Course: B.Tech. in Agricultural Engineering

Faculty of Technology

Uttar Banga Krishi Viswavidyalaya

P.O.-Pundibari, Dist.-Coochbehar

West Bengal - 736165

Syllabus(*6th Deans' Committee*) from 2025-26 onwards

Course Curricula for Undergraduate Programme in Agricultural Engineering UG-Certificate in Agricultural Engineering UG-Diplomain Agricultural Engineering B. Tech. (Agricultural Engineering).

INTRODUCTION

In the recent years, the technological developments in agricultural engineering have seen rapid momentum, specifically in the fields of precision agriculture, high-efficiency irrigation systems, farm energy systems, remote sensing and geographical studies, etc. Digital agriculture, smart farming systems; internet of things (IoT), sensors, automation and robotics, etc. are finding more and more applications. Intelligent machines and autonomous vehicles are being introduced to increase efficiency and reduce environmental impact. There is a focus on optimizing food processing operations through the measurement of food properties, innovations in equipment design, and advancements in heat and mass transfer. Agricultural engineering has also expanded to include environmental aspects, with a focus on sustainable agricultural systems and the integration of expertise from various engineering fields with biological and socio-economic sciences. In addition to addressing the challenges such as increasing agricultural production, the discipline is evolving to meet the needs of sustainable development, such as improved food security and reduced poverty, and reducing gaseous emissions from agricultural production, which have been contributing towards the UN Sustainable Development Goals. Progress in agricultural engineering technologies and related applications has been leading to the globalization of agricultural mechanization and modernization. Even in the developing countries, agricultural engineering is playing a major role for moving towards more commercialization of agriculture. Hence, the education and research in agricultural engineering in appropriate areas have become of paramount importance in the present context.

However, the actual benefits of these can be properly harvested only if the students have sound exposure to the latent developments in the field in addition to having due acquaintance with the traditional and indigenous knowledge in the related fields. Also, it is imperative that the students acquire both professional and soft skills to contribute to the proper adoption of technologies by the society. It will also make the students more acceptable and fitting as a leader of change that the society strives to see in the next generation graduates.

In view of these, the restructuring of under-graduate programs in Agricultural Engineering has been carried out as per NEP guidelines. It is aimed to build among students a strong foundation of knowledge with increased practical exposure and skilling to build competence and confidence for the application of the gained knowledge. The restructured course curriculum aims at strengthening critical thinking, creativity, communication and collaboration among students. More emphasis has been given on basic skill enhancement courses, exposure visits and case studies, industry attachments, flexibility in choice of courses through electives and also through online courses. Provision has also been made for advanced skill development through project work or experiential learning/ incubation, etc. These activities have been intended at conceptual learning than rote learning as well as for inculcating ingenuity and critical thinking. Besides, as per NEP-2020, provision for multiple exit and entry options have also been included.

The details of the course structure for the Undergraduate courses in Agricultural Engineering (UG-Certificate, UG-Diploma and B. Tech.) have been prepared after having multistage in-depth deliberations and discussions with the Deans and faculty members of the Agricultural Engineering discipline of different SAUs and CAUs, stakeholders from related industries, Govt. Institutions and alumni. It is expected that the course curriculum will strengthen the knowledge and skill base of the students and meet the expectations of the NEP-2020 towards making India a knowledge superpower and realizing the dream of *Atmanirbhar Bharat*.

HIGHLIGHTS

- The B. Tech. (Agricultural Engineering) programme will be of 180 credits, which includes 174 credits offered by the parent institute and 6 credits of online courses (to be taken by the student as per his/her/ze choice). In addition, there will be four credits of two non-gradial courses (Deeksharambh (Introduction-cum-Foundation course): 2 credits and Study tour: 2 credits).

- After the admission of students in the university, the students will register for the *Deeksharambh* of two weeks' duration in the I semester. The course will include, but not restricted to, discussions on operational framework of academic process in university, interactions with alumni, business leaders, scientists and perspective employers, University academic and research managers and classes on personality development (instilling life and social skills, social awareness, ethics and values, team work, leadership, etc.) and communication skills. Steps will be taken to identify the strength and weakness of students (with remedial measures) and 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 course is dedicated for skill development/ enhancement in agricultural engineering sector with few introductory courses. After satisfactory completion of I year (two semesters) 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 Agricultural Engineering 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 basic engineering courses as well as fundamental courses in agricultural engineering with adequate theory and practical components, enabling the student to get acquainted with the basic principles and applications of agricultural engineering. After satisfactory completion of the courses of 2nd 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-Diploma in Agricultural Engineering on exit. The students continuing the study further, would not have to attend the internship after 2nd year.

- The Skill Enhancement courses will be offered in three stages. In the first year, the course entitled Skill Enhancement (8 credits) will aim at skill enhancement for employment and entrepreneurship. The students will have flexibility and choice in selection of skill areas from a bouquet of skill enhancement modules to be offered/ listed by the parent institute. After two to three days' common orientation on different skill enhancement modules, students will take up either two or more modules (maximum four modules recommended) as per the local needs and gain complete hands-on experience on these modules. In addition to the modules proposed in this report, the SAUs can formulate other modules relevant to the respective regions or modify the titles of the proposed modules.

- In the final year, the Project-I (3 credits in 7" semester) and Project-II (4 credits in 8" 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 (Rand 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.

- An institution is at liberty to (and in fact it should) work in partnership with capable organizations/ companies/ NGOs/ progressive entrepreneurs for running the Skill Enhancement courses. In such cases, a detailed content should be prepared in consultation with the industry/ organization and the institution should have a regular monitoring for the learning process. The evaluation can be done jointly by the institute and collaborating partners.

- The third year and fourth year courses have been designed to impart specialized knowledge to the students in the major disciplines. In the 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 any particular field.

- There will be adequate choice of electives/ specialized courses for the students. The Universities will have flexibility to include more courses as Electives depending on specific needs and situational variations. The student may also opt any relevant course offered in the same semester by other constituent colleges of the HAEI as Elective.
- In the final year, the students will also undergo an 8-week In-plant training/ research internship to expose them to real working situations in industry/ research institutions. In• plant training may be conducted in split manner in more than one industry/ organization/ institute.

- During the 5th semester, the students will have a study tour of 10-14 days duration, which will be counted as 2 credits (Non-gradial).

- The students will take a minimum of 6 credits of online courses (any one or more courses totaling at least 24 weeks or 80 hours' duration) during the third and fourth year as a partial requirement for the B. Tech. (Agricultural Engineering) programme. These online courses will be non-gradial as separate certificates would be issued by institutes offering the courses. However, the university/ institute 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.

- At each stage of exit (UG-Certificate/ UG-Diploma and B. Tech.), the students are expected to acquire competency and confidence to get jobs, to face the real challenges in varied jobs and research, as well as to start their own enterprise. The social skills acquired by the students will also make the students more empathetic towards the society and social issues.

- The credits (and contact hours) have been proposed in such a way that class room teaching can be accommodated in 5 days in a week. On Saturdays, the students will take up activities as NSS/ NCC, 'Physical Education, First Aid and Yoga Practice during the 1and 2" year. The courses as Seminar and Case study (with analysis and presentation of findings in seminars as well as in reports form) will be taken in the 3" year. This will increase their acquaintance with the social/ technical problems, improve their analytical ability of the issues/ challenges and enhance their social responsibility. However, these are suggestive only and the Universities can plan their timetables as per the local facilities/ university norms and needs.

- In case the skill enhancement/ internship programs are conducted in collaboration with industry/ other organizations/ agencies, the students may be expected to remain out of the campus for a certain period within the semester. In that situation, the timetable should be so adjusted for the remaining part of the net instruction days (NIDs) of the corresponding semester, that each credit has at least 15 contact hours.

Entry and Exit Options

The entry and exit options for the UG programs in Agricultural Engineering are shown in the Figure 1

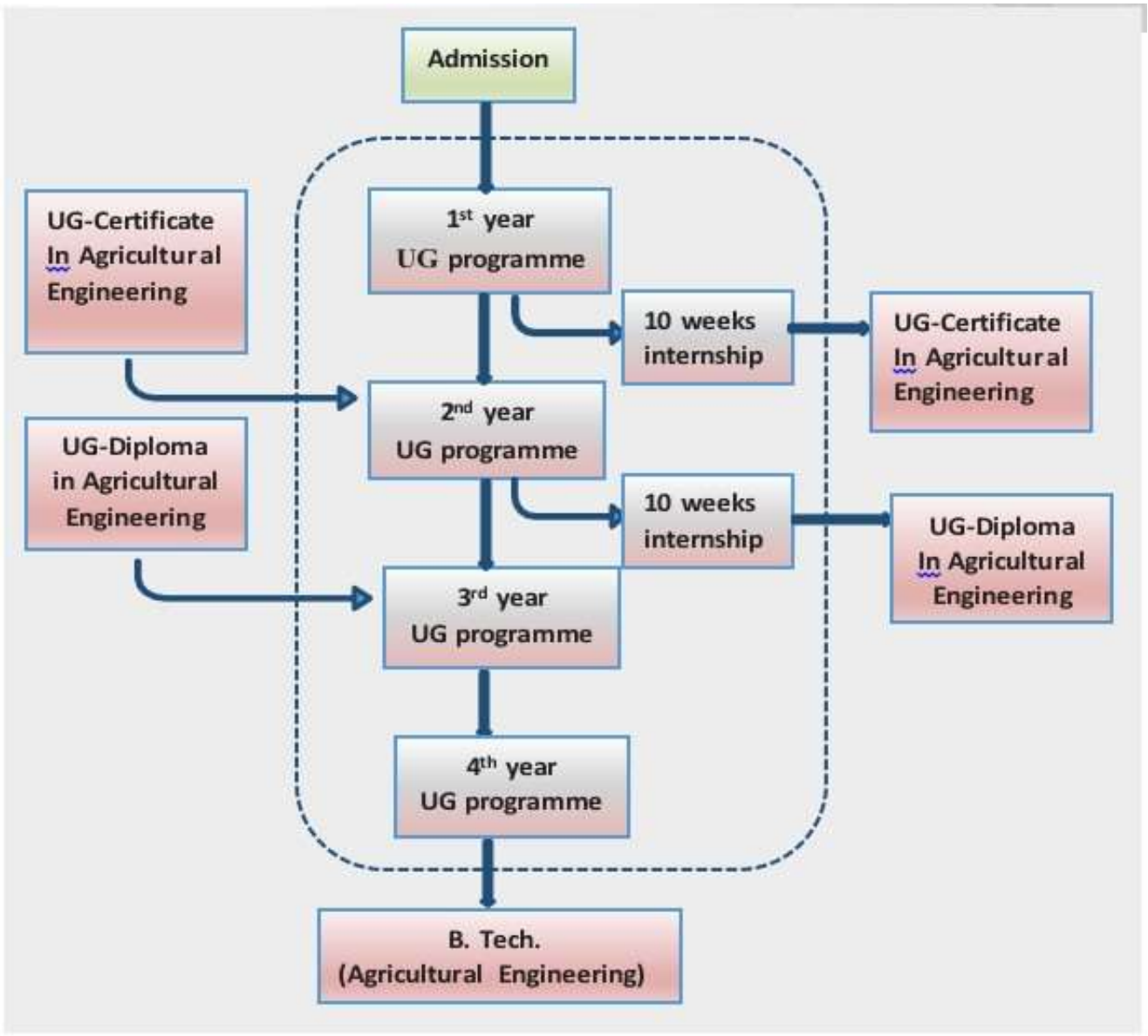

Fig. 1 Entry and Exit options for the UG programs in Agricultural Engineering

Eligibility for Entry into 1st year UG programme

+2 Science with Mathematics as one subject or as per the criteria decided by the ICAR/ SAU.

Exit options

1. **UG-Certificate in Agricultural Engineering** (exit after first year and completion of 10 weeks'internship).
2. **UG-Diploma in Agricultural Engineering** (exit after second year and completion of 10 weeks'internship).
3. **B. Tech. (Agricultural Engineering)** (on successful completion of four-year degreerequirements).

The Universities may consider allowing lateral entry for the candidates having Diploma in Agricultural Engineering (as such courses are available in many states and lateral entry is practicedin some Universities). In such cases, the candidates having Diploma in Agricultural Engineering (with minimum 3 years course programme after 10^{th} or equivalent) may be allowed admission intothe 2^{nd} year of the UG programme, as per the provisions to be notified by the respective AU from time to time.

ACADEMIC PROGRAMME

Semester wise course distribution

First Year

I semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Deeksharambh	0+2 (NG) Non-gradial	DS 101	Foundation course / Ability enhancement course	20(9+11) +2 (Non-gradial)
2.	Introduction to Agricultural Engineering	4 (3+1)	AE 101	FMP (Course leader), SWC, PFE, CE	
3.	Farming Based Livelihood Systems	3 (2+1)	AGR 102	AGR(Ag.), AST(Ag.), ECO(Ag.)	
4.	Communication Skills	2 (1+1)	EXT 102	EXT(Ag.)	
5.	Surveying and Levelling	3 (1+2)	CE 101	CE	
6.	Engineering Drawing	2 (0+2)	ME 101	ME	
7.	Basic Electrical Gadgets and Instruments	3 (2+1)	EE 101	EE	
8.	Computer Programing and Data Structures	2 (0+2)	CSE 101	CSE	
9.	NSS- I/ NCC- I	1 (0+1)	NSS 101	NSS Coordinator UBKV	

II semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Skill Enhancement - I	4 (0+4)	TSEC 151	FMP, PFE, SWC, ME	21 (7+14)
2.	Skill Enhancement - II	4 (0+4)	TSEC 152		
3.	Workshop Technology and Practice	2 (0+2)	ME 151	ME	
4.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	CSE 151	CSE	
5.	Crop Production and Protection Technologies	4(3+1)	AG 151	AGR(Ag.),SSAC(Ag.), VSC(Hort.)	
6.	Environmental Studies and Disaster Management	3 (2+1)	HOR 151	FOR(Hort.)	
7.	NSS-II/ NCC- II	1 (0+1)	NSS 151	NSS Coordinator UBKV	

Post-II semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Internship (for 10 weeks, only for the exit option for the award of the UG-Certificate)	10 (0+10)	INTC 199	To be done at other Institutes / Organizations for a duration of 2½ months	10 (0+10)

Second Year

III semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Engineering Mathematics- I	3 (3+0)	MTH 201	Math	25 (16+9)
2.	Engineering Physics	3 (2+1)	PHY 201	Physics	
3.	Renewable Energy Sources	3 (2+1)	REE 201	Renewable Energy	
4.	Engineering Mechanics	3 (2+1)	CE 201	CE	
5.	Soil Mechanics	2 (1+1)	CE 202	CE	
6.	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	SWC 201	SWC	
7.	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	PFE 201	PFE	
8.	Farm Machinery & Equipment- I	3 (2+1)	FMP 201	FMP	
9.	Physical Education, First Aid, Yoga Practice and meditation	2 (0+2)	PED 201	Physical Education	

IV semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Engineering Mathematics-II	3 (3+0)	MTH 251	Math	25 (18+7)
2.	Engineering Chemistry	3 (2+1)	CHM 251	Chemistry	
3.	Theory of Structures	2 (1+1)	CE 251	CE	
4.	Building Construction & Cost Estimation	2 (2+0)	CE 252	CE	
5.	Watershed Hydrology	3 (2+1)	SWC 251	SWC	
6.	Soil and Water Conservation Engineering	3 (2+1)	SWC 252	SWC	
7.	Farm Machinery & Equipment II	3 (2+1)	FMP 251	FMP	
8.	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	PFE 251	PFE	
9.	Entrepreneurship Development and Business Management	3 (2+1)	AG 251	ECO(Ag.)	

