICRO 102	Elementary Microbiology (For B.Tech. Biotechnology)	2 (1+1)	II
MICRO 302	Agricultural Microbiology and Phyto-remediation (For B.Sc. (Hons.) Agriculture)	2 (1+1)	VI
	Total Credits	**6 (2+4)**	

MICRO 101 (SEC II)	**PRODUCTION TECHNOLOGY FOR BIO-AGENTS & BIO-FERTILIZERS (For B.Sc. (Hons.) Agribusiness Management)**	**2 (0+2)**	**SEM I**

Objectives

1. To understand the principles and methods of producing bio-agents and bio-fertilizers.
2. To learn techniques for mass production and formulation of beneficial microorganisms.
3. To explore the role of bio-agents and bio-fertilizers in sustainable agriculture and soil health management.
4. To develop skills to integrate bio-agents and bio-fertilizers into crop production systems for enhanced yield and reduced environmental impact.

Practical

Agricultural Microbiology: Relevance of Biofertilizer in Agriculture. Types of Biofertilizers [(a) Nitrogen fixers: Rhizobium, Azotobacter, Azospirillum, Glucano acetobacter, Cyanobacteria and Azolla; (b) P-solubilizers: PSB, PSF; (c) K-solubilizers; (d) Zn-solubilizers; (e) P-mobilizers: AM fungi; (f) Development of consortia]. Mass Production Techniques [(a) Carrier based; (b) Liquid Biofertilizers]. Methods of application. Quality Control (Standards as per FCO (1985) amended in 2009).

Suggested Readings

1. Atlas Bartha. Microbial Ecology - Fundamentals and Application. Pearson (Fourth edn).
2. Bhoopander Giri, Ram Prasad et al. Biofertilizers for Sustainable Agriculture and Environment (Soil Biology Book 55).
3. Bikas R. Pati and Santi M. Mandal. Recent Trends in Biofertilizers.
4. Eiri Board. Handbook of Biofertilizers and Vermiculture. 1 January 2009.

5. Himadri Panda. Complete Technology Book on Biofertilizer and Organic Farming.
6. J. Nicklin, K. Graeme-Cook, T. Paget and R. Killington. Instant Notes in Microbiology. Viva.
7. M K Rai. Handbook of Microbial Biofertilizers.
8. Mark S. Coyne. Soil Microbiology - An Exploratory Approach. Delmar Publishers-2004
9. Michael Madigan, John Martinko, David Stahl and David Clark. Brock-Biology of Microorganisms. Pearson (Thirteen Edition).

MICRO 102	ELEMENTARY MICROBIOLOGY (For B.Tech. Biotechnology)	2 (1+1)	SEM II

Objectives

To study the-

1. History of microbiology and major groups of eukaryotes and prokaryotes
2. Preservation methods and repositories
3. Bacterial growth and metabolism
4. Applications of microbes

Theory

History of microbiology and its applied areas. Microorganisms and their role in health and the environment. Control and prevention measures against microorganisms/ diseases. Introduction to eukaryotic and prokaryotic cells. Major groups of eukaryotes: fungi, algae and protozoa. Major groups of prokaryotes: bacteria, archaea, rickettsia and chlamydia. Preservation of microorganisms and microbial repositories at the national and international levels.

Bacterial growth. Metabolism in bacteria, ATP generation, chemoautotrophy, photoautotrophy, respiration, and fermentation. Viruses, Bacteriophages, structure and properties, lytic and lysogenic cycles, viroids, and prions. Role of microorganisms in nutrient recycling (Biogeochemical cycles)

Beneficial microorganisms in agriculture, biofertilisers, and microbial pesticides. Microbes in composting and biodegradation. Microbiology of water and food.

Practical

Microscope and other instruments in a microbiological laboratory. Media preparation, sterilisation and aseptic methods for isolation, identification, preservation and storage. Identification of bacteria by staining methods. Purification of microorganisms by streak plate method. Enumeration of bacteria by pour plate and spread plate methods. Micrometry.

Suggested Readings

1. Woolverton CJ, Sherwood LM, and Willey JM, 2016, Prescott's Microbiology, McGraw-Hill Education.

MICRO 302	AGRICULTURAL MICROBIOLOGY AND PHYTO-REMEDIATION (For B.Sc. (Hons.) Agriculture)	2 (1+1)	SEM VI

Objectives

1. To get an introduction to microbiology with specific focus on its significance in agriculture science
2. To get acquainted with the bacterial structure and the function of the different bacterial components
3. To get highlights on different fields of microbiology
4. To get highlights on the bioremediation of polluted soils using microbial mediators and phytoremediation
5. To get a concept of biological control and the role of biopesticides in plant disease management.

Theory

Introduction to Microbiology: Definition, applied areas of Microbiology and Importance of Microbiology. History of Microbiology: Discovery of microscope, spontaneous generation theory, Germ theory of diseases, Immunization, fermentation, and origin of life**.** Bacteria: cell structure, nutritional classification of bacteria, growth. Bacterial genetics: Genetic recombination- transformation, conjugation and transduction, genetic engineering. Soil Microbiology: Nutrient mineralization and transformation**,** Air Microbiology: Phyllosphere microflora, Phylloplane microflora, microflora of floral parts etc. Food Microbiology: Microbial spoilage and principles of food preservations, Food poisoning**.** Water Microbiology: Types of water, water microorganisms, and microbial analysis of water e.g. coliform test, Purification of water. Industrial Microbiology: Microbial products, Biodegradation, Biogas production, Biodegradable plastics etc. Biological control: Microbial biopesticides for plant disease management Concepts of rhizosphere microbiology- Rhizodeposits - biochemical nature, release mechanism in rhizosphere, function, Carbon flow in rhizosphere, Rhizosphere microbiomeresidents and their roles. Potential of plant growth promoting rhizobacteria (PGPR) and endophytes on soil health and sustainability**.** Bioremediation of polluted soils using microbial mediators**.** Phytoremediation of polluted soils**.**

Practical

Study of the microscope; Acquaintance with laboratory material and equipment; Microscopic observation of different groups of microorganisms: moulds & yeasts; Direct staining of bacteria by crystal violet; Negative or indirect staining of bacteria by nigrosin; Gram staining of bacteria; Study of phyllosphere and rhizosphere microflora; Measurement of microbial growth; Preparation of culture media; Isolation and purification of rhizospheric microbes; Isolation and purification of N-fixers; Isolation and purification of Nutrient solubilizers; Isolation and purification of Endophytes.

Suggested Readings

1. Pelczar, M.J., Chan, E.C.S. and Kreig, N.R. 2002. Microbiology. 5th Edition, Tata McGraw-Hill, New Delhi.
2. Rangaswami, G. and Bagyaraj, D. J. 2005. Agricultural Microbiology. Prentice-Hall of India Pvt. Ltd., New Delhi.
3. Mukherjee, N. and Ghosh, T. 2004. Agricultural Microbiology. Kalyani Publishers, Calcutta
4. Dubey, H.C. 2007. A Textbook of Fungi, Bacteria and Viruses. Vikas Publishing House Ltd., New Delhi − 10014
5. Salyers, A. A. and Whitt, D. D. 2001. Microbiology: diversity, disease, and the environment. Fitzgerald Science Press, Inc.
6. Prescott, L. M. 2002. Microbiology 5th Edition. McGraw-Hill Inc, US

PHYSICS

Course No.	Course Title	Credits	Semester
PHY 203	Engineering Physics (For B. Tech. Agricultural Engineering)	3 (2+1)	III
	Total Credits	**3 (2+1)**	

PHY 203	ENGINEERING PHYSICS (For B. Tech. Agricultural Engineering)	3 (2+1)	SEM III

Objectives

To make the students acquainted with applications of physics in engineering and different physical processes in agricultural engineering

Theory

Unit-I: Magnetism : Dia, para and ferro-magnetism- classification; Langevin theory of dia, and para magnetism, adiabatic demagnetization, Weiss molecular field theory and ferromagnetism, Curie-Weiss law.

Unit-II: Introduction to quantum mechanics : Wave particles duality, photoelectric effect, de-Broglie concept, uncertainty principle, wave function, time dependent and time independent Schrodinger equation.

Unit-III: Spectroscopy : Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy.