Post-IV semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Internship (for 10 weeks, only for the exit option for the award of UG-Diploma)	10 (0+10)	INTD 299	To be done at other Institutes / Organizations for a duration of 2½ months	10 (0+10)

In-plant Training/ Research Internship –I (July/August after 4th Semester: 01-month duration)

Third Year

V semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Strength of Materials	2 (1+1)	CE 301	CE	21 (14+7) +2 (Non-gradial)
2.	Theory of Machines	2 (2+0)	ME 301	ME	
3.	Bioenergy Systems: Design and Applications	3 (2+1)	REE 301	Renewable Energy	
4.	Tractor & Automotive Engines	3 (2+1)	FMP 301	FMP	
5.	Irrigation and Drainage Engineering	4 (3+1)	IDE 301	Irrigation & Drainage Engineering	
6.	Food and Dairy Engineering	4 (3+1)	PFE 301	PFE	
7.	Personality Development	2 (1+1)	AG 301	EXT (Ag.)	
8.	Seminar	1 (0+1)	SEM 301	Common Agricultural Engineering (course will be assigned to teachers on a rotational basis)	
9.	Study tour	2 (0+2) NG Non-gradial	EDT 301	Common Agricultural Engineering (course will be assigned to teachers on a rotational basis)	

VI semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Tractor Systems & Controls	3 (2+1)	FMP 351	FMP	21 (14+7)
2.	Groundwater, Wells and Pumps	3 (2+1)	IDE 351	Irrigation & Drainage Engineering	
3.	Sensors, AI and Robotics in Agriculture	3 (2+1)	CSE 351	CSE	
4.	Agricultural Structures & Environment Control	3 (2+1)	CE 351	CE (Course leader), PFE, AGR(Ag.), FMAP(Hort.)	
5.	Thermodynamics, Refrigeration and Air-conditioning	3 (2+1)	ME 351	ME (Course Leader), PFE	
6.	Heat Transfer	3 (3+0)	ME 352	ME	
7.	Post-harvest Engineering of Horticultural Crops	2 (1+1)	PFE 351	PFE (Course Leader) PPHT (Hort.)	
8.	Case Study	1 (0+1)	CS 351	Common Agricultural Engineering (course will be assigned to teachers on a rotational basis)	

In-plant Training/ Research Internship –II (July/August after 6th Semester: 01-month duration

Fourth Year

VII semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Project- I	3 (0+3)	PRJ 401	Advanced skill for research (It will encompass project planning, literature review, formulation of the problem statement, execution strategy, report submission, and a presentation to be conducted in the presence of students and Faculty members.): The course will be assigned among all the teachers.	20(10+10)
2.	Electrical Machines	3 (2+1)	EE 401	EE	
3.	Food Quality and Safety	3 (2+1)	PFE 401	PFE (Course leader), PPHT(Hort.), SSAC(Ag.)	
4.	Watershed Planning and Management	3 (2+1)	SWC 401	SWC	
5.	Sprinkler & Micro Irrigation Systems	2 (1+1)	IDE 401	Irrigation & Drainage Engineering	
6.	Machine Design	2 (2+0)	ME 401	ME	
7.	Engineering Graphics and Design	2 (0+2)	ME 402	ME	
8.	Agricultural Statistics and Data Analysis	2 (1+1)	AG 401	AST(Ag.)	

VIII semester

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
1.	Project –II	4 (0+4)	PRJ 451	Advanced skill for research (It will include the methodology, discussion of results, conclusion, submission of the final report, and a final presentation to be delivered in the presence of students and Faculty members.): The course will be assigned among all the teachers.	21 (6+15)
2.	In-plant Training/ Research Internship –I (Evaluation)	4 (0+4)	TRN 451	The in-plant training courses, TRN 451 and TRN 452, will be conducted after the 4th and 6th semesters end-term examinations, respectively, each spanning a	
3.	In-plant Training/ Research Internship –II (Evaluation)	4 (0+4)	TRN 452		

				duration of one month. The evaluation of both training components will take place during the 8th semester. The Training and Placement Officer (TPO) of the Faculty will be responsible for coordinating and facilitating the arrangements for these in-plant training programs or research internships and will also coordinate the evaluation process.	
4.	Elective- I	3 (2+1)	-	To be decided	
5.	Elective- II	3 (2+1)	-	To be decided	
6.	Elective- III	3 (2+1)	-	To be decided	
		TOTAL (Sem I to Sem VIII)-			174 (94+80)

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
	*On-line courses	6 (Non-gradial)	----	Decided by students from Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language Communication skills / Music etc. and cn be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal	6 (Non-gradial)
		Grand Total			**174+6***

ELECTIVE COURSES

Total Credit Hours - 9 (Any three courses to be chosen):

Sl. No.	Course Title	Credit Hours	Specialization	Course Number
1.	Mechanics of Tillage and Traction	3 (2+1)	FMP	FMP 451
2.	Farm Machinery Design and Production	3 (2+1)	FMP	FMP 452
3.	Tractor Design and Testing	3 (2+1)	FMP	FMP 453
4.	Hydraulic Drives and Controls	3 (2+1)	FMP	FMP 454
5.	Human Engineering and Safety	3 (2+1)	FMP	FMP 455
6.	Precision Agriculture and System Management	3 (2+1)	FMP	FMP 456
7.	Photovoltaic Technology and Systems	3 (2+1)	EE	EE 451
8.	Wind Power Technology and Systems	3 (2+1)	REE	REE 451
9.	Waste and By-products Utilization	3 (2+1)	CE	CE 451
10.	Floods and Control Measures	3 (2+1)	SWC	SWC 451
11.	Remote Sensing and GIS Applications	3 (2+1)	SWC	SWC 452

Sl. No.	Course Title	Credit Hours	Specialization	Course Number
12.	Information Technology for Land and Water Management	3 (2+1)	SWC	SWC 453
13.	Wasteland Development	3 (2+1)	SWC	SWC 454
14.	Minor Irrigation and Command Area Development	3 (2+1)	IDE	IDE 451
15.	Management of Canal Irrigation System	3 (2+1)	IDE	IDE 452
16.	Water Quality and Management Measures	3 (2+1)	IDE	IDE 453
17.	Landscape Irrigation Design and Management	3 (2+1)	IDE	IDE 454
18.	Application of Plastics in Agriculture	3 (2+1)	Common Agricultural Engineering, AGR(Ag.), PCP(Hort.)	AE 451
19.	Precision Farming Techniques for Protected Cultivation	3 (2+1)	FMAP(Hort.)	HORE 451
20.	Environmental Engineering	3 (2+1)	CE	CE 452
21.	Development of Processed Food Products	3 (2+1)	PFE	PFE 451
22.	Food Packaging Technology	3 (2+1)	PFE	PFE 452
23.	Food Plant and Equipment Design	3 (2+1)	PFE	PFE 453
24.	Emerging Technologies in Food Processing	3 (3+0)	PFE	PFE 454
25.	Processing of Livestock, Fish and Marine Products	3 (2+1)	PFE, AGR	PFE 455
26.	Food Business Management and Entrepreneurship Development	3 (3+0)	ECO(Ag.)	AGE 451
27.	MATLAB Programming	3 (1+2)	EE	EE 452
28.	Python Programming	3 (1+2)	CSE	CSE 451
29.	Artificial Intelligence Applications	3 (2+1)	CSE	CSE 452
30.	Advances in Automation and Robotics in Agriculture	3 (2+1)	EE, CSE	EE 453
31.	Machine Learning	3 (2+1)	CSE	CSE 453
32.	Operations Research	3 (3+0)	MATH	MTH 451
33.	Mechatronics	3 (2+1)	EE, ME	EE 454
34.	Natural Fibres: Extraction & Properties	3 (2+1)	AGR(Ag.)	AGE 452
35.	Natural Fibre Applications in Agriculture	3 (2+1)	AGR(Ag.)	AGE 453
36.	Processing of Natural Fibres	3 (2+1)	PFE, AGR	PFE 456
37.	Agricultural Marketing and Trade	3 (2+1)	ECO(Ag.)	AGE 454

SUMMARY OF CREDIT DISTRIBUTIONS

Type of courses		Credits
Core courses (major & minor/s)	:	**125**
Common courses (MDC+VAC+AEC)	:	**26**
Skill Enhancement Courses (SEC)	:	**8**
Internship/ in-plant training	:	**8**
Project		**7**
*** Online courses**	:	**6**
Total	:	**174+6***

The credits of *Deeksharambh* (0+2) and Study tour (0+2) have not been included in the total 180 credit hours.

Credits allocation scheme of UG Agricultural Engineering programs is given in Table-1

Table 1 Credits Allocation Scheme of UG Agricultural Engineering programs (Credit hours)

Sem-ester	Core Courses* (majors/ Minors)	Multi-Disciplinary Course (MDC)	Value Added Course (VAC)	Ability Enhancement Course (AEC)	Skill En-hancement Course (SEC)	Internship/ Project/ Student READY	Total Credits	Non-Gradial courses	Online Cours-es/ MOOC
I	12	4(2)	3(3)	1(4)	-	-	20	2(1)	
II	2	3(5)	3(6)	2(7) +1(8) + 2(9)	8	-	21	-	
Post-II semester	-	-	-	-	-	10(10)			
III	23	-		2(11)	-	-	25		
IV	22	3(12)	-	-	-	-	25	-	
Post-IV semester	-	-	-	-	-	10(13)			6
V	19	-	-	2(14)	-	-	21	2(15)	
VI	21	-	-	-	-	-	21	-	
VII	17	-	-	-	-	3	20	-	
VIII	9	-	-	-	-	12	21	-	
Total	125	10	6	10	8	15	174	4	6

(1) *Deeksharambh* (Induction-cum-Foundation Course); (2) Crop Production and Protection Technologies (3) Agricultural Informatics; (4) NCC-I/ NSS-I; (5) Farming Based Livelihood Systems; (6) Environmental Studies and Disaster Management; (7) Communication Skills; (8) NCC-II/ NSS-II; (9) Computer Programming and Data Structures (10) Internship (only for those opting for an exit with UG-Certificate) (11) Physical Education, First Aid and Yoga Practices (12) Entrepreneurship Development and Business Management (13) Internship (only for those opting for an exit with UG-Diploma); (14) Personality Development; (15) Study tour

*Includes the Elective courses.

Detailed Syllabi

I semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Deeksharambh	0+2 (NG) Non-gradial	DS 101	Foundation course / Ability enhancement course	20(9+11) +2 (Non-gradial)
2.	Introduction to Agricultural Engineering	4 (3+1)	AE 101	FMP (Course leader), SWC, PFE, CE, AGR(Ag.)	
3.	Farming Based Livelihood Systems	3 (2+1)	AGR 102	AGR(Ag.), AST(Ag.), ECO(Ag.)	
4.	Communication Skills	2 (1+1)	EXT 102	EXT(Ag.)	
5.	Surveying and Levelling	3 (1+2)	CE 101	CE	
6.	Engineering Drawing	2 (0+2)	ME 101	ME	
7.	Basic Electrical Gadgets and Instruments	3 (2+1)	EE 101	EE	
8.	Computer Programing and Data Structures	2 (0+2)	CSE 101	CSE	
9.	NSS- I/ NCC- I	1 (0+1)	NSS 101	NSS Coordinator UBKV	

1. Deeksharambh (Induction-cum-Foundation Programme) (DS 101) 0+2 (NG)

The activities to be taken under Deeksharambh, in addition to giving a broad view and application areas of the subject of study, also will aim at creating a platform for

• Helping students from different backgrounds for cultural integration

• Knowing about the operational framework of the academic process in university

• Instilling life and social skills, leadership qualities, team working spirit

• Developing social awareness, ethics and values, creativity

• Helping students to identify the traditional values and indigenous cultures along with diverse potentialities both in indigenous and developed scenario.

The details of activities/ schedules will be decided by the parent universities.

The structure shall include, but not restricted to:

I. Discussions on the operational framework of the academic process in the university, as well as interactions with academic and research managers of the University

II. creating awareness on the subject of study, and the traditional values and indigenous cultures along with diverse potentialities, both in the indigenous and developed scenarios

III. interaction with alumni, business leaders, prospective employers, outstanding achievers in related fields, and people with inspiring life experiences;

IV. Group activities to identify the strengths and weaknesses 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;

V. field visits to related fields/ establishments; and

VI. sessions on personality development (instilling life and social skills, social awareness, ethics and values, teamwork, leadership, etc.) and communication skills.

2. Introduction to Agricultural Engineering (AE 101) 4 (3+1)

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 and mouth pieces; 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 planning of 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. Dash S K, Bebartta J P and Kar. 2012. A. Rice Processing and Allied Operations. Kalyani Publishers, 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.

3. Farming-based livelihood systems (AGR 102) 3 (2+1)

Objective

1. To make the students aware about farming-based livelihood systems in agriculture
2. To disseminate the knowledge and skill how farming-based systems can be a source of livelihood

Theory

Status of agriculture in India and different states, Income of farmers and rural people in India, Livelihood-Definition, concept and livelihood pattern in urban and rural areas, Different indicators to study livelihood systems. Agricultural livelihood systems (ALS): Meaning, approach, approaches and framework, Definition of farming systems and farming based livelihood systems Prevalent Farming systems in India contributing to livelihood. Types of traditional and modern farming systems. Components of farming system/ farming-based livelihood systems- Crops and cropping systems, Livestock (Dairy, Piggery, Goatry, Poultry, Duckry etc.), Horticultural crops, Agro--forestry systems, Aqua culture Duck/Poultry cum Fish, Dairy cum Fish, Piggery cum Fish etc., Small-, medium- and large- enterprises including value chains and secondary enterprises as livelihood components for farmers, Factors affecting integration of various enterprises of farming for livelihood. Feasibility of different farming systems for different agro-climatic zones, Commercial farming-based livelihood models by NABARD, ICAR and other organizations across the country, Case studies on different livelihood enterprises associated with the farming. Risk and success factors in farming-based livelihood systems, Schemes and programs by Central and State Government, Public and Private organizations involved in promotion of farming-based livelihood opportunities. Role of farming-based livelihood enterprises in 21st Century in view of circular economy, green economy, climate change, digitalization and changing life style.

Practical

Survey of farming systems and agricultural-based livelihood enterprises, Study of components of important farming-based livelihood models/ systems in different agro-climatic zones, Study of production and profitability of crop based, livestock based, processing based and integrated farming-based livelihood models, Field visit of innovative farming system models. Visit of Agri-based enterprises and their functional aspects for integration of production, processing and distribution sectors and Study of agri-enterprises involved in industry and service sectors (Value Chain Models), Learning about concept of project formulation on farming-based livelihood systems along with cost and profit analysis, Case study of Start-Ups in agri-sectors.