Unit-IV: Solid state physics : Statement of Bloch function, bands in solids, distinction between metals, insulators and semi-conductors; Semiconductors: intrinsic and extrinsic semi-conductors, donors and acceptor levels, law of mass action, determination of energy gap in semi-conductors, Hall effect; Superconductivity: super conductivity, critical magnetic field, Meissner effect, Type I and II superconductors, isotope effect, London equations, BCS Theory, Josephsons effect, DC and AC squids, introduction to high Tc superconductors.

Unit-V: LASERS and MASERS : Spontaneous and stimulated emission, Einstein A & B coefficients, population inversion, Ruby lasers, He-Ne laser and semiconductor laser; Masers.

Unit-VI: Optical fibre and Illumination : Optical fibre**:** Physical structure, basic theory, type of modes, characteristics of optical fibre and applications.

Illumination**:** Laws of illumination, luminous flux, luminous intensity, candle power and brightness.

Practical

To verify law of transverse vibrations along a string using electrical tuning fork; To study hysteresis loss of magnetic materials; To demonstrate the Meissner effect; To measure the transition temperature of a high; temperature superconductor; Determine dielectric constant of material using De Sautys bridge; Study the variation of magnetic field with distance along the axis of a current carrying circular coil and to determine the radius of the coil; Determine the energy band gap in a semi-conductor

using a p-n junction diode; Determine the low resistance using Carey Foster bridge without calibrating the bridge wire.

Suggested Readings

1. Avadhanulu M N. 2013. An Introduction to Lasers theory and applications. S. Chand Publication
2. Chattopadhyay D and Rakshit P C. 2011. Electricity and Magnetism. S. Chand
3. Ghatak A K and Lokanathan S. 2022. Quantum Mechanics, Theory and Application. Trinity Press.
4. Griffiths D J and Schroeter 2018. Introduction to Quantum Mechanics. Cambridge University Press.
5. Khandelwal D P. 1985. A laboratory Manual of Physics. Vani Publications.
6. Kittel C. 2005. Introduction to Solid State Physics. Wiley Eastern Pvt. Ltd.
7. Mani H S and Mehta G K. 2022. Modern Physics. Affiliated East-West Press.
8. Omar M A. 2002. Elementary Solid State Physics. Pearson.
9. Prakash S. 2011. Optics. Pragati Prakashan, Meerut.
10. Saraf B and Khandelwal D P. 1982. Physics through Experiments, Vol. I & II. Vikas Publication, New Delhi.
11. Subramanyam N, Lal B and Avadhanulu M N. 2012. A Text book of Optics. S. Chand.
12. Taneja, S.P. 2004. Modern Physics for Engineers, R. Chand & CO, New Delhi.

SOCIOLOGY

Course No.	Course Title	Credits	Semester
SOC 101	Rural Sociology and Educational Psychology (For B.Sc. (Hons.) Agriculture)	2(2+0)	I
SOC 201	Rural Sociology (For B.Sc. (Hons.) Community Science)	2 (2+0)	III
SOC 202	Human Ethics (For B.Tech. Biotechnology)	1 (1+0)	IV
	Total Credits	**5 (5+0)**	

SOC 101	RURAL SOCIOLOGY AND EDUCATIONAL PSYCHOLOGY (For B.Sc. (Hons.) Agriculture)	2 (2+0)	SEM I

Objectives

Provide knowledge on concept and importance of sociology and rural sociology as well as the relationship with Extension Education

Theory

Sociology and rural sociology: Meaning, definition, scope, importance of rural sociology in Agricultural Extension, and interrelationship between rural sociology and Agricultural Extension. Extension Education and Agricultural Extension: Meaning, definition, scope, and importance. Indian Rural Society: important characteristics, differences and relationship between rural and urban societies. Social Groups: Meaning, definition, classification, factors considered information and organization of groups, motivation in group formation and role of social groups in Agricultural Extension.