Suggested Readings

1. Agarwal, A. and Narain, S. 1989. Towards Green Villages: A strategy for Environmentally, Sound and Participatory Rural Development, Center for Science and Environment, New Delhi, India.
2. Ashley, C. and Carney, D. 1999. Sustainable Livelihoods: Lessons from Early Experience; Department for International Development: London, UK; Volume 7. [Google Scholar]
3. Carloni, A. 2001. Global Farming Systems Study: Challenges and Priorities to 2030 – Regional Analysis: Sub-Saharan Africa, Consultation Document, FAO, Rome, Italy
4. Dixon, J. and A. Gulliver with D. Gibbon. 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO & World Bank, Rome, Italy & Washington, DC, USA
5. Evenson, R.E. 2000. Agricultural Productivity and Production in Developing Countries'. In FAO, The State of Food and Agriculture, FAO, Rome, Italy
6. Livelihood Improvement of Underprivileged Farming Community: Some Experiences from Vaishali, Samastipur, Darbhanga and Munger Districts of Bihar by B. P. Bhatt, Abhay Kumar, P.K. Thakur, AmitavaDeyUjjwal Kumar, Sanjeev Kumar, B.K. Jha, Lokendra Kumar, K. N. Pathak, A. Hassan, S. K. Singh, K. K. Singh and K. M. Singh ICAR Research Complex for Eastern Region ICAR Parisar, P.O. Bihar Veterinary College, Patna - 800 014, Bihar
7. Panwar et al. 2020. Integrated Farming System models for Agricultural Diversification, Enhanced Income and employment, Indian Council of Agricultural Research, New Delhi.
8. Reddy, S.R. 2016. Farming System and Sustainable Agriculture, Kalyani Publishers, New Delhi.
9. Singh, J.P., et al. 2015. Region Specific Integrated Farming System Models, ICAR-Indian Institute of Farming Systems Research, Modipuram.
10. Walia, S. S. and Walia, U. S. 2020. Farming System and Sustainable Agriculture, Scientific Publishers, Jodhpur, Rajasthan.

4. Communication Skills (EXT 102) 2 (1+1)

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. Dale, Carnegie. 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

5. Surveying and Levelling (CE 101) 3 (1+2)

Objective

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, planimeter; Errors in measurements, their elimination and correction; Plane table surveying, methods, advantages and disadvantages.

Levelling, levelling difficulties and 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; Measurement of slope in the field;

Study on contour and its characteristics; Contour survey of an area and preparation of contour map; Introduction of software in drawing contour; 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; Use of modern computers for surveying.

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.

6. Engineering Drawing (ME 101) 2 (0+2)

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; Cycloidal and involute curves. Practice on orthographic projections, references planes, points and lines in space; Drawing for orthographic projection of points by first angle projection method; Third angle methods of projection; Projection of planes; Projections of solids: polyhedra, cylinder, cone; Projections of solids: prisms and pyramids; Development of surfaces of geometrical solids; Drawing the section of solids: cylinder, cone and sphere; Introduction to isometric scale, isometric view and isometric drawing; Isometric projection of geometrical solids; Preparation of working drawing from models and isometric views; Sectional drawing of simple machine parts; Nomenclature, thread profiles, multi start threads, left and right hand threads; Conventional representation of threads; Forms of screw threads like metric thread, whit worth thread; Square thread: acme thread, knuckle thread, buttress thread; Square headed and hexagonal nuts and bolts; Different types of lock nuts, studs, machine screws, cap screws and wood screws; Drawing of different types of rivet heads and riveted joints and foundation bolts; Drawing of stud screws, set screws, butt, hexagonal and square; Drawing of keys: taper, rank taper, hollow saddle etc.; Symbols for different types of welded joints.

Suggested Readings

1. Bhatt, N. D. 2010. Elementary Engineering Drawing. Charotar Publishing House Pvt. Ltd., Anand.
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.

7. Basic Electrical Gadgets and Instruments (EE 101) 3 (2+1)

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. 0operations; Difference between AC and DC supply system; 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).

Introduction to digital electronics and logic gates: Basic theorem of boolean algebra, combinational logic circuits (basic gates, SOP rule and K-map), binary adder.

Principles of general instruments, measurement of displacement, temperature, velocity, force and pressure using different instruments like strain gauges, load cell, thermistors, thermocouples, pyrometer, linear variable differential transformer (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 switch board to control two light points, one plug point, one fan pointand fuse (House wiring); To prepare an electrical switch board 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 a AC single phase series RLC circuit; To measure 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 verify different logic gates; 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 Device 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 Theraja A K. 2005. A Text Book of Electrical Technology. Vol. I & II. S Chand & Co., New Delhi.

8. Computer Programming and Data Structures (CSE 101) 2 (0+2)

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 CIDE; 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.

9. NSS- I/ NCC- I (NSS 101) 1(0+1)

NSS- I

Objective

1. Evoking social consciousness among students through various activities, viz., working together, constructive, and creative social work
2. To be skilful in executing democratic leadership, developing skill in program
3. To be able to seek self-employment, reducing gap between educated and uneducated, increasing awareness and desire to help sections of society

Practical/ Awareness activities

• 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 programme activities. Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analyzing guiding financial patterns of scheme, youth programs/ 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.

NCC- I

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 citizens.
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 activities

• 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.

II semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Skill Enhancement - I	4 (0+4)	TSEC 151	FMP, PFE, SWC, ME	21 (7+14)
2.	Skill Enhancement - II	4 (0+4)	TSEC 152		
3.	Workshop Technology and Practice	2 (0+2)	ME 151	ME	
4.	Agricultural Informatics and Artificial Intelligence	3 (2+1)	CSE 151	CSE	
5.	Crop Production and Protection Technologies	4(3+1)	AG 151	AGR(Ag.),SSAC(Ag.), VSC(Hort.)	
6.	Environmental Studies and Disaster Management	3 (2+1)	HOR 151	FOR(Hort.)	
7.	NSS-II/ NCC- II	1 (0+1)	NSS 151	NSS Coordinator UBKV	

Post-II semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Internship (for 10 weeks, only for the exit option for the award of the UG-Certificate)	10 (0+10)	INTC 199	To be done at other Institutes / Organizations for a duration of 2½ months	10 (0+10)

**Students intending to exit the program with a UG Certificate after the first year are required to complete a 10-week internship at a reputed organization, research institute or industry-such as "INTRNFORTE" or any other recognized establishment with an approval of Dean and through their own arrangements.

1. Skill Enhancement – I (TSEC 151) 4(0+4)

2. Skill Enhancement – II (TSEC 152) 4(0+4)

For the courses Skill Enhancement – I (TSEC 151) and Skill Enhancement – II (TSEC 152), any two of the following modules are to be offered to the students:

Module: 01

Operation and Maintenance of Drying Equipment and Workshop Machinery (0+4)

- ♣ Introduction to drying curves and their significance in drying processes.
- ♣ Study on drying characteristics of materials.
- ♣ Principles of moisture content determination and their measurements.

- ♣ Brief introduction to common types of industrial and agricultural dryers (e.g. batch dryers, continuous dryers, cabinet dryers) and their basic working principles.
- ♣ Principle and operation of different drying equipment.
- ♣ Open sun-drying of cereals, pulses, oilseed crops and fruits/vegetables.
- ♣ Operation and management of Indirect Heat Drying (Traditional).
- ♣ Study of traditional and modern drying methods.
- ♣ Troubleshooting common drying problems: (e.g. uneven drying, case hardening, and excessive energy consumption).
- ♣ Routine maintenance of drying equipment.
- ♣ Detailed study and operations on drilling machine such as drilling, boring, reaming etc.
- ♣ Thorough study and operations on shaper machine like slot cutting, shaping etc.
- ♣ Detailed study and operations on lathe such as facing, turning, grooving, threading, drilling etc.
- ♣ Detailed study and operations on grinding machine like weld edge preparation, surface finishing etc.
- ♣ Thorough study and operations on milling machine such as slot forming, gear cutting etc.
- ♣ Study and operation on hydraulic hacksaw like cutting of a metal piece.
- ♣ Working of manual metal arc welding (MMAW) and oxy-acetylene gas welding.
- ♣ Study on pattern, mould making and casting operation.
- ♣ Study on coolant and lubrication system, working principle and basic maintenance.
- ♣ Application of various tools and instruments in engineering workshop such as vernier-caliper, micrometer, radius gauge, try square, v-block, tap, die, punch etc.

Module: 02

Design of Carbon-Free Fuel Combustion System Using Softwares (0+4)

- ♣ Study on various types of carbon-free fuel, their features, applications and impact upon environment.
- ♣ Overview of software tools commonly used for carbon-free fuel combustion system design (e.g., Ansys-Fluent, Chemkin etc.), Purpose and capabilities of each software tool, Installation and setup instructions for the selected softwares.
- ♣ Gathering necessary input data: boundary conditions, system specifications, energy capacity etc.
- ♣ Determining the appropriate size of the combustion system, and other system components.
- ♣ Running simulations to estimate the performance and energy yield of the proposed system, analyzing simulation results to evaluate the system's energy production capacity factor and efficiency.
- ♣ Optimizing the system configuration and parameters to maximize energy production and efficiency.
- ♣ Performing a financial analysis to assess the economic feasibility of the project, calculating the return on investment (ROI), payback period, net present value (NPV), and other financial metrics.
- ♣ Conducting sensitivity analysis to evaluate the impact of variations in key parameters (e.g., efficiency, system size) 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.

Module: 03

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/ intercultural 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 levelers, 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 irrigation equipment such as different types of pumps, sprinkler irrigation system/drip irrigation system
- ♣ 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.

Module: 04

Repair and Maintenance of Tractors and Power Tillers 4 (0+4)

- ♣ Study of different systems of tractor and power tiller
- ♣ Study of different components of 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

Module: 05

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

Module: 06

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

Module: 07

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

Module: 08

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 multi-sensor 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

Module: 09

Design of Solar PV Systems Using Softwares 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.

Module: 10

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

Module: 11

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.

Module: 12

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, bio-based 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

Module: 13

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

Module: 14

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

Module: 15

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

Module: 16

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
- ♣ Introduction to basic modules of ArcGIS
- ♣ Introduction to basic modules of QGIS
- ♣ 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

Module: 17

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 digital water level recorder (DWLR)
- ♣ 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

Module: 18

Geophysical Survey and Investigations for Groundwater Exploration and Installation of Tube Well/ Bore Well (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

Module: 19

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

Module: 20

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

Module: 21

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

Module: 22

Argo 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

Module: 23

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

Module: 24

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

Module: 25

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

Module: 26

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

3. Workshop Technology and Practice (ME 151) 2(0+2)

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 workshop; 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; Preparation of a paper weight; Study of various carpentry tools, types of wood and their characteristics and working with carpentry tools; Preparation of simple joints in carpentry: like cross half lap joint, T-half joint, Mortise and Tenon joint dovetail joint, bridle joint etc.; Exercise on Drawing, Punching, Riveting; Making different types of sheet metal joints using G.I. sheets; Study of welding, types of welding, oxy-acetylene 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 and study of different tools used in lathe; Exercise on simple turning, step turning in lathe; Preparation of job on taper turning, drilling, knurling and threading in lathe; 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.; Practice job on shaper; changing a round MS rod into square section with a shaper; Exercise on a milling machine such as making a slot, gear tooth forming and indexing.

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.

4. Agricultural Informatics and Artificial Intelligence (CSE 151) 3(2+1)

Objective

To acquaint students with the basics of computer applications in agriculture, multimedia, database management, application of mobile app and decision- making processes, etc.

To provide basic knowledge of computer with applications in Agriculture and to make the 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 database, Uses of DBMS in Agriculture, Internet and World Wide Web (www): Concepts and components. Computer programming: General concepts, Introduction to Visual Basic, Java, Fortran, C/C++, etc. 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, structure, 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, postharvest 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 document, MS- EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, Creating graphs, Analysis of scientific data, Handling macros. 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 smart phones 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.

5. Crop Production and Protection Technologies (AG 151) 4(3+1)

Objective

To enable the students to have basic idea on crop production and protection practices to understand the domain of agricultural sciences and to have an idea of the different types of machineries/ equipment that can be adopted for these operations

Theory

Introduction and scope of agronomy; Classification of crops; Effect of different weather parameters on crop growth and development; Principles of tillage, tilth and its characteristics; Crop seasons; Time and method of sowing of major field crops, seed rate for important crops; Methods and time of application of manures and fertilizers, fertigation; Basic principles of natural farming, organic farming and sustainable agriculture.

Soil-water-plant relationship, crop coefficients, water requirement of crops and critical stages for irrigation; Weeds and their management in crops; Crop rotation, cropping systems, cropping scheme, relay cropping, mixed cropping and intercropping.

Soil forming processes; Classification and composition of soil, soil taxonomy orders; Important soil physical properties and their importance; soil particle distribution; soil inorganic colloids‑ their composition, properties and origin of charge; ion exchange in soil and nutrient availability; soil organic matter‑ its composition and decomposition, effect on soil fertility; Soil reaction ‑ acidic, saline and sodic soils; Quality of irrigation water. Essential plants nutrients- their functions and deficiency symptoms in plants; Important inorganic fertilizers and their reactions in soils; Gypsum requirement for reclamation of sodic soils and neutralizing RSC; Liquid fertilizers and their solubility and compatibility.

Types of horticultural crops; Sowing and planting times and methods; Seed rate and seed treatment for vegetable crops; Macro and micro propagation methods; Types of plant growing structures; Pruning and training; Water requirements and critical stages; Management of orchard; Major pests and diseases of horticultural crops and their management.

Practical

Identification of crops and their varieties, seeds and weeds; Study of different fertilizer application methods and weed control methods; Judging the maturity time for harvesting of crop; Study of seed viability and germination test; Identification of rocks and minerals; Examination of soil profile in the field; Determination of bulk density; particle density and porosity of soil; Determination of organic carbon of soil; Identification of nutrient deficiency symptoms of crops in the field; Determination of gypsum requirement of sodic soils; Identification and description of important fruits, flowers and vegetables crops; Study of different garden tools; Preparation of nursery bed; Practices of pruning and training in some important fruit crops; Study of cultural operations for vegetable crops (sowing, fertilizer application, mulching, irrigation and weed control); Seed extraction techniques; Visit to commercial greenhouse/ polyhouse.

Suggested Readings

1. Ahamad S, Anwar Ali and Sharma P K (Eds). 2018. Plant Disease Management in Horticultural Crops. Daya Publishing House, Delhi.
2. Biswas T D and Mukharjee S K. 1987. A Text Book of Soil Science. Tata McGraw-Hill publishing Co. Ltd.
3. Brady N C and Ray R Weill. 2002. The Nature and Properties of Soil. Pearson Education Inc. New Delhi.
4. Chadha K L. 2003. Handbook of Horticulture. ICAR Publication, New Delhi.
5. Das D K. 2020. Introductory to Soil Science. Kalyani publication, Ludhiana.
6. Dey G C. 2013. Fundamentals of Agronomy. Jain Book Depot.
7. Ghildyal B P and Tripathy R P. 1987. Soil Physics. Wiley Eastern Ltd., New Delhi.
8. Hillel D. 1982. Introduction to Soil Physics. Academic Press, New York.
9. Indian Society of soil science. 2002. Fundamentals of Soil Science. ISSC, IARI, New Delhi.
10. Janick J. 1979. Horticultural Science. Surjeet Publications, Delhi.
11. Kumar N. 2017. Introduction to Horticulture. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Muthukrishnan N, Ganapathy N, Nalini R and Rajendran R. 2005. Pest Management in Horticultural Crops. New Madura Publishers, Madurai, Tamil Nadu.
13. Reddy S R. 2020. Principles of Agronomy. Kalyani Publisher.
14. Reddy Yellamanda T and Reddy Shankar G H. 1995. Principles of Agronomy. Kalyani Publishers Ludhiana.
15. Sehgal J L. 1996. Soil Pedology. Kalyani publication, Ludhiana.
16. Singh Jitendra. 2018. Fundamentals of Horticulture. Kalyani Publishers, Ludhiana.
17. Singh S S and Singh R. 2013. Principles and practices of Agronomy. Kalyani Publisher.
18. Sudheer K P and Indira V. 2016. Post-harvest Technology of Horticultural Crops. New India Publishing Agency, New Delhi.