Social Stratification: Meaning, definition, functions, basis for stratification, forms of social stratification- characteristics and- differences between class and caste system. Cultural concepts: culture, customs, folkways, mores, taboos, rituals. Traditions: Meaning, definition and their role in Agricultural Extension. Social Values and Attitudes: Meaning, definition, types and role of social values and attitudes in agricultural Extension. Social Institutions: Meaning, definition, major institutions in rural society, functions, and their role in agricultural Extension. Social Organizations: Meaning, definition, types of organizations and role of social organizations in agricultural Extension. Social Control: Meaning, definition, need of social control and means of social control. Social change: Meaning, definition, nature of social change, dimensions of social change and factors of social change. Leadership: Meaning, definition, classification, roles of leader, different methods of selection of professional and lay leaders. Training of Leaders: Meaning, definition, methods of training, Advantages and limitations in use of local leaders in Agricultural Extension, Psychology and educational psychology: Meaning, definition, scope, and importance of educational psychology in Agricultural Extension. Intelligence: Meaning, definition, types, factors affecting intelligence and importance of intelligence in Agricultural Extension. Personality: Meaning, definition, types, factors influencing

the personality and role of personality in agricultural Extension. Teaching: Learning process: Meaning and definition of teaching, learning, learning experience and learning situation, elements of learning situation and its characteristics. Principles of learning and their implication of teaching.

Suggested Readings

1. A. R. Desai -Rural Sociology in India
2. Dahama O. P. and Bhatnagar, O. P. - Education and Communication for Development
3. J.B. Chitambar -Introductory Rural Sociology
4. M.B. Ghorpade- Essential of psychology
5. C.N. Shankar Rao – Sociology: Principles of Sociology with an Introduction to Sociological Thought. S Chand and Company Ltd. New Delhi.
6. Prepared You Tube videos
7. R Velusamy Textbook on Rural Sociology and Educational Psychology
8. Ray, G. L. -Extension Communication and Management
9. Sandhu A. S. -Textbook on Agricultural Communication
10. Web Materials

SOC 201	**RURAL SOCIOLOGY** **(For B.Sc. (Hons.) Community Science)**	**2 (2+0)**	**SEM III**

Objectives

1. To develop understanding about sociological concepts with special reference to rural community.
2. To understand approaches to rural planning and status of rural women

Theory

Sociology and Rural sociology – Meaning and significance; Difference between rural and urban community; Indian rural social stratification: Caste & Class- Concept, characteristics and difference, Change in social stratification and implementation of constitutional provisions; Indian rural institutions: Social- Family and marriage (Nature, forms and changes), Economic- Jajmani system and division of labour, Political- Panchayati Raj; Religion: Functional significance of beliefs, traditions and customs; Rural poverty: Meaning, types and causes; Rural social change: Concept, process and factors of transformation; Planned social change- Approaches to rural planning, improvement and transformation; Status of women in rural India and their role in rural and agricultural development.

Suggested Readings

1. Chitambar, J.B. (1973). Introductory rural sociology. New York, John Wilex and Sons.
2. Desai, A.R. (1978). Rural sociology in India. Bombay, Popular Prakashan, 5th Rev.ed.
3. Doshi,S.L. (2007). Rural sociology. Delhi Rawat Publishers.
4. Jayapalan, N. (2002). Rural sociology. New Delhi, Altanic Publishers.
5. Sharma, K.L. (1997). Rural society in India. Delhi, Rawat Publishers

SOC 202	HUMAN ETHICS (For B.Tech. Biotechnology)	1 (1+0)	SEM IV

Objectives

1. To study the meaning and concepts of human behaviour
2. To study human ethical values
3. To study spirituality and attitude
4. To study the methods of stress management

Theory

Universal human aspirations, happiness, and prosperity. Human values and ethics: concept, definition, significance, and sources. Fundamental values: right conduct, peace, truth, love, and non-violence. Ethics: professional, environmental, and ICT. Sensitisation towards others, particularly senior citizens, the developmentally challenged, and gender.

Spirituality, positive attitude and scientific temper. Teamwork and volunteering. Rights and responsibilities. Road safety, Human relations, and family harmony. Modern challenges and value conflict. Sensitization against drug abuse and other social evils. Developing personal code of conduct (SWOT Analysis). Management of anger and stress.

Suggested Readings

1. Gaur RR, Sangal R and Bagaria GP, 2011, A Foundation Course in Human Values and Professional Ethics, Excel Books.
2. Mathur SS, 2010, Education for Values, Environment and Human Rights, RSA International.
3. Sharma RA, 2011, Human Values and Education -Axiology, Inculcation and Research, R. Lall Book Depot.
4. Sharma RP and Sharma M, 2011, Value Education and Professional Ethics, Kanishka Publishers.
5. Srivastava S, 2011, Human Values and Professional Ethics, S K Kataria and Sons.
6. Srivastava S, 2011, Environmental Science, S K Kataria and Sons.
7. Tripathi, A. N., 2009, Human Values, New Age International (P) Ltd, Publishers.