6. Environmental Studies and Disaster Management (HOR 151) 3(2+1)

Objective

1. To expose and acquire knowledge on the environment
2. To gain the state-of-the-art - skill and expertise on management of disasters

Theory

Introduction to Environment - Environmental studies - Definition, scope and importance -Multidisciplinary nature of environmental studies - Segments of Environment - Spheres of Earth - Lithosphere - Hydrosphere - Atmosphere - Different layers of atmosphere. Natural Resources: Classification - Forest resources. Water resources. Mineral resources Food resources. Energy resources. Land resources. Soil resources. Ecosystems - Concept of an ecosystem - Structure and function of an ecosystem - Energy flow in the ecosystem. Types of ecosystems. Biodiversity and its conservation: Introduction, definition, types. Biogeographical classification of India. Importance and Value of biodiversity. Biodiversity hot spots. Threats and Conservation of biodiversity

Environmental Pollution: Definition, cause, effects and control measures of: a. Air pollution. b. Water pollution. c. Soil pollution. d. Marine pollution. e. Noise pollution. f. Thermal pollution. h. light pollution. Solid Waste Management: Classification of solid wastes and management methods, Composting, Incineration, Pyrolysis, Biogas production, Causes, effects and control measures of urban and industrial wastes. Social Issues and the Environment: Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Human Population and the Environment: Environment and human health: Human Rights, Value Education. Women and Child Welfare. Role of Information Technology in Environment and human health.

Disaster management - Disaster definition - Types - Natural Disasters - Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves. Man Made Disasters - Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, road accidents, rail accidents, air accidents, sea accidents. International and National strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community-based organizations and media in disaster management. Central, state, district and local administration in disaster control; Armed forces in disaster response; Police and other organizations in disaster management.

Practical

Visit to a local area to document environmental assets river/forest/grassland/hill/mountain. Energy: Biogas production from organic wastes. Visit to wind mill / hydro power / solar power generation units. Biodiversity assessment in farming system. Floral and faunal diversity assessment in polluted and un polluted system. Visit to local polluted site - Urban/Rural/Industrial/Agricultural to study of common plants, insects and birds. Environmental sampling and preservation. Water quality analysis: pH, EC and TDS. Estimation of Acidity, Alkalinity. Estimation of water hardness. Estimation of DO and BOD in water samples. Estimation of COD in water samples. Enumeration of E. coli in water sample. Assessment of Suspended Particulate Matter (SPM). Study of simple ecosystem - Visit to pond/river/hills. Visit to areas affected by natural disaster

Suggested Readings

1. De, A.K. 2010. Environmental chemistry. Published by New Age International Publishers, New Delhi. ISBN:13-978 81 224 2617 5. 384 pp

2. Dhar Chakrabarti, P.G. 2011. Disaster management - India's risk management policy frameworks and key challenges. Published by Centre for Social Markets (India), Bengaluru. 36 pp.

3. Erach Bharucha. Text book for Environmental studies. University Grants Commission, New Delhi.

4. Parthiban, K.T. Vennila, S. Prasanthrajan, M. Umesh Kanna, S. 2023. Forest, Environment, Biodiversity and Sustainable development. Narendra Publishing House, New Delhi.

5. Prasanthrajan, M. and Mahendran, P.P. 2008. A text book on Ecology and Environmental Science. ISBN 81-8321-104-6. Agrotech Publishing Academy, Udaipur

6. Sharma, P.D. 2009, Ecology and Environment, Rastogi Publications, Meerut, India.

7. Tyler, Miller and Spoolman, Scot. 2009. Living in the Environment (Concepts, Connections, and Solutions). Brooks/cole, Cengage learning publication, Belmont, USA

7. NSS-II/ NCC- II (NSS 151) 1(0+1)

NSS-II

Objective

To evoke 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 activities

• 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.

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 activities

• 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.

Post-II semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Internship (for 10 weeks, only for the exit option for the award of the UG-Certificate)	10 (0+10)	INTC 199	To be done at other Institutes / Organizations for a duration of 2½ months	10 (0+10)

**Students intending to exit the program with a UG Certificate after the first year are required to complete a 10-week internship at a reputed organization, research institute or industry-such as "INTRNFORTE" or any other recognized establishment with an approval of Dean and through their own arrangements.

Post – II Semester

Internship (only for exit option for award of UG-Certificate) (INTC 199) 10 (0+10)

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute, so that in case they exit with UG-certificate, they will be able to get proper engagement/ employment and will be competent to start an enterprise.

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres, prototype production facilities, etc.) or in industry, farm machinery service centre or related organisations involved in agri-engineering activities. The College/ University will facilitate attaching the students to the organisations.

After completion of internship, the students will have to submit a report on their learnings and also present in form of a seminar. The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the College. Ideally the weightage will be 50% each for both internal and external. The SAUs may modify the weightage and breakups.

III semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Engineering Mathematics- I	3 (3+0)	MTH 201	Math	25 (16+9)
2.	Engineering Physics	3 (2+1)	PHY 201	Physics	
3.	Renewable Energy Sources	3 (2+1)	REE 201	Renewable Energy	
4.	Engineering Mechanics	3 (2+1)	CE 201	CE	
5.	Soil Mechanics	2 (1+1)	CE 202	CE	
6.	Fluid Mechanics and Open Channel Hydraulics	3 (2+1)	SWC 201	SWC	
7.	Engineering Properties of Agricultural Produce and Food Science	3 (2+1)	PFE 201	PFE	
8.	Farm Machinery & Equipment- I	3 (2+1)	FMP 201	FMP	
9.	Physical Education, First Aid, Yoga Practice and meditation	2 (0+2)	PED 201	Physical Education	

1. Engineering Mathematics- I (MTH 201) 3(3+0)

Objective

To make the students acquainted with the basic mathematics applied in engineering and their applications in solving engineering problems

Theory

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

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

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 inverse of the 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.

2. Engineering Physics (PHY 201) 3 (2+1)

Objective

To make the students acquainted with applications of physics in engineering and different physical processes in agricultural engineering

Theory

Magnetism: Dia, para and ferro-magnetism- classification; Langrevin theory of dia, and para magnetism, adiabatic demagnetization, Weiss molecular field theory; Introduction to quantum mechanics: wave particles duality, deBroglie concept uncertainty principle, time dependent and time independent Schrodinger equation.

Spectroscopy: Qualitative explanation of Zeeman effect, Stark effect and Paschen back effect, Raman spectroscopy; Solid state physics: statement of Bloch function, bands in solids, effective mass, distinction between metals, insulators and semi-conductors.

Semiconductors: Intrinsic and extrinsic semi-conductors, law of mass action, determination of energy gap in semi-conductors, donors and acceptor levels; Superconductivity: super conductivity, critical magnetic field, Meissner effect, isotope effect, Type I and II superconductors, Josephsons effect, DC and AC squids, introduction to high Tc superconductors.

LASERS and MASERS: Spontaneous and stimulated emission, Einstein A and B coefficients, population inversion, He, Ne and Ruby lasers, Ammonia and Ruby masers; Holography and optical fibre: 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, brightness.

Practical

To verify law of transverse vibrations along a string using electrical tuning fork; To determine e/m of electron using magnetron valve method; 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 semiconductor using a p-n junction diode; Study the LCR circuit; Find the wave length of light by using prism and spectrometer; 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 Publication.
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. Laud, B. B. 2011. Lasers and Non-linear Optics. New Age International Publishers.
8. Mani, H. S. and Mehta, G. K. 2022. Modern Physics. Affiliated East-West Press.
9. Omar, M. A. 2002. Elementary Solid State Physics. Pearson.
10. Prakash, S. 2011. Optics. Pragati Prakashan, Meerut.
11. Saraf, B. and Khandelwal, D. P. 1982. Physics through Experiments. Vol. I & II. Vikas Publication, New Delhi.
12. Subramanyam, N., Lal, B. and Avadhanulu, M. N. 2012. A Textbook of Optics. S. Chand.
13. White, H. E. 2019. Introduction to Atomic Spectra. Mc-Graw Hill Publication.
14. Worsnop, B. L. and Flint, H. C. 1951. Advanced Practical Physics. Littlehampton Book Services Ltd.

3. Renewable Energy Sources (REE 201) 3 (2+1)

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.

4. Engineering Mechanics (CE 201) 3 (2+1)

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. Torsion of circular shaft, torsional effect, hoop stress, power transmitted by a shaft. Principal stresses and strain, analysis of plane and complex stress, principal planes and principal stresses, Mohr's circle, finding out principal stresses, different analysis.

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.

5. Soil Mechanics (CE 202) 2 (1+1)

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, triangle 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 grain size by hydrometer method; Determination of liquid limit by Casagrande apparatus; Determination of liquid limit by cone penetrometer; Determination of plastic limit of soil specimen; Determination of shrinkage limit of soil; Determination of optimum moisture content of saturated soil by Abbot's 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.

6. Fluid Mechanics and Open Channel Hydraulics (SWC 201) 3 (2+1)

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, pressure forces on plane and curved surfaces, centre of pressure, pressure diagram, application of hydrostatics in engineering structures; Buoyancy, Archimede's principle, metacentre and metacentric height, 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, streak lines and 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, transmission of power through pipes.

Open channel design and hydraulics: Chezy's formula, Bazin's formula, Kutter's, Manning's formula, best hydraulic section, velocity and pressure profiles in open channels, hydraulic jump; Discharge measurement in open channels: current meter.

Dimensional analysis and similitude: Rayleigh's method and Buckingham's `pi' theorem, types of similarities, dimensionless numbers; Introduction to fluid machinery.

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, rotational flow; Determination of meta-centric height; 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 of Rugosity and Chezy's roughness coefficient; Study of various types of models and prototypes: geometrical, kinematic and dynamic similarities; Study on non-dimensional constants such as Froude's number and Reynold's number; Study of various types of pumps and its components.

Suggested Reading

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.

7. Engineering Properties of Agricultural Produce and Food Science (PFE 201) 3 (2+1)

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 terminal velocity 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.

8. Farm Machinery and Equipment- I (FMP 201) 3 (2+1)

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.

9. Physical Education, First Aid, Yoga Practice and Meditation (PED 201) 2 (0+2)

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 Yoga, Types of Yoga, Introduction to Yoga

• Asanas: Definition and Importance, Padmasan, Gaumukhasan, hadrasan, Vajrajasan, Shashankasan, Pashchimotasan, Ushtrasan, Tadasan, Padhastasan, Ardhchandrasan, Bhujangasan, Utanpadasan, Sarvangasan, Parvatasan, Patangasan, Shishupalanasan‐ left legright 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.

IV semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Engineering Mathematics-II	3 (3+0)	MTH 251	Math	25 (18+7)
2.	Engineering Chemistry	3 (2+1)	CHM 251	Chemistry	
3.	Theory of Structures	2 (1+1)	CE 251	CE	
4.	Building Construction & Cost Estimation	2 (2+0)	CE 252	CE	
5.	Watershed Hydrology	3 (2+1)	SWC 251	SWC	
6.	Soil and Water Conservation Engineering	3 (2+1)	SWC 252	SWC	
7.	Farm Machinery & Equipment II	3 (2+1)	FMP 251	FMP	
8.	Post-harvest Engineering of Cereals, Pulses and Oilseeds	3 (2+1)	PFE 251	PFE	
9.	Entrepreneurship Development and Business Management	3 (2+1)	AG 251	ECO(Ag.)	

Post-IV semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Internship (for 10 weeks, only for the exit option for the award of UG-Diploma)	10 (0+10)	INTD 299	To be done at other Institutes / Organizations for a duration of 2½ months	10 (0+10)

**Students intending to exit the program with a UG Diploma after the second year are required to complete a 10-week internship at a reputed organization, research institute or industry-such as "INTRNFORTE" or any other recognized establishment with an approval of Dean and through their own arrangements.

In-plant Training/ Research Internship –I (July/August after 4th Semester: 01-month duration)

1. Engineering Mathematics-II (MTH 251) 3 (3+0)

Objective

To make the students acquainted with the application of various advanced mathematics such as vector calculus, Fourier series and Laplace transform and applications of numerical methods in engineering

Theory

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), functions of a complex variable, limit, continuity and analytic function, Cauchy- Reimann equations, harmonic functions. 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; 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.

2. Engineering Chemistry (CHM 251) 3 (2+1)

Objective

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, causes, types and methods of prevention- proper designing.

Corrosion: 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 flavoring 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.

Type of polymerization with examples (addition, free radical); Different properties of polymerschemical resistance, crystallinity.

Polymers: Effect of heat on polymers, general use, basic principles of determination of molecular weight by viscosity methods, basic principles of determination of molecular weight by light scattering methods.

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 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; To study the different types of food preservatives and their active principles; To estimate chloride in water sample; To estimate dissolved oxygen in water sample;

To estimate chloride in water samples; To study the different properties of lubricants; 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. Danpat 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.

3. Theory of Structures (CE 251) 2 (1+1)

Objectives

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.

4. Building Construction and Cost Estimation (CE 252) 2 (2+0)

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, aluminium, 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.

5. Watershed Hydrology (SWC 251) 3 (2+1)

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, Cook' s 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, synthetic hydrograph, applications and limitations.

Flood routing - channel and reservoir routing; Hydrology of dry land areas, Troll' s climatic classification; 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 - duration 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 Cook

's method and 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 synthetic 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.

6. Soil and Water Conservation Engineering (SWC 252) 3 (2+1)

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 and graded 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. Energy and momentum principles in open channels; specific energy and specific force, hydraulic jump and its application, types of hydraulic jump, energy dissipation due to the jump. 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. Land capability classification, dryland farming; Rate of sedimentation, silt monitoring and storage loss in tanks, control of sedimentation in reservoirs. 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 ractice (CP) factors; Estimation/measuring techniques of soil loss; Study of rainfall simulator for erosion assessment, estimation of sediment rate using Coshocton wheel sampler and multi-slot devisor; 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 SAF energy dissipater; Design of drop inlet spillway; Study on components of earth embankments and its design; Design of water harvesting structures; Study on prioritization of watershed; Visit to soil erosion sites and watershed project areas for studying erosion control and water conservation measures; Visit to a watershed.

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.

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.

7. Farm Machinery and Equipment II (FMP 251) 3 (2+1)

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 harvestingcotton 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 sprayerstypes, 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.

8. Post-Harvest Engineering of Cereals, Pulses and Oilseeds (PFE 251) 3 (2+1)

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; Preparation of rice products as rice flakes and puffed rice.

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 operations and 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.

9. Entrepreneurship Development and Business Management (AG 251) 3 (2+1)

Objective

1. To provide the student an insight into the concept and scope of entrepreneurship
2. To expose to various aspects of establishment and management of a small business unit
3. To enable the student to develop financially viable agribusiness proposal.