CENTRE OF FOOD SCIENCE AND TECHNOLOGY

Course No.	Course Title	Credits	Semester
FST 301	Food Science and Processing (For B.Tech. Biotechnology)	3 (2+1)	VI
FST 401	Food Safety and Standards (For B.Sc. (Hons.) Agriculture)	4 (3+1)	VII
FST 402	Food Science and Nutrition (For B.Sc. (Hons.) Agriculture)	4 (3+1)	VII
	Total Credits	**11 (8+3)**	

FST 301	**FOOD SCIENCE AND PROCESSING (For B.Tech. Biotechnology)**	**3 (2+1)**	**SEM VI**

Objectives

1. To study food and nutrition for good health
2. To study food spoilage, processing and preservation
3. To study the methods of assessing physical and chemical qualities

Theory

Food and nutrition; Food production and consumption trends in India; Food groups and concept of balanced diet, RDA, biotoxins, antinutritional factors and secondary metabolites; Major deficiencies of calories, proteins, vitamins and micronutrients; Causes of food spoilage; Principles of processing and preservation of food by heat, low temperature, drying and dehydration, chemicals and fermentation; Preservation through ultraviolet and ionizing radiations; Postharvest handing and processing technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry; Food safety, adulteration, HACCP and Indian food laws; Status of food industry in India.

Practical

Physical and chemical quality assessment of cereals, fruits, vegetables, egg, meat and poultry; Value added products from cereals, millets, fruits, vegetables, milk, egg and meat; Visit to local processing units.

Suggested Readings

1. Gopalan, C., Rama Sastri, B.V. and Bala Subramanian, S.C. (2005). *Nutritive Value of Indian Foods*. NIN, ICMR, Hyderabad.
2. ICAR. (2013). *Handbook of Agricultural Engineering*. ICAR Publications, New Delhi
3. Manay, S. & Shadaksharaswamy, M. (2020). *Foods Facts and Principles*. New Age International Publishers.
4. Srivastava, R.P. and Kumar, S. (2019). *Fruit and Vegetable Preservation-Principles and Practices*, CBS Publishers.
5. www.fassi.gov.in

FST 401	FOOD SAFETY AND STANDARDS (For B.Sc. (Hons.) Agriculture)	4 (3+1)	SEM VII

Objectives

1. To know hazards and understand to protect food from contamination
2. To understand the need for food safety systems
3. To use the scientific approach and practices towards safety

Theory

Food safety: definition, importance and factors affecting food safety; recent concerns- new and emerging pathogens, recent outbreaks; hazards- types (physical, chemical, biological), sources of contamination, management of hazards/contaminations- need and control of parameters: temperature, production design, packaging and food storage; hygiene and sanitation- personal hygiene, food establishments and surface sanitation; pest and rodent control; water- hygiene and quality standards; waste disposal; food safety measures: food safety management systems- basic concepts, components, need and newer approaches to food safety; risk analysis; PRPs- GHPs, GMPs, SSOPs, etc.; HACCP and TQM; GFSI; Food laws and standards: Indian food regulatory regime- FSSA; global scenario- CAC, WTO, SPS, TBT, etc.; other laws and standards related to food- ISO series; Indian and International standards for food products; product labelling and nutritional labelling, organic foods.

Practical

Quality attributes of raw and processed foods, water quality analysis; assessment of surface sanitation by swab/rinse method; personal hygiene; process flow for food establishment; GHP and GMP in a food factory; FSMS: hazard identification and risk analysis; OPRPs. development of HACCP plan; understand the ISO 22000; organizational structure of FSSAI and CAC; design a label for food product.

Suggested Readings

1. Deshpande, H.W. & Katke, S.D. 2021. Food Quality, Assurance and Certification.
2. Fernandes, C. *Safe Food Handling: HACCP Booklet for Food Handlers*, Notion Press.
3. Fortin, N.D. 2009. Food Regulation. John Wiley & Sons, New Jersey.
4. Khatekar, D. & Sarkate, N. 2023. *Handbook of Food Safety*, Step Up Academy.
5. Mathur, P. 2018. *Food Safety and Quality Control*, The Orient Blackswan.
6. Sherikar, A.T., Bachhil, V.N. & Thapliyal, D.C. 2013. *Textbook of Elements of Veterinary Public Health*. ICAR.

FST 402	FOOD SCIENCE AND NUTRITION (For B.Sc. (Hons.) Agriculture)	4 (3+1)	SEM VII

Objectives

To impart knowledge on the biochemical aspects of various nutrients and its interactions in food during processing, storage and deterioration

Theory

Introduction on fundamentals of food science and human nutrition; food- sources and its functions; basic food groups; concept of balanced diets; nutritional requirements and recommended daily allowances (RDA); malnutrition- over and under nutrition and nutritional disorders; water in foods, properties and water activity; major food constituents-carbohydrates, proteins, fats- sources, classification, functions, physico-chemical and nutritional characteristics; effect of processing; digestion, absorption, transport and metabolism in human system; vitamins and minerals- classification, dietary sources, functions, deficiency diseases and effect of processing; anti-nutritional factors; postharvest storage and losses during processing; food spoilage; enzymes in food industry; food additives.

Practical

Standard solutions and buffers; TSS; pH; acidity; water activity; proximate analysis of foods; calorific value of foods, estimation of vitamins, phenols, flavonoids, carotenoids, anti-nutrients in food stuff

Suggested Readings

1. De Man, J.M. 1976. *Principles of Food Chemistry*. AVI.
2. Gibney M.J., Lanham-New S.A., Cassidy, A. & Voster, H.H. (ed.) 2009. *Introduction to Human Nutrition*. Wiley-Blackwell
3. Gopalan, C., Rama Sastri, B.V. & Bala Subramanian, S.C. 2021. *Nutritive Value of Indian Foods*, NIN, ICMR, Hyderabad.
4. Kumar, D. 2019. *Food Science and Nutrition*, Random Publications.
5. Manay, N.S. & Shadaksharaswamy, M. 2020. *Foods Facts and Principles*, New Age International Publishers.
6. Mudambi, R.S. & Rao, S. 1985. *Food Science*, Wiley Eastern Ltd.
7. Rekhi, T. and Yadav, H. 2014. *Fundamentals of Food and Nutrition*. Elite Publishing House.
8. Swaminathan, M. 1999. *Essentials of Foods and Nutrition*, Vol. I. The Bangalore Printing and Publishing Co. Ltd., Bangalore.
9. Trueman, P. 2007. *Nutritional Biochemistry*, MJP Publishers

DIRECTORATE OF STUDENTS' WELFARE


Chaudhary Charan Singh Haryana Agricultural University, Hisar
NATIONAL SERVICE SCHEME
NATIONAL INTEGRATION CAMP
October 23-29, 2024
Youth for my Bharat
Dr. M.L. Khichar
Prof. B.R. Kamboj
Sh. Randhir Panihar
M.L.A., NALWA
Dr. Dinesh Kumar
State NSS Officer


Chaudhary Charan Singh Haryana Agricultural University, Hisar
NATIONAL SERVICE SCHEME


3 HAR BN NCC HISAR

DIRECTORATE OF STUDENTS' WELFARE

Course No.	Course Title	Credits	Semester
NCC I/ NSS I (AEC)	National Cadet Corps I/ National Service Scheme I	2 (0+2)	I
NCC II/ NSS II (AEC)	National Cadet Corps II/ National Service Scheme II	2 (0+2)	II
CCA 102	Co-curricular Activity	1 (0+1) NG	II
CCA 201 (AEC)	Physical Education, First Aid, Yoga Practices and Cultural Activities	2 (0+2)	III
NCC III/ NSS III	National Cadet Corps III/ National Service Scheme III	2 (0+2) NG	III
CCA 202	Co-curricular Activity	1 (0+1) NG	IV
NCC IV/ NSS IV	National Cadet Corps IV/ National Service Scheme IV	2 (0+2) NG	V
	Total Credits	**6 (0+6)**	

NCC I/ NSS I (AEC)	NATIONAL CADET CORPS I/ NATIONAL SERVICE SCHEME I	2 (0+2)	SEM I

National Cadet Corps (NCC I)