Theory

Development of entrepreneurship, motivational factors, social factors, environmental factors, characteristics of entrepreneurs, entrepreneurial attributes/competencies. Concept, need for and importance of entrepreneurial development. Evolution of entrepreneurship, objectives of entrepreneurial activities, types of entrepreneurs, functions of entrepreneurs, importance of entrepreneurial development, and process of entrepreneurship development. Environment scanning and opportunity identification need for scanning‑spotting of opportunity-scanning of environment‑ identification of product / service ‑ starting a project; factors influencing sensing the opportunities. Infrastructure and support systems- good policies, schemes for entrepreneurship development; role of financial institutions, and other agencies in entrepreneurship development. Steps involved in functioning of an enterprise. Selection of the product / services, selection of form of ownership; registration, selection of site, capital sources, acquisition of manufacturing know how, packaging and distribution. Planning of an enterprise, project identification, selection, and formulation of project; project report preparation, Enterprise Management. Production management ‑ product, levels of products, product mix, quality control, cost of production, production controls, Material management. Production management ‑ raw material costing, inventory control. Personal management ‑ manpower planning, labour turn over, wages / salaries. Financial management / accounting ‑ funds, fixed capital and working capital, costing and pricing, long term planning and short-term planning, book keeping, journal, ledger, subsidiary books, annual financial statement, taxation. Marketing management- market, types, marketing assistance, market strategies. Crisis management- raw material, production, leadership, market, finance, natural etc.

Practical

Visit to small scale industries/agro-industries, Interaction with successful entrepreneurs/ agricentrepreneurs. Visit to financial institutions and support agencies. Preparation of project proposal for funding by different agencies.

Suggested Readings

• Charantimath, P.M. 2009. Entrepreneurship Development and Small Business Enterprises. Pearson Publications, New Delhi.
• Desai, V. 2015. Entrepreneurship: Development and Management. Himalaya Publishing House.
• Desai, V.1997. Small Scale Industries and Entrepreneurship. Himalaya Publ. House
• Grover, Indu. 2008. Handbook on Empowerment and Entrepreneurship. Agrotech Public Academy.
• Gupta, C.B. 2001. Management Theory and Practice. Sultan Chand & Sons.
• Khanka, S. S. 1999. Entrepreneurial Development. S. Chand & Co.
• Mehra, P. 2016. Business Communication for Managers. Pearson India, New Delhi.
• Pandey, M. and Tewari, D. 2010. The Agribusiness Book. IBDC Publishers, Lucknow.
• Singh, D. 1995. Effective Managerial Leadership. Deep & Deep Publ.
• Singhal, R.K. 2013. Entrepreneurship Development and Management. Katson Books.
• Tripathi, P. C. and Reddy, P. N. 1991. Principles of Management. Tata McGraw Hill.

Post-IV semester

Post-IV semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Internship (for 10 weeks, only for the exit option for the award of UG-Diploma)	10 (0+10)	INTD 299	To be done at other Institutes / Organizations for a duration of 2½ months	10 (0+10)

**Students intending to exit the program with a UG Diploma after the second year are required to complete a 10-week internship at a reputed organization, research institute or industry-such as "INTRNFORTE" or any other recognized establishment with an approval of Dean and through their own arrangements.

1. Internship (only for exit option for award of UG-Diploma) 10 weeks (INTD 299) 10 (0+10)

Objective

To provide students with an opportunity to put into practice the skills they have learned while studying in the institute, so that in case they exit with UG-Diploma, they will be able to get proper engagement/ employment and will be competent to start an enterprise

Activity

The students will have internship/ training for 10 weeks' duration either in the parent institute (attaching the students to facilities such as farm machinery testing centre, incubation centres, prototype production facilities, etc.) or in industry, farm machinery service centre or related organisations involved in agri-engineering activities. The College/ University will facilitate attaching the students to the organisations. After completion of internship, the students will have to submit a report on their learnings and also present in form of a seminar. The assessment will be based on the report / assessment received from the industry/ organisation and the report and the presentation made at the College. Ideally the weightage will be 50% each for both internal and external. The HAEIs may modify the weightage and breakups.

In-plant Training/ Research Internship –I (July/August after 4th Semester: 01-month duration):
TPO, F/Technology will arrange such In-plant training/Research Internship

V semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Strength of Materials	2 (1+1)	CE 301	CE	21 (14+7) +2 (Non-gradial)
2.	Theory of Machines	2 (2+0)	ME 301	ME	
3.	Bioenergy Systems: Design and Applications	3 (2+1)	REE 301	Renewable Energy	
4.	Tractor & Automotive Engines	3 (2+1)	FMP 301	FMP	
5.	Irrigation and Drainage Engineering	4 (3+1)	IDE 301	Irrigation & Drainage Engineering	
6.	Food and Dairy Engineering	4 (3+1)	PFE 301	PFE	
7.	Personality Development	2 (1+1)	AG 301	EXT (Ag.)	
8.	Seminar	1 (0+1)	SEM 301	Common Agricultural Engineering (course will be assigned to teachers on a rotational basis)	
9.	Study tour	2 (0+2) NG Non-gradial	EDT 301	Common Agricultural Engineering (course will be assigned to teachers on a rotational basis)	

1. Strength of Materials (CE 301) 2 (1+1)

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 problems.

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.

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.

2. Theory of Machines (ME 301) 2 (2+0)

Objective

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 mechanism: determination of velocity and acceleration using graphical (instantaneous centres) and analytical 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 gear 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 friction, laws of dry friction; friction of pivots and collars; single disc, multiple disc, and cone clutches, rolling friction; Types of governors, constructional details and analysis of Watt, Porter, Proell governors, effect of friction, controlling force curves. Sensitiveness, stability, hunting, isochronism, power and effort of a governor. Static and dynamic balancing, balancing of rotating masses in one and different planes.

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 Publishing House (P) Ltd, New Delhi.
4. Ratan, S. S. 2010. A Text Book of Theory of Machines. Tata McGraw Hill Publishing Company Ltd, New Delhi.

3. Bioenergy Systems: Design and Applications (REE 301) 3 (2+1)

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.

4. Tractor and Automotive Engines (FMP 301) 3 (2+1)

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, carburettors 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.

5. Irrigation and Drainage Engineering (IDE 301) 4 (3+1)

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 and lining of irrigation field channels, on-farm structures for water conveyance, control and distribution; Underground pipe conveyance system: components and design; land grading; Criteria for land levelling, land levelling design methods. 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 soil moisture by different instruments; Measurement of irrigation water; Measurement of infiltration characteristics; Determination of bulk density, field capacity and wilting point; 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; evaluation of furrow irrigation method; evaluation of check basin 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 and installation of subsurface drainage systems; Determination of various chemical properties of soil and water; Study of tile drainage; cost analysis of surface and sub-surface drainage system; Visit to a waterlogged area and study of a drainage project.

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. 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.

6. Food and Dairy Engineering (PFE 301) 4 (3+1)

Objective

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

7. Personality Development (AG 301) 2 (1+1)

Objective

To make students realize their potential strengths, cultivate their inter-personal skills and improve employability

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, Myers-Briggs Typology Indicator, Locus of control and performance, Type A and Type B Behaviours, personality and Organizational Behaviour. Foundations

of individual behavior and factors influencing individual behavior, Models of individual behavior, Perception and attributes and factors affecting perception, Attribution theory and case studies on Perception and Attribution. Learning: Meaning and definition, theories and principles of learning, Learning and organizational behavior, Learning and training, learning feedback. Attitude and values, Intelligence- types of Intelligence, theories of intelligence, measurements of intelligence, factors influencing intelligence, intelligence and Organizational behavior, emotional intelligence. Motivation- theories and principles, Teamwork and group dynamics.

Practical

MBTI personality analysis, Learning Styles and Strategies, Motivational needs, Firo-B, Interpersonal Communication, Teamwork and team building, Group Dynamics, Win-win game, Conflict Management, Leadership styles, Case studies on Personality and Organizational Behavior.

Suggested reading

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.

8. Seminar (SEM 301) 1 (0+1)

Objective

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.

9. Study tour (EDT 301) 2 (0+2) NG

The study tour will be of 10-14 days duration within the 5th semester. The students will visit industries/ institutions, preferably outside the state, so that, in addition to visiting the organisations/ industries (related to the profession), they will also be exposed to the geographical, social, socio-economic and cultural diversity of different places/ states. After the visit, the students will submit a report/ make a presentation.

VI semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Tractor Systems & Controls	3 (2+1)	FMP 351	FMP	21 (14+7)
2.	Groundwater, Wells and Pumps	3 (2+1)	IDE 351	Irrigation & Drainage Engineering	
3.	Sensors, AI and Robotics in Agriculture	3 (2+1)	CSE 351	CSE	
4.	Agricultural Structures & Environment Control	3 (2+1)	CE 351	CE (Course leader), PFE, AGR(Ag.), FMAP(Hort.)	
5.	Thermodynamics, Refrigeration and Air-conditioning	3 (2+1)	ME 351	ME (Course Leader), PFE	
6.	Heat Transfer	3 (3+0)	ME 352	ME	
7.	Post-harvest Engineering of Horticultural Crops	2 (1+1)	PFE 351	PFE (Course Leader) PPHT (Hort.)	
8.	Case Study	1 (0+1)	CS 351	Common Agricultural Engineering (course will be assigned to teachers on a rotational basis)	

In-plant Training/ Research Internship –II (July/August after 6th Semester: 01-month duration):

TPO, F/Technology will arrange such In-plant training/Research Internship

1. Tractor Systems and Controls (FMP 351) 3 (2+1)

Objective

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

2. To understand the ergonomically 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.

2. Groundwater, Wells and Pumps (IDE 351) 3 (2+1)

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 different method such as Theis, Jacob and Chow's, Theis recovery method; Design of tube well and gravel pack, sanitary protection of tube wells. 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, computation of safe yield by Hill's method, conjunctive use of groundwater. Quality of groundwater, groundwater pollution; Artificial groundwater recharge techniques; different direct, indirect and combination of methods; Sea water intrusion, coastal aquifers, sources of saline water intrusion, upcoming of saline water, Ghyben-Herzberg relationship between fresh and saline water.

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; testing of well screen; Estimation of specific yield and specific retention; Estimation of aquifer parameters by Theis method, Coopers-

Jacob method, Chow method and Theis Recovery method; Design of well; Study of well losses and well efficiency; Determination of safe yield by Hill's method; 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; Visit to a groundwater project and a river lift project.

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.

3. Sensors, Artificial Intelligence and Robotics in Agriculture (CSE 351) 3 (2+1)

Objective

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. **Sensors Fundamentals:** Introduction to sensors and transducers; Need for sensors in the 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 - Peizoresistive effect - Piezoelectric effect - Pyroelectric effect- Magneto mechanical effect (magnetostriction) - Magneto resistive effect. Basics of detector materials/ sensor type (Silicon diod, InGaAS- etc.) and their characteristics. Fundamentals of visual, NIR, IR and FTIR spectroscopy, Remote sensing, data acquisition and their analysis; Training and validation of sensor and its results. **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. Biosensors, general components of biosensor, biomolecules in biosensors such as enzyme, DNA, antibody, Nanomaterials in biosensors- Quantum dots.

Selection of sensors:

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, conflict resolution, multiple rules, forward chaining, backward chaining; Advantages and limitations of AI systems. **Problem-solving through Search**: Forward and backward, state-space, blind, heuristic, problem reduction, alpha-beta pruning, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, bidirectional search, heuristic search, problems and examples. **Knowledge Representation and Reasoning**:

Foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications. Planning: planning as search, partial order planning, construction and use of planning graphs. **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; Controlled system and chain type: Serial manipulator and Parallel Manipulator. 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; image processing- shape analysis, feature detection and object location; 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 on open source image processing software for shape analysis and object detection; 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. 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.
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.

4. Agricultural Structures and Environment Control (CE 351) 3 (2+1)

Objective

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.
6. Ojha, T. P. and Michael, A. M. 1966. Principles of Agricultural Engineering. Vol. I. Jain Brothers, Karol Bag, New Delhi.
7. Pandey, P. H. 2004. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana.
8. Rao, P. V. 2012. Text Book of Environmental Engineering. Prentice Hall of India, New Delhi.
9. Sahay, K. M. and Singh, K. K. 2004. Unit Operations of Agricultural Processing. Vikas Publishing Pvt. Ltd, Noida.

5. Thermodynamics, Refrigeration and Air-conditioning (ME 351) 3 (2+1)

Objective

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

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 steady flow process; energy-a property of system, perpetual motion machine of the first kind-PMM1; characteristic equation of state; 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; Principles of heat engine, heat pump and refrigeration system; Clausius statement, Kelvin-Planck statement; Perpetual motion machine of the second kind-PMM2; Clausius inequality; Rankine cycle, Carnot Cycle, Carnot's Theorem, entropy, entropy changes for a closed system. Air standard cycles (Otto, Diesel and Dual). Thermodynamic properties of gases; specific heats. Definition of pure substance; 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; 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. 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, psychrometric chart and its use, elementary psychrometric 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; types of air conditioners and their applications; Cold storage plants; calculation of refrigeration load and cold storage design considerations.

Practical

Solving problems on entropy and thermodynamic cycles. 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 psychrometrics; 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. Gupta, C. P. and Prakash, R. 2008. Engineering Heat Transfer. Nem Chand and Bros., Roorkee.

2. Holman, J. P. 2018. Heat Transfer. McGraw Hill Book Co., New Delhi.

3. Incropera, F. P. and De Witt, D. P. 2016. Fundamentals of Heat and Mass Transfer. John Wiley and Sons, New York.
4. Kumar, D. S. 2016. Engineering Thermodynamics. S.K. Kataria & Sons, Delhi.
5. Rajput, R. K. 2019. A Text Book of Heat and Mass Transfer. S. Chand & Company Ltd., New Delhi.

6. Heat Transfer (ME 352) 3 (3+0)

Objective

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

Theory

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, thermal resistance, insulation materials and fins; Free and forced convection, Newton's law of cooling, heat transfer coefficient in convection. Non-dimensional numbers; equation of laminar boundary layer on flat plate and in a tube; Continuity, Navier-Stokes and energy equation. Couette flow, Plane Poiseuille and Hagen Poiseuille flow. Laminar forced convection on a flat plate and tube, combined free and forced convection. Thermal radiation, black body radiation, Stefan-Boltzmann law, Kirchhoff's law, grey body, black body emissive power, emissivity, absorptivity, reflectivity and transmissivity. Solid angle, intensity of radiation. Radiation exchange between black surfaces, geometric configuration factor. Radiation network analysis. 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, diffusion resistance.

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.

7. Post-Harvest Engineering of Horticultural Crops (PFE 351) 2 (1+1)

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.

8. Case study (CS 351) 1 (0+1)

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.

VII semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Project- I	3 (0+3)	PRJ 401	Advanced skill for research (It will encompass project planning, literature review, formulation of the problem statement, execution strategy, report submission, and a presentation to be conducted in the presence of students and Faculty members.): The course will be assigned among all the teachers.	20(10+10)
2.	Electrical Machines	3 (2+1)	EE 401	EE	
3.	Food Quality and Safety	3 (2+1)	PFE 401	PFE (Course leader), PPHT(Hort.), SSAC(Ag.)	
4.	Watershed Planning and Management	3 (2+1)	SWC 401	SWC	
5.	Sprinkler & Micro Irrigation Systems	2 (1+1)	IDE 401	Irrigation & Drainage Engineering	
6.	Machine Design	2 (2+0)	ME 401	ME	
7.	Engineering Graphics and Design	2 (0+2)	ME 402	ME	
8.	Agricultural Statistics and Data Analysis	2 (1+1)	AG 401	AST(Ag.)	