Objectives

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness programmes

- Aims, objectives, organization of NCC and NCC song. DG's cardinals of discipline.
- Drill- aim, general words of command, attention, stands at ease, stand easy and turning.
- Sizing, numbering, forming in three ranks, open and close order march, and dressing.
- Saluting at the halt, getting on parade, dismissing, and falling out.
- Marching, length of pace, and time of marching in quick/slow time and halt. Side pace, pace forward and to the rear. Turning on the march and wheeling. Saluting on the march.
- Marking time, forward march, and halt. Changing step, formation of squad and squad drill.
- Command and control, organization, badges of rank, honors, and awards
- Nation Building- cultural heritage, religions, traditions, and customs of India. National integration. Values and ethics, perception, communication, motivation, decision making, discipline and duties of good citizens. Leadership traits, types of leadership. Character/ personality development. Civil defense organization, types of emergencies, firefighting, protection. Maintenance of essential services, disaster management, aid during development projects.

- Basics of social service, weaker sections of society and their needs, NGO's and their contribution, contribution of youth towards social welfare and family planning.
- Structure and function of human body, diet and exercise, hygiene and sanitation. Preventable diseases including AIDS, safe blood donation, first aid, physical and mental health. Adventure activities. Basic principles of ecology, environmental conservation, pollution and its control.

As per government guidelines, for getting B and C certificate in NCC, minimum years of requirement is 2 and 3 years, respectively along with 1-2 annual camps.

National Service Scheme (NSS I)

Objective

1. Evoking social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skilful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness programmes

- Orientation: history, objectives, principles, symbol, badge; regular programs under NSS
- Organizational structure of NSS, Code of conduct for NSS volunteers, points to be considered by NSS volunteers' awareness about health.
- NSS program activities: Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth program/ schemes of GOI, coordination with different agencies and maintenance of diary. Understanding youth. Definition, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change.
- Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership. Social harmony and national integration.
- Indian history and culture, role of youth in nation building, conflict resolution and peacebuilding. Volunteerism and shramdaan. Indian tradition of volunteerism, its need, importance, motivation, and constraints; shaman as part of volunteerism.
- Citizenship, constitution, and human rights: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information. Family and society. Concept of family, community (PRIs and other community-based organizations) and society.

A student enrolled in NSS course should put in at least 60 hours of social work in different activities in a semester other than five regular one-day camp in a year and one special camp for duration of 7 days at any semester break period in the two years. Different activities will include orientation lectures and practical works. Activities directed by the Central and State Government have to be performed by all the volunteers of NSS as per direction.

NCC II/ NSS II (AEC)	NATIONAL CADET CORPS II/ NATIONAL SERVICE SCHEME II	2 (0+2)	SEM II

National Cadet Corps (NCC II)

Objective

1. To develop qualities of character, courage, comradeship, discipline, leadership, secular outlook, spirit of adventure and sportsmanship and the ideals of selfless service among the youth to make them useful citizen.
2. To create a human resource of organized trained and motivated youth to provide leadership in all walks of life including the Armed Forces and be always available for the service of the nation.

Practical/ Awareness programmes

- Arms Drill-Attention, stand at ease, stand easy. Getting on parade. Dismissing and falling out. Ground/take up arms, examine arms. Shoulder from the order and vice-versa, present from the order and vice-versa. Saluting at the shoulder at the halt and on the march. Short/ long trail from the order and vice- versa. Guard mounting, guard of honor, Platoon/Coy Drill.
- Characteristics of rifle (.22/.303/SLR), ammunition, fire power, stripping, assembling, care, cleaning, and sight setting. Loading, cocking, and unloading. The lying position and holding.
- Trigger control and firing a shot. Range Procedure and safety precautions. Aiming and alteration of sight. Theory of groups and snap shooting. Firing at moving targets. Miniature range firing. Characteristics of Carbine and LMG.
- Introduction to map, scales, and conventional signs. Topographical forms and technical terms.
- The grid system. Relief, contours, and gradients. Cardinal points and finding north. Types of bearings and use of service protractor. Prismatic compass and its use. Setting a map, finding north and own position. Map to ground and ground to map. Knots and lashings, Camouflage and concealment, Explosives and IEDs.
- Field defenses obstacles, mines and mine lying. Bridging, waterman ship. Field water supplies, tracks and their construction. Judging distance. Description of ground and indication of landmarks. Recognition and description of target. Observation and concealment. Field signals. Section formations. Fire control orders. Fire and movement. Movement with/without arms. Section battle drill. Types of communication, media, latest trends and developments.