1. Project-I (PRJ 401) 3 (0+3)

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).

It will encompass project planning, literature review, formulation of the problem statement, execution strategy, report submission, and a presentation to be conducted in the presence of students and Faculty members.

2. Electrical Machines (EE 401) 3 (2+1)

Objective

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 torque for starting and running condition. 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, shaded pole motors, performance characteristics.

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; Toperformno-loadteston3-phase induction motor and to determine its noload 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-teston1-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.

3. Food Quality and Safety (PFE 401) 3 (2+1)

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/

4. Watershed Planning and Management (SWC 401) 3 (2+1)

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; Dry farming techniques - inter-terrace and inter-bund land management; 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; Introduction to Remote Sensing and GIS, Map projections and co-ordinate system. Spatial data structure: Raster, vector. Spatial relationship. Topology. Delineation of watersheds and generation of stream network; Preparation of various thematic maps in watershed; Hydrological Response Unit (HRU); 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; Soil water assessment tool (SWAT); Case studies. 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; Study of watershed action plan using GIS; Prioritization of watersheds based on sediment yield index; Study of functional requirement of watershed development structures; Study on components of earth embankments and its design; Study of watershed management technologies; Study of role of various functionaries in watershed development programs; Study of accounting and financial management systems in watershed entities; 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.

5. Sprinkler and Micro Irrigation Systems (IDE 401) 2 (1+1)

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 and pattern efficiency. 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 of cost economics 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; Study of cost economics 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.

6. Machine Design (ME 401) 2 (2+0)

Objective

To make the students acquainted with design considerations for various machine components so as 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, sleeve, and rigid flange couplings; Cotter joints, design of socket and spigot cotter joint; knuckle joint; Design of welded joints subjected to static loads; Design of helical and leaf springs; Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear and bolted joints subjected to eccentric loading; Design of flat belt and V-belt drives and pulleys; Design of gears; Selection of anti-friction bearings.

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.

7. Engineering Graphics and Design (ME 402) 2 (0+2)

Objective

1. To acquaint the students with CAD Softwares 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, cotter joint, knuckle joint; Sectioning of foot step bearing and stuffing box; Drawing of different couplings. Drawing of hexagonal, nut and bolt and other machine parts; Practice on 3-D commands- Extrusion and lift, sweep and press pull, revolving, joining. 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.

8. Agricultural Statistics and Data Analysis (AG 401) 2 (1+1)

Objective

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 hypothesis, 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.
4. Gupta, S. C. and Kapoor, V. K. 2019. Fundamental Applied Statistics. Sultan Chand & Sons.
5. Nageswara Rao, G. 2007. Statistics for Agricultural Sciences. BS Publications.
6. Rangaswamy, R. 2018. A Text Book of Agricultural Statistics. New Age Int. publications Ltd.

VIII semester					
Sl. No.	**Course Title**	**Credit Hours**	**Course Number**	**Specialization/Remarks**	**Total Credit hours**
1.	Project –II	4 (0+4)	PRJ 451	Advanced skill for research. It is the continuation of Project-I (PRJ 401). (It will include the methodology, discussion of results, conclusion, submission of the final report, and a final presentation to be delivered in the presence of students and Faculty members.): The course will be assigned among all the teachers.	21 (6+15)
2.	In-plant Training/ Research Internship –I (Evaluation only)	4 (0+4)	TRN 451	The in-plant training courses, TRN 451 and TRN 452, will be conducted after the 4th and 6th semesters end-term examinations, respectively, each spanning a duration of one month. The evaluation of both training components will take place during the 8th semester. The Training and Placement Officer (TPO) of the Faculty will be responsible for coordinating and facilitating the arrangements for these in-plant training programs or research internships and will also coordinate the evaluation process.	
3.	In-plant Training/ Research Internship –II (Evaluation only)	4 (0+4)	TRN 452		
4.	Elective- I	3 (2+1)	-	To be decided	

5.	Elective- II	3 (2+1)	-	To be decided	
6.	Elective- III	3 (2+1)	-	To be decided	
		TOTAL (Sem I to Sem VIII)-			**174 (94+80)**

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
	*On-line courses	6 (Non-gradial)	----	Decided by students from Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language Communication skills / Music etc. and cn be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal	6 (Non-gradial)

1. Project-II (PRJ 451) 4 (0+4)

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

It will include the methodology, discussion of results, conclusion, submission of the final report, and a final presentation to be delivered in the presence of students and Faculty members.

2. In-plant Training/ Research Internship - I (Evaluation only) (TRN 451) 4 (0+4)

(To be undertaken after the completion of the fourth semester.)

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 4 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 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.

3. In-plant Training/ Research Internship - II (Evaluation) (TRN 452) 4 (0+4)

(To be undertaken after the completion of the sixth semester.)

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 4 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 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.

4. Electives- I **3 (2+1)**

The options for Elective courses and the details are given after this section.

5. Elective- II **3 (2+1)**

The options for Elective courses and the details are given after this section.

6. Elective- III **3 (2+1)**

The options for Elective courses and the details are given after this section.

Sl. No.	Course Title	Credit Hours	Course Number	Specialization/Remarks	Total Credit hours
	*On-line courses	6 (Non-gradial)	----	Decided by students from Engineering, Basic Sciences, Humanities, Psychology, Anthropology, Economics, Business Management, Languages including foreign language Communication skills / Music etc. and cn be taken from NPTEL, mooKIT, edX, Coursera, SWAYAM or any other portal	6 (Non-gradial)

ONLINE COURSES **6 (Non-gradial)**

Students are required to complete a minimum of 6 credits through online courses (as per UGC guidelines for online courses), comprising one or more courses, as a partial requirement of the for the B. Tech. (Agricultural Engineering) program.

In accordance with UGC guidelines, a SWAYAM course carrying 1 to 3 credits is expected to be completed within a duration of 4 to 12 weeks, including assessments. The total engagement time ranges from 40 hours for a 3-credit course to 80 hours for a 6-credit course, encompassing activities such as e-content learning, reading reference materials, participating in discussion forums, and completing assignments. These online courses may be selected from a broad spectrum of disciplines, including Basic Sciences, Humanities, Psychology, Anthropology, Economics, Engineering, Business Management, Languages (including foreign languages), Communication Skills, Music, and more. Students may opt for courses offered through platforms such as NPTEL, mooKIT, edX, Coursera, SWAYAM, or any other recognized online portal. These courses will be non-graded, with separate certificates issued by the offering institutions. Students may undertake these courses at any time during the UG programme, though they are preferably to be completed during the 3rd and 4th years.

The Dean, Faculty of Technology, will coordinate the implementation and monitoring of online course participation by students. However, the Deputy Registrar, UBKV, 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.

ELECTIVE COURSES

Total Credit Hours - 9 (Any three courses to be chosen):

Sl. No.	Course Title	Credit Hours	Specialization	Course Number
1.	Mechanics of Tillage and Traction	3 (2+1)	FMP	FMP 451
2.	Farm Machinery Design and Production	3 (2+1)	FMP	FMP 452
3.	Tractor Design and Testing	3 (2+1)	FMP	FMP 453
4.	Hydraulic Drives and Controls	3 (2+1)	FMP	FMP 454
5.	Human Engineering and Safety	3 (2+1)	FMP	FMP 455
6.	Precision Agriculture and System Management	3 (2+1)	FMP	FMP 456
7.	Photovoltaic Technology and Systems	3 (2+1)	EE	EE 451
8.	Wind Power Technology and Systems	3 (2+1)	REE	REE 451
9.	Waste and By-products Utilization	3 (2+1)	CE	CE 451
10.	Floods and Control Measures	3 (2+1)	SWC	SWC 451
11.	Remote Sensing and GIS Applications	3 (2+1)	SWC	SWC 452
12.	Information Technology for Land and Water Management	3 (2+1)	SWC	SWC 453
13.	Wasteland Development	3 (2+1)	SWC	SWC 454
14.	Minor Irrigation and Command Area Development	3 (2+1)	IDE	IDE 451
15.	Management of Canal Irrigation System	3 (2+1)	IDE	IDE 452
16.	Water Quality and Management Measures	3 (2+1)	IDE	IDE 453
17.	Landscape Irrigation Design and Management	3 (2+1)	IDE	IDE 454
18.	Application of Plastics in Agriculture	3 (2+1)	Common Agricultural Engineering, AGR(Ag.), PCP(Hort.)	AE 451
19.	Precision Farming Techniques for Protected Cultivation	3 (2+1)	FMAP(Hort.)	HORE 451
20.	Environmental Engineering	3 (2+1)	CE	CE 452
21.	Development of Processed Food Products	3 (2+1)	PFE	PFE 451
22.	Food Packaging Technology	3 (2+1)	PFE	PFE 452
23.	Food Plant and Equipment Design	3 (2+1)	PFE	PFE 453
24.	Emerging Technologies in Food Processing	3 (3+0)	PFE	PFE 454
25.	Processing of Livestock, Fish and Marine Products	3 (2+1)	PFE, AGR	PFE 455
26.	Food Business Management and Entrepreneurship Development	3 (3+0)	ECO(Ag.)	AGE 451
27.	MATLAB Programming	3 (1+2)	EE	EE 452
28.	Python Programming	3 (1+2)	CSE	CSE 451
29.	Artificial Intelligence Applications	3 (2+1)	CSE	CSE 452
30.	Advances in Automation and Robotics in Agriculture	3 (2+1)	EE, CSE	EE 453
31.	Machine Learning	3 (2+1)	CSE	CSE 453
32.	Operations Research	3 (3+0)	MATH	MTH 451
33.	Mechatronics	3 (2+1)	EE, ME	EE 454
34.	Natural Fibres: Extraction & Properties	3 (2+1)	AGR(Ag.)	AGE 452
35.	Natural Fibre Applications in Agriculture	3 (2+1)	AGR(Ag.)	AGE 453
36.	Processing of Natural Fibres	3 (2+1)	PFE, AGR	PFE 456
37.	Agricultural Marketing and Trade	3 (2+1)	ECO(Ag.)	AGE 454

ELECTIVE COURSES

The detailed syllabi of elective courses is given below.

1. Mechanics of Tillage and Traction (FMP 451) 3 (2+1)

Objective

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.

2. Farm Machinery Design and Production (FMP 452) 3 (2+1)

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.

3. Tractor Design and Testing (FMP 453) 3 (2+1)

Objective

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.

4. Hydraulic Drives and Controls (FMP 454) 3 (2+1)

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.

5. Human Engineering and Safety (FMP 455) 3 (2+1)

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, thermoregulation 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.

6. Precision Agriculture and System Management (FMP 456) 3 (2+1)

Objective

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 levelers, 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

7. Photovoltaic Technology and Systems (EE 451) 3(2+1)

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.

8. Wind Power Technology and Systems (REE 451) 3 (2+1)

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.

9. Waste and By-Products Utilization (CE 451) 3 (2+1)

Objective

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-Harvest 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.

10. Floods and Control Measures (SWC 451) 3 (2+1)

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 dams

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 embankmentsfunctions, 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.

11. Remote Sensing and GIS Applications (SWC 452) 3 (2+1)

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.

12. Information Technology for Land and Water Management (SWC 453) 3 (2+1)

Objective

To enable the students to understand the application of IT natural resources management and design and application of decision support system and expert systems for NRM

Theory

Concept of Information Technology (IT) and its application potential, role of IT in natural resources management; Existing system of information generation and organizations involved in the field of land and water management; Application and production of multimedia, internet application tools and web technology, networking system of information, problems and prospects of new information and communication technology; Development of database concept for effective natural resources management; Application of remote sensing, geographic information system (GIS) and GPS; Rational data base management system, object oriented approaches; Information system, decision support systems and expert systems; Agricultural information management systems- use of mathematical models and programs; Application of decision support systems, multi sensor data loggers and overview of software packages in natural resource management; Video-conferencing of scientific information.

Practical

Multimedia production; Internet applications: E-mail, voice mail, web tools and technologies; Handling and maintenance of new information technologies and exploiting their potentials; Exercises on database management using database and spreadsheet programs; Usage of remote sensing, GIS and GPS survey in information generation and processing; Exercises on running computer software packages dealing with water balance, crop production, land development, land and water allocation, watershed analysis etc.; Exercises on simple decision support and expert systems for management of natural resources; Multimedia production using different softwares; Exercises on development of information system on selected theme(s); Video-conferencing of scientific information.

Suggested Readings

1. Bian F and Xie Y (Eds.). 2015. Geo-Informatics in Resource Management and Sustainable Ecosystem. Springer, New York.

2. De, D. and Basavaprabhu, J. (Eds). 2010. Communication Support for Sustainable Development. Ganga Kaveri Publishing House, Varanasi.

3. FAO. 2013. Climate-Smart Agriculture- Source Book. FAO, Rome.

4. FAO. 1998. Land and Water Resources Information Systems. FAO Land and Water Bulletin 7, Rome.

5. ICFAI Business School (IBS). 2012. Information Technology and Systems. IBS Centre for Management Research, Hyderabad.

6. Loucks, D. P. and Beek, E. V. 2005. Water Resources Systems Planning and Management – An Introduction to Methods, Models and Applications. UNESCO, Paris.

7. Malliva, R. and Thomas, M. 2012. Arid Lands Water Evaluation and Management. Environmental Science. Springer, New York.

8. Sarvanan, R. 2011. Information and Communication Technology for Agriculture and Rural Development. New India Publishing Agency, New Delhi.

9. Soam, S. K., Sreekanth, P. D. and Rao, N. H. (Eds). 2013. Geospatial Technologies for Natural Resources Management. New India Publishing Agency, Delhi.

13. Wasteland Development (SWC 454) 3 (2+1)

Objective

1. To enable the students to plan for wasteland development keeping in view of agro-climatic conditions, development options, contingency plans, conservation measures, water harvesting and recycling methods in consideration

2. To know the different land reclamation and rehabilitation measures for wasteland development and use of micro-irrigation for sustainable wasteland development against adverse situations like drought and water-scarce situations

Theory

Land degradation- concept, classification, arid, semiarid, humid and sub-humid regions, Troll' s climatic classification, denuded range land and marginal lands; Wastelands- factors causing waste lands, classification and mapping of wastelands, planning of wasteland development- constraints, agro-climatic conditions, development options, contingency plans; Conservation structures- gully stabilization, ravine rehabilitation, sand dune stabilization, water harvesting and recycling methods; Afforestation- agro-horti-forestry-silvipasture methods, forage and fuel crops, socioeconomic constraints; Shifting cultivation, optimal land use options; Wasteland development- hills, semiarid, coastal areas, water scarce areas, reclamation of waterlogged and salt-affected lands; Mine spoils- impact, land degradation and reclamation and rehabilitation, slope stabilization and mine environment management; Micro-irrigation in wastelands development; Sustainable wasteland

development- drought situations, socio-economic perspectives; Participatory approach in wasteland management; Preparation of proposal for wasteland development and benefit-cost analysis.

Practical

Mapping and classification of wastelands; Identification of factors causing wastelands; Estimation of vegetation density and classification; Planning and design of engineering measures for reclamation of wastelands; Design and estimation of different soil and water conservation structures under arid, semi-arid and humid conditions; Planning and design of micro-irrigation in wasteland development; Study on utilization of fly-ash in hydraulic structures; Study on mine spoil areas by plantation; Study on mine spoil areas by back filling of fly-ash; Study on environmental impact assessment (EIA) of mine spoil areas; Cost estimation of the various wasteland development measures; Study on PRA exercise on wasteland management; Preparation of DPR of wasteland development projects; Visit to wasteland development project sites.