National Service Scheme (NSS II)

Objective

1. To evoke social consciousness among students through various activities viz., working together, constructive, and creative social work, to be skillful in executing democratic leadership, developing skill in programme, to be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society.

Practical/ Awareness programmes

- Importance and role of youth leadership
- Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership, Life competencies
- Definition and importance of life competencies, problem-solving and decision-making interpersonal communication. Youth development programs
- Development of youth programs and policy at the national level, state level and voluntary sector; youth-focused and youth-led organizations
- Health, hygiene and sanitation. Definition needs and scope of health education; role of food, nutrition, safe drinking water, water borne diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programs and reproductive health. Youth health, lifestyle, HIV AIDS and first aid. Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid. Youth and yoga. History, philosophy, concept, myths, and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

CCA 201 (AEC)	**PHYSICAL EDUCATION, FIRST AID, YOGA PRACTICES AND CULTURAL ACTIVITIES**	**2 (0+2)**	**SEM III**

Objectives

1. To make the students aware about Physical Education, First Aid and Yoga Practices
2. To disseminate the knowledge and skill how to perform physical training, perform first aid and increase stamina and general wellbeing through yoga

Practical

Physical education; Training and Coaching - Meaning and Concept; Methods of Training; aerobic and aerobic exercises; Calisthenics, weight training, circuit training, interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory and Digestive systems; Balanced Diet and Nutrition: Effects of Diet on Performance; Physiological changes due to ageing and role of regular exercise on ageing process; Personality, its dimensions and types; Role of sports in personality development; Motivation and Achievements in Sports; Learning and Theories of learning; Adolescent Problems and its Management; Posture; Postural Deformities; Exercises for good posture.

Yoga; History of Yog, Types of Yog, Introduction to Yog,

- Asanas (Definition and Importance) Padmasan,san, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan – left leg-right leg, Pavanmuktasan, Halasan, Sarpasan, Ardhdhanurasan, Sawasan
- Suryanamskar Pranayama (Definition and Importance) Omkar, Suryabhedan, Chandrabhedan, AnulomVilom, Shitali, Shitkari, Bhastrika, Bhramari
- Meditation (Definition and Importance), Yogic Kriyas (Kapalbhati), Tratak, Jalneti and Tribandh

- Mudras (Definition and Importance) Gyanmudra, Dhyanmudra, Vayumudra, Akashmudra, Pruthvimudra, Shunyamudra, Suryamudra, Varunmudra, Pranmudra, Apanmudra, Vyanmudra, Uddanmudra
- Role of yoga in sports
- Teaching of Asanas – demonstration, practice, correction and practice.

History of sports and ancient games, Governance of sports in India; Important national sporting events; Awards in Sports; History, latest rules, measurements of playfield, specifications of equipment, skill, technique, style and coaching of major games (Cricket, football, table Tennis, Badminton, Volleyball, Basketball, Kabaddi and Kho-Kho) and Athletics Need and requirement of first aid. First Aid equipment and upkeep. First aid Techniques, First aid related with Respiratory system. First aid related with Heart, Blood and Circulation. First aid related with Wounds and Injuries. First aid related with Bones, Joints Muscle related injuries. First aid related with Nervous system and Unconsciousness. First aid related with Gastrointestinal Tract. First aid related with Skin, Burns. First aid related with Poisoning. First aid related with Bites and Stings. First aid related with Sense organs, Handling and transport of injured traumatized persons. Sports injuries and their treatments.

Music- Importance of Music in life, rhythm in music, role of music in personality development, naad, swar, shruti, alankar, gamak, vadi-samvadi, in music. Importance of expression, Dance and Meditation.

Dramatics- History and theory of theatre. Acting, directing, stage design craft of script and dialogue

Haryana Folk Lore and Culture- Society and Folk Lore, Historical context, folk music in different regions, instruments used in Haryana Folk Lore, Singing style of different folk gharanas.

COMMITTEE FOR FINALISATION OF UG COURSE CURRICULUM