Suggested Readings

1. Abrol, I. P. and Dhruvanarayana, V. V. 1998. Technologies for Wasteland Development. ICAR, New Delhi.
2. Ambast, S. K., Gupta, S. K. and Singh, G. (Eds). 2007. Agricultural Land Drainage – Reclamation of Waterlogged Saline Lands. Central Soil Salinity Research Institute, Karnal, Haryana.
3. Karthikeyan, C., Thangaraja, K., Fernandez, C. C. and Chandrakandon, K. 2009. Dryland Agriculture and Wasteland Management. Atlantic Publishers and Distributors Pvt. Ltd., New Delhi.
4. Lal, R. and Stewart, B. A. (Eds). 2015. Soil Management of Smallholder Agriculture. Volume 21 of Advances in Soil Science. CRC Press, USA.
5. Malliva, R. and Missimer, T. 2012. Arid Lands Water Evaluation and Management. Springer Heidelberg, New York.
6. Pachauri, R. K. and Sridharan, P. V. (Eds) 2003. Looking Back to Think Ahead Green India 2047. TERI, New Delhi.
7. Swaminathan, M. S. 2010. Science and Integrated Rural Development. Concept Publishing Company (P) Ltd., Delhi.
8. Virmani, S. M (Ed.). 2010. Degraded and Wastelands of India: Status and Spatial Distribution. ICAR, New Delhi.
9. Yadav, H. R. 2013. Management of Wastelands. Concept Publishing Company. New Delhi.

14. Minor Irrigation and Command Area Development (IDE 451) 3 (2+1)

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.

15. Management of Canal Irrigation System (IDE 452) 3 (2+1)

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; Participatory irrigation management (PIM), 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.

16. Water Quality and Management Measures (IDE 453) 3 (2+1)

Objective

To enable the students to understand the quality of surface and ground water, water contamination due to inorganic and organic compounds and the water decontamination technologies and the cultural and management practices for using poor quality water for irrigation

Theory

Natural factors affecting quality of surface water and groundwater, sources and pollution of groundwater; Water quality objectives in relation to domestic, industrial and agricultural activities, drinking water quality standards, irrigation water quality classification as per USSL and AICRP criteria; Point and non-point water pollution sources; Water contamination due to inorganic and organic compounds, water contamination related to agricultural chemicals, food industry, hydrocarbon and synthetic organic compounds; Arsenic and fluoride contamination in groundwater and remedial measures; Water decontamination technologies; Cultural and management practices for using poor quality water for irrigation.

Practical

Water quality analysis and classification according to USSL and AICRP criteria; Soil chemical analysis and estimation of lime and gypsum requirements; Study of salinity development under shallow and deep water table conditions; Study of saline water ingress in coastal areas; Study of contamination movement and transport in soil profile; Study of turbidity of water through turbidity meter; Study of different water decontamination techniques; Study of different cultural and management practices for using poor quality water for irrigation; Visit to a water treatment plant; Visit to a water quality laboratory; Field visit to industrial effluent disposal sites.

Suggested Readings

1. FAO. 1996. Control of Water Pollution from Agriculture - FAO Irrigation and Drainage. Paper 55.
2. Gray, N. F. 2010. Water Technology. CRC Press.
3. Hussain, S. K. 1986. Text Book of Water Supply and Sanitary Engineering. Oxford & IBH Publishing Co. New Delhi.
4. Manahan, S. E. 2009. Fundamentals of Environmental Chemistry. CRC Press, New York.
5. McGauhey, P. H. 1968. Engineering Management of Water Quality. McGraw Hill Book Company, New York.
6. Minhas, P. S. and Tyagi, N. K. 1998. Guidelines for Irrigation with Saline and Alkali Waters. Bull. No, 1/98, CSSRI, Karnal, p. :36
7. Punmia, B. C. and Lal, P. B. B. 1981. Irrigation and Water Power Engineering. Standard Publishers Distributors, Delhi.

17. Landscape Irrigation Design and Management (IDE 454) 3 (2+1)

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, shrub adopter, 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 landscaping 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.

18. Application of Plastics in Agriculture (AE 451) 3 (2+1)

Objective

To enable the students to understand the applications in moisture conservation, canal and pond lining, use of plastic pipes in irrigation and drainage; know about soil solarisation, mulching, covering materials in green houses, shade houses, poly houses, surface covered cultivation, plastic fencing, nets for insects, birds etc. and in food grain structures, packaging materials, aquaculture, etc.

Theory

Introduction of plasticulture- types and quality of plastics used in soil and water conservation, production agriculture and post-harvest management, present status and future prospective of plasticulture in India, quality control measures; Water management- use of plastics in in-situ moisture conservation and rain water harvesting; Plastic film lining in canal, pond and reservoir, plastic pipes for irrigation water management, bore-well casing and subsurface drainage, drip and sprinkler irrigation systems, use of polymers in control of percolation losses in fields; Soil conditioning- soil solarisation, effects of different colour plastic mulching in surface covered cultivation; Nursery management- use of plastics in nursery raising, nursery bags, trays, etc.; Controlled environmental cultivation- plastics as cladding material, green / poly / shade net houses, wind breaks, poly tunnels and crop covers; Plastic nets for crop protection- anti insect nets, bird protection nets, plastic fencing. Plastics in drying, preservation, handling and storage of agricultural produce, innovative plastic packaging solutions for processed food products, Plastic CAP covers for storage of food grains in open; Use of plastics as alternate material for manufacturing farm equipment and machinery; Plastics for aquacultural engineering and animal husbandry- animal shelters,

vermi-beds and inland fisheries; Silage film technique for fodder preservation; Agencies involved in the promotion of plasticulture in agriculture at national and state level. Human resource development in plasticulture applications.

Practical

Design, estimation and laying of plastic films in lining of canal, reservoir and water harvesting ponds; Study of plastic components of drip and sprinkler irrigation systems, laying and flushing of laterals; Study of components of subsurface drainage system; Study of different colour plastic mulch laying; Design, estimation and installation of green, poly and shade net houses, low tunnels, etc; Study on CAP device for food grain storage; Study of innovative packaging solutions – leno bags, crates, bins, boxes, vacuum packing, unit packaging, CAS and MAP; Study on use of plastics in nursery, plant protection, inland fisheries, animal shelters; Preparation of vermi-bed and silage film for fodder preservation; Study of plastic parts in making farm machinery; Visits to nearby manufacturing units/ dealers of PVC pipes, drip and sprinkler irrigation systems, greenhouse/ polyhouse/shade-house/ net-house etc; Visits to farmers' fields with these installations.

Suggested Readings

1. Brown, R. P. 2004. Polymers in Agriculture and Horticulture. RAPRA Review Reports: Vol. 15,No. 2, RAPRA Technology Limited, U.K.

2. Central Pollution Control Board. 2012. Material on Plastic Waste Management. Parivesh Bhawan, East Arjun Nagar, Delhi.

3. Charles A. Harper. 2006. Handbook of Plastics Technologies. The Complete Guide to Properties and Performance. McGraw-Hill, New Delhi.

4. Chanda, M. and Roy, S. K. 2008. Plastics Fundamentals, Properties, and Testing. CRC Press.

5. Dubois. 1978. Plastics in Agriculture. Applied Science Publishers Limited, Essex, England.

6. Ojha, T. P. and Michael, A. M. 2012. Principles of Agricultural Engineering - I. Jain Brothers, Karol Bagh, New Delhi.

7. Pandey, P. H. 2014. Principles and Practices of Agricultural Structures and Environmental Control. Kalyani Publishers, Ludhiana, India.

8. Shankar, A. N. 2014. Integrated Horticulture Development in Eastern Himalayas. Plasticulture in Agri-Horticulture Systems, 241-247.

9. Singh, Brahma, Singh, B., Sabir, N. and Hasan, M. 2014. Advances in Protected Cultivation. New India Publishing Agency, New Delhi.

10. Srivastava, R. K., Maheswari, R. C., Ojha, T. P. and Alam, A. 1988. Plastics in Agriculture. Jain Brothers, Karol Bagh, New Delhi.

19. Precision Farming Techniques for Protected Cultivation (HORE 451) 3 (2+1)

Objective

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, history, origin, 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; Root media- types, soil and soilless media, composition, estimation, preparation and disinfection, bed preparation. Planting techniques in green house cultivation; 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; Insect and disease management in greenhouse and net houses; Selection of crops for greenhouse cultivation, major crops in greenhouse- irrigation requirement, fertilizer management, cultivation, harvesting and post-harvest techniques; Economic analysis.

Practical

Estimation of material requirement for construction of greenhouse; Determination of fertilization schedule and rate of application for various crops; Estimation of material requirement for preparation of root media; Root media preparation, bed preparation and disinfections; Study of different planting techniques; 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; Economic analysis of greenhouses and net houses; 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.

20. Environmental Engineering (CE 452) 3 (2+1)

Objective

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.

21. Development of Processed Food Products (PFE 451) 3 (2+1)

Objective

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.

22. Food Packaging Technology (PFE 452) 3 (2+1)

Objective

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 watervapour 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.

23. Food Plant and Equipment Design (PFE 453) 3 (2+1)

Objective

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.

24. Emerging Technologies in Food Processing (PFE 454) 3 (3+0)

Objective

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

25. Processing of Livestock, Fish and Marine Products (PFE 455) 3 (2+1)

Objective

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.

26. Food Business Management and Entrepreneurship Development (AGE 451) 3 (3+0)

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

27. MATLAB Programming (EE 452) 3 (1+2)

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.

28. Python Programming (CSE 451) 3 (1+2)

Objective

1. To enable the students to know the different features of Python programming and have handson exercise on it
2. To use the Python programming for different agricultural engineering applications

Theory

Introduction: history, applications, installation. Variables, data types, keywords, literals, operators, comments. Conditional statements: if else, loops, for loop, while loop, break, continue, pass. strings, lists, tuples, list vs tuple. Functions: functions, built-in functions, lambda functions. Files I/O, modules, exceptions, date, Regex, read CSV File, write CSV File, read excel file, write excel file, assert, list comprehension, collection. Module, math module, OS module, random module, statistics module, sys module, IDEs, arrays, command line arguments, stack and queue. Python OOPs: OOPs concepts, object class, constructors, inheritance, abstraction.

Practical

Hands on experience with Python and its installation on different platforms; Accessing python from GUI and from command prompt / terminal, a project based on real time agricultural engineering problems.

29. Artificial Intelligence Applications (CSE 452) 3 (2+1)

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, highlevel 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.
2. Rich, E. and Knight, K. 1991. Artificial Intelligence. Times McGraw-Hill.

3. Russell, S. and Norvig, P. 1998. Artificial Intelligence: A Modern Approach. Prentice Hall.

4. Winston, P. H. 1992. Artificial intelligence. Addition Wesley 3rd edn.

30. Advances in Automation and Robotics in Agriculture (EE 453) 3 (2+1)

Objective

To enable the students to gain advanced knowledge and skill for application of automation and robotics in agriculture, know about the modelling of robot mechanisms, robot control architectures and robot design and considerations for agricultural operations

Theory

Sensors and sensor-driven robot Control, Robot Sensors, Proximity sensors- Infrared sensors, Ultrasonic sensor, Laser range finder, Robot Vision sensors- RGB camera, Thermal Camera, Multispectral sensor, Hyperspectral sensor, Stereo vision system, Optical flow sensor, GPS sensor-RTK, PPK. Sensor noise and uncertainty- Sensor uncertainty, Non-observability, Action uncertainty. Introduction to Robotics and its importance in Agriculture, classification of robots (Anatomy), Automation and Robotics in Intelligent Environments, History of Robotics, Robot manipulators, Mobile robots, Walking Robot, Humanoid Robots, Autonomous Robots, Traditional Industrial Robots, Requirements for Robots in Intelligent Environments, Status and scope in Agriculture; Modeling of robot mechanisms, Kinematics, Dynamics, Robot sensor selection, Active and passive proximity sensors, Low-level control of actuators, Closed-loop control, Control architectures, Traditional planning architectures, Behavior-based control architectures, and Hybrid architectures. Modeling the Robot Mechanism, Forward kinematics, Inverse kinematics, Jacobian calculation, and Mobile Robot Odometry. Robot Actuator Control system, Mass, inertia, friction and force, frequent actuators, control approach Proportional, PI, and PID control, Actuators- DC motor, BLDC motor, Linear actuator, Servomotor, Stepper motor, Drivers and control algorithms. Ground Control station system, Transmitters, and receivers, PWM, PPM signal, telemetry system, band, and frequency. Transmitter, receiver, PWM, PPM, Telemetry system, band and frequency; Robot Navigation, Path planning addresses and computing a trajectory, Algorithms, and control navigation, mission planning and control, Geofencing, Triggering, Software for robot control and navigation, Probabilistic Robot Localization- Localization, Mapping, and Model Building; Robot Control Architectures, Deliberative Control Architecture-Perception, modeling, planning, task execution and motor control, Advantages, and disadvantages; Behavior-Based Robot Control Architectures, Reactive, Behavior-Based Control Architectures, Hybrid Control Architectures, Intuitive Robot Interfaces-Graphical programming interfaces, Deictic (pointing) interfaces, Voice recognition and reaction. AI adaptation and Learning for Robots-Supervised learning, Learning Sensory Patterns -Neural networks, Decision trees, Reinforcement Learning, AI programming techniques. Classical AI, the concept of expert system, conflict resolution, multiple rules, forward chaining, and backward chaining. Advantages and disadvantages of expert system. Robot design and considerations for agricultural operations, Robots for Seedbed preparation, sowing and transplanting, weeding operation-mechanical and chemical, fruit harvesting, robots for greenhouse application, moisture management, post-harvest losses management, dairy and food packaging, humanoid robots, cattle and poultry farm management, VRT robots, Driverless Autonomous tractor.

Practical

Demonstration of different types of robots and their use in agricultural operations; Robot mechanisms, forward kinematics, inverse kinematics calculations and modelling; PID control of actuators and their calibration for precise control; Practical on robot actuator control systems for determination of mass, inertia, friction, and forces; Calibration of PID controllers for close-loop controls of the system; Mission planning and computation of trajectory for a robot through Python coding and other software; Sensor-driven robot control for obstacle avoidance using different sensors; Calibration of GPS sensors and 3-D

fixing for precise control; Robot control architecture design, control, and behavior study; Robot-supervised learning for sensory patterns to detect leaves, flowers, fruit, animal, human body, etc; Robot design consideration for sowing and transplanting operation; Robot design for weeding operation; Robotic arm design for fruit detection and harvesting; Robotic prime mover design for greenhouse operations for selected crops; Automation of machines for food packaging; Robots for food control and cleaning in cattle and poultry farms; Robots for variable rate application of agricultural inputs; Driverless and autonomous tractor for straight control calibration of movement; Control of humanoid robots for selected agricultural operations and active voice command control.

Suggested Readings

1. Ben-Ari, Mordechai and Mondada, Francesco. Elements of Robotics. Springer Nature, 2017.
2. Braunl, T. Embedded Robotics Mobile Robot Design and Applications with Embedded Systems. Springer Berlin Heidelberg, 2013.
3. Craig, John J. Introduction to Robotics Mechanics and Control. 5 Pearson Education, Inc. Pearson Prentice Hall Pearson Education, Inc. Upper Saddle River, NJ, 2005.
4. Miller, Mark R. and Miller, Rex. Robots and Robotics, Principles, Systems, and Industrial Applications. McGraw-Hill Education, 2017.
5. Schilling, Robert. J. Fundamentals of Robotics – Analysis and Control. Prentice Hall of India,1990.
6. Siegwart, Roland, Nourbakhsh, Illah Reza and Scaramuzza, Davide. Introduction to autonomous Mobile Robots. MIT press, 2011.
7. Zhang, Dan, and Bin Wei, eds. Robotics and mechatronics for agriculture. CRC Press, 2017.

31. Machine Learning (CSE 453) 3 (2+1)

Objective

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, Vapnik Chernonenkis 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. Sarah Guido, O' Reilly

3. Muller, J P. and Massaron, L. 2021. Machine Learning for Dummies. 2nd edn. Weily.

32. Operations Research (MTH 451) 3 (3+0)

Objective

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).

Suggested Readings

1. Taha, H. 2003. Operations Research. Macmillan Publishing Company.

2. Winston, W. L. 2004. Operations Research: Applications and Algorithms. Indian University.

33. Mechatronics (EE 454) 3 (2+1)

Objective

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, microcontrollers, 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.

34. Natural Fibres: Extraction and Properties (AGE 452) 3 (2+1)

Objective

To enable the students to

1. Importance of natural fibres and the quality management of natural textile fibres
2. Understand the properties of different types of natural fibres and their extraction methods
3. Understand the different equipment involved in natural fibres extraction

Theory

Introduction to Natural Fibres: Natural fibres definition, Detailed Classification; Natural fibres‑physical and chemical properties, Advantages and disadvantages of Natural Fibres; Plant Fibres; Animal Fibres; Applications of Natural Fibres. Identification, characterization and quality management of natural textile fibres. Cotton: Types, Morphology, Physical and Chemical properties, grading and marketing, Organic and Bt cotton, processing and utilization; Wool: types, Morphology, Physical and Chemical Properties, grading and marketing processing and application; Jute: Cultivation- Extraction and Retting methods, physical and mechanical properties, grading and marketing, significance of Jute in Packaging. diversified application of jute; Other (Natural) Textile Fibres: Long Vegetables fibres, Cultivation and extraction of Flax, Sisal, Pineapple leaf, Maize, banana, hemp; Physical and Chemical Properties, grading and marketing, processing and end use application. Silk: Types of Silk, Cultivation of mulberry, production of silk cocoon, storage, Sorting, cooking, brushing, reeling (Methods and Machines), morphology, Physical and Chemical Properties, grading and marketing, processing-degumming and weighting. Physical Properties of Natural fibres: Fibre Morphology; Fibre length, diameter, l/b ratio and its significance; concept of denier and tex; colour and lustre, Fibre defects and root content; cross sectional study of fibres; yarn count, moisture regain, thermal behavior; Mechanical Properties: Stress-stain curve, tenacity, elongation, tensile modulus, bundle strength, compressional and resilience properties.

Practical

Identification of natural fibres; Extractions of jute, cotton, flax, banana, sisal and ramie; Retting of Jute and Flax; Quality evaluation of jute and other fibres; Determination of mechanical and insulation properties.

Suggested Readings

1. Cook, J. G. 2005. Hand Book of Textile Fibers. Wood Head Publishers, London, Vol 1 & 2
2. Corbmann, P. B. 2001. Textile Fiber to Fabric. Mc Graw-Hill International Education, 6th edn.
3. Gohl and Vilensky. 2003. Textile Science. 2nd edn. Mahajan Book Publishers,
4. Mishra, S.P. 1998. Fibre Science and Technology. New Age India International Ltd. New Delhi.
5. Shenai, V. A. 2004. Technology of Textile Processing- Textile Fibers. Sevak Publications.
6. Sreenivasa Murthy, H.V. 1994. Introduction Textile Fibres. Textile Association of India, Bombay.
7. Tammanna and Sonwalkar, N. 2002. Handbook of Silk Technology. Wiley Eastern Limited, New Delhi.

35. Natural Fibre Applications in Agriculture (AGE 453) 3 (2+1)

Objective

To enable the students to

1. Know the different applications of natural fibres such as in soil and water conservation, packaging, energy production and soil less farming, etc.
2. Understand the economics of using natural fibres for these applications

Theory

Natural Fibre based Agrotextiles, Characterization and their application: Overview of Agrotextile, Technical Textile, Non-woven technology, Design principles for Natural Fibre based Agrotextiles, Tensile and Hydro-physical properties, Estimation techniques, Application as crop mulch, Effect on soil properties, Measurement of soil hydrothermal regime, Effects on crop yield, Effects on soil moisture retention and weed population, Application as shade net, Biodegradability, Life cycle and environmental impact, Economic evaluation. Natural Fibre based Geotextiles, Characterization and their application: Overview of Geotextile in soil and water conservation, Woven technology, Design principles for Natural Fibre based Geotextiles (Coir, jute, bamboo etc), Blended Geotextiles its application and case studies, Tensile and Hydro-physical properties, Estimation techniques, Application as soil saver, Effect on soil degradation properties, Factors affecting soil erosion, Rainfall erosivity and indices, Wischmeir' s equation for its prediction, isoerodent map of India, Soil erodibility and its measurement, Method of soil loss estimation and measurement (USLE and RUSLE), Water erosion prediction programme (WEPP), sediment transport equations, runoff measurement, sediment measurement (multislot divisor),Concept of integrated watershed management and role of RS and GIS, Bioengineering, Role of jute, coir and bamboo based geotextile in soil conservation, Reinforcement, Biodegradability, Life cycle and environmental impact, Economic evaluation. Natural Fibre based sustainable packaging for Agricultural/Horticultural produce: Overview of the packaging industry and current packaging materials, Principle behind packaging of perishable crop produce, Characteristics and properties of natural fibers suitable for packaging, Natural fibre based Green composite and their role in packaging, Design principles for natural fiber-based packaging, natural fibre-based reaper binder, Advantages and limitations of natural fiber-based packaging compared to synthetic alternatives, Biodegradable plastics for packaging agricultural produce. Life cycle assessment and environmental impact analysis, Government policies and regulations related to sustainable packaging. Potential of natural fibers as a source of renewable energy: Characteristics of natural fibers and their suitability as a source of renewable energy, Methods of converting natural fibers into energy, such as combustion and gasification, Economic and environmental analysis of natural

fiber-based renewable energy systems, Comparison of natural fiber-based energy systems with other renewable energy sources, Government policies and incentives related to renewable energy (Bioethanol). Role of Natural Fibre in Organic and Soilless Farming: Overview of organic and natural farming, soilless farming, natural fibre waste, characterization of waste, different methods of compost preparation, role of fibre waste as compost, Characteristics of natural fibers and their suitability as a source of soilless media, Effect on crop yield, Biodegradability, Life cycle and environmental impact, Economic evaluation.

Practical

Preparation of woven and nonwoven fabrics; Estimation of different mechanical and hydrophysical properties; Agro-textile field trial/experiment; Natural fibre-based Packaging; Production of energy from natural fibres.

Suggested Readings

1. Blackburn, R. S. (Ed). 2009. Sustainable Textiles: Life Cycle and Environmental Impact. Woodhead Publishing. ISBN 978-1-84569-453-1.

2. Cheng, H. N., Byron, A. E. and Okos, M. R. (Eds). 2017. Sustainable Fiber-Based Packaging. John Wiley & Sons. ISBN: 978-1-119-17306-4.

3. Fangueiro, R. and Rana, S. (Eds). 2016. Natural Fibre Composites in Geotextiles: Design and Applications. Woodhead Publishing. ISBN: 978-0-08-100215-7

4. Hakeem, K. R., Jawaid, M., and Alothman, O. Y. (Eds). 2019. Biomass and Bioenergy: Processing and Properties. Springer. ISBN: 978-981-13-8562-2.

5. Hardin, M. R. (Ed.). 2007. Natural and Artificial Fiber Nonwoven Textiles. CRC Press. ISBN: 978-0-8493-6454-9.

6. Kozłowski, Ryszard M. (Ed). 2012. Handbook of natural fibres. Volume 2: Processing and applications. Woodhead Publishing Limited. ISBN 978-1-84569-698-6.

7. Tripathy, R.P. and Singh, H.P. (Eds). 1993. Soil Erosion and Conservation. New Age International (P) Limited, Publishers. ISBN: 81-224-0305-0.

36. Processing of Natural Fibres (PFE 456) 3 (2+1)

Objective

To enable the students to

1. Understand the chemical composition of natural fibres and their conversion methods
2. Understand the different mechanical and chemical processing methods of natural fibres
3. Know about the different value addition methods for natural fibres

Theory

Concept of spinning: Hand spinning system; Charkha spinning system; Concepts and working principles of ginning, opening, cleaning and blending. Concept of Yarn Manufacture: cotton system, woolen system, worsted system, jute system, flax (wet) system: Blow room, Carding (Flat type and roller-clearer), Drawing machine, roving machine, Ring spinning, Rotor spinning; Modern developments in spinning; Principle of ring doubler and two-for-one twister; Fibre packing density of yarn; Yarn twist and its relation to yarn properties. Stress-strain relation, Mass irregularity. Preparatory weaving: Winding, Warping, Sizing, beaming, drawing and denting; Weaving: Concept of weaving, Handloom, Primary and secondary motions of loom; shedding, picking, Beatup, Loom timing, Take-up and Let-off motions; Type of sheds; Tappet, dobby and jacquard Warp and weft stop motions; Warp protector motion. Shuttle loom, Shuttle-less looms, Basic designs; Basic woven fabric structure and design; Knitting: Concept of knitting, Warp knitting, weft knitting, advances in knitting; Nonwoven: Concept of nonwoven and classification of nonwoven, advances in non-woven preparation. Basic Yarn testing: Count, Twist, tensile strength, CSP, Hairiness, Fabric testing: GSM, EPI, PPI, Tensile strength, tearing strength, Bursting strength, Crease recovery

angle, Stiffness, Air permeability, Thermal conductivity; Fabric hand and comfort; Wetting and wicking; Water-vapour transmission. Chemical composition of plant and animal fibres - Natural and added impurities; Pre-treatment of natural fibre for surface cleaning/ removing impurities - Desizing; Scouring; Degumming; Bleaching- reductive, oxidative; combined scouring and bleaching; Woollenization; Mercerization; fluorescent brightening agents; de-pigmentation; cottonisation; Carbonization, Felting of wool. Value-addition of natural fibre by colouration- Introduction to dyes and pigments; Classification of dyes based on the source and application; Colouration of natural fibres- Direct, Acid, basic, Reactive, Vat, Sulphur, Solubilized and Natural dyes; Measurement of colour parameters; Evaluation of colour fastness against washing, light, bleaching, solvent; Dyeing machine; Dyeing of different textile forms-Hank yarn, Cone, Loose fibre, woven fabric, knitted fabrics and nonwoven fabric; Finishing: Physical, mechanical, physico-mechanical and chemical finishing; temporary and permanent finishing.

Practical

Basic concepts of spinning; Manufacture of yarn from natural fibres; Practical on weaving and knitting; Yarn and fabric testing; Pre-treatments of natural fibres; Bleaching and dyeing of natural fibres; Finishing of natural fibres.

Suggested reading

1. Booth J. E. 1996. Principles of Textile Testing: An Introduction to Physical Methods of Testing Textile Fibres, Yarns and Fabrics. 6th edn. London: Newnes Butterworths
2. Brown, R. 1978. Weaving, Spinning and Dyeing Book. London: Routledge and Kegan Paul.
3. Cegarra, J. P. and Valladperas, J. 1992. The Dyeing of Textile Manual, the Scientific Bases and the Techniques of Application. Italy: NecovaOflito.
4. Corbman, B. P. 1983. Fibre to Fabric step by Step Weaving. 6th edn. New York: McGraw Hill.
5. David G, Sinclair, Roy, S. 1989. Giles Laboratory Course in Dyeing. 4th edn. London: Society of Dyers and Colourist.
6. Eichhorn SJ, Hearle JWS, Jaffe M, and Kikutani T. 2009. Handbook of Textile Fibre Structure: Fundamentals and Manufactured Polymer Fibres, Volume 1 in Woodhead Publishing Series in Textiles.
7. Fannin and Allen, A. 1979. Handloom Weaving Technology. New York: Van Nostrand Reinhold.
8. Jarman, C. 1998. Plant Fibre Processing: A Handbook. eBook 9781780442990, pp.64
9. Ponting, K. G. 1981. A Dictionary of Dyes and Dyeing. London: Bell and Hymen Ltd.
10. Rouette, H. K. 2001. Encyclopaedia of Textile Finishes. Berlin: Springer Verlag.
11. Saville, B. P. 1999. Physical Testing of Textiles. Woodhead publication. CRC Press.
12. Shenai, V. A. 1985. Technology of Dyeing: Technology of Textile Processing. Vol. VI. Sevak Publication.
13. Shenai, V. A. 1985. Technology of Printing: Technology of Textile Processing. Vol. IV. Sevak Publication.

37. Agricultural Marketing and Trade (AGE 454) 3 (2+1)

Objective

To enable the students to

1. understand the fundamentals of agricultural marketing and trade
2. analyze the factors influencing supply and demand in agricultural markets
3. explore different marketing channels and strategies in agriculture
4. examine the role of government policies and regulations in agricultural markets

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets; demand, supply and producer's

surplus of agri commodities: nature and determinants of demand and supply of farm products, producer' s surplus - meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; pricing and promotion strategies: pricing considerations and approaches - cost based and competition based pricing; market promotion - advertising, personal selling, sales promotion and publicity -meaning, merits and demerits; marketing process and functions: Marketing process concentration, dispersion and equalization; exchange functions - buying and selling; physical functions - storage, transport and processing; facilitating functions - packaging, branding, grading, quality control and labelling (Agmark); Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; number of channel levels; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing: Public sector institutions-CWC, SWC, FCI, CACP and DMI - their objectives and functions; cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for innovations in agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. Present status and prospects of international trade in agri-commodities; WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR. Role of government in agricultural marketing. Role of APMC and its relevance in the present day context.

Practical

Plotting and study of demand and supply curves and calculation of elasticities; Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit to market institutions -NAFED, SWC, CWC, cooperative marketing society, etc. to study their organization and functioning. Application of principles of comparative advantage of international trade.

Suggested Readings

□□Acharya, S.S. and Agarwal, N.L. 2006. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

□□Chinna, S. S. 2005. Agricultural Economics and Indian Agriculture. Kalyani Pub, N Delhi.

□□Dominic Salvatore. Micro Economic Theory.

□□Kohls Richard, L. and Uhl Josheph, N. 2002. Marketing of Agricultural Products. Prentice-Hall of India Private Ltd., New Delhi.

□□Kotler and Armstrong. 2005. Principles of Marketing. Pearson Prentice-Hall.

□□Lekhi, R. K. and Singh, J. 2006. Agricultural Economics. Kalyani Publishers, Delhi.

□□Memoria, C.B., Joshi, R.L. and Mulla, N.I. 2003. Principles and Practice of Marketing in India. Kitab Mahal, New Delhi.

□□Pandey, M. and Tewari, D. 2004. Rural and Agricultural Marketing. International Book Distributing Co. Ltd, New Delhi.

□□Sharma, R. 2005. Export Management. Laxmi Narain Agarwal, Agra.

End