B.E. AGRICULTURE ENGINEERING
Regulations 2016

SEMESTER I

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16HE1101	Essential English for Engineers	3	2	0	4	25	75	100	HS
2	19MA1101	Engineering Mathemeatics-I Matrices and Calculus	3	2	0	4	25	75	100	BS
3	16PH1101	Engineering Physics	3	0	0	3	25	75	100	BS
4	16CY1101	Engineering Chemistry	3	0	0	3	25	75	100	BS
5	16GE1102	Engineering Graphics	2	0	4	4	25	75	100	ES
6.	16GE1103	Problem Solving and Python Programming	3	0	0	3	25	75	100	ES
PRACTICAL										
7	16PH1001	Physical Sciences Lab-I	0	0	0	1	50	50	100	BS
8	16GE1004	Problem Solving and Python Programming Laboratory	0	0	4	2	50	50	100	ES
9	16GE1002	Engineering Practices Laboratory	0	0	4	2	50	50	100	ES
10	16HE1003	Value Added Course-I Language competency enhancement course - I	0	0	1	0	0	100	100	HS
		Total	**17**	**4**	**14**	**27**			**1000**	

SEMESTER II

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16HE2102	Essential English for Engineers – II	3	2	0	4	25	75	100	HS
2	16MA2102	Engineering Mathematics-II (Vector Calculus, Complex Variables and Laplace Transforms)	3	2	0	4	25	75	100	BS

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3	16CY2102	Environmental Science	3	0	0	3	25	75	100	BS
4	16EE2201	Basics of Electrical and Electronics Engineering	3	0	0	3	25	75	100	ES
5	16GE2101	Engineering Mechanics	3	2	0	4	25	75	100	ES
6.	16AG2201	Principles and Practices of Crop Production	3	0	0	3	25	75	100	PC
PRACTICAL										
7	16PS2001	Physical Sciences Laboratory II	0	0	2	1	50	50	100	BS
8	16AG2001	Crop Husbandry Laboratory	0	0	4	2	50	50	100	PC
9	16GE2001	Value Added Course II Language Competency Enhancement Course-II	0	0	0	1	0	100	100	HS
		Total	**17**	**4**	**14**	**27**			**1000**	

SEMESTER III

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16MA3111	Fourier analysis and Z transforms	3	1	0	4	25	75	100	BS
2	16AG3201	Soil Science and Engineering	3	0	0	3	25	75	100	PC
3	16AG3202	Fluid Mechanics and Hydraulics	3	1	0	4	25	75	100	ES
4	16ME3232	Theory of Machines	3	0	0	3	25	75	100	ES
5	16CE3207	Surveying and Leveling	3	0	0	3	25	75	100	ES
6.	16ME3233	Thermodynamics	3	1	0	4	25	75	100	ES
PRACTICAL										
7	16AG3001	Fluid Mechanics Laboratory	0	0	4	2	50	50	100	ES
8	16CE3004	Surveying and Leveling Laboratory	0	0	4	2	50	50	100	ES
		Total	**18**	**3**	**8**	**25**			**800**	

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SEMESTER IV

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16MA4112	Applied Statistics and Numerical methods	3	0	2	4	25	75	100	BS
2	16AG4201	Unit Operations in Agricultural Processing	3	0	0	3	25	75	100	PC
3	16AG4202	Farm Tractors	3	0	0	3	25	75	100	PC
4	16AG4203	Hydrology and Water Resources Engineering	3	0	0	3	25	75	100	PC
5	16AG4204	Irrigation and Drainage Engineering	3	0	0	3	25	75	100	PC
6	16ME4231	Strength of Materials	3	0	0	3	50	50	100	ES
PRACTICAL										
7	16AG4001	Soil Science Laboratory	0	0	4	2	50	50	100	PC
8	16AG4002	Irrigation Field Laboratory	0	0	4	2	50	50	100	PC
		Total	**18**	**0**	**10**	**23**			**800**	

SEMESTER V

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16AG5201	Refrigeration and Cold chain management	3	0	0	3	25	75	100	PC
2	16AG5202	Farm Machinery and Equipment	3	0	0	3	25	75	100	PC
3	16AG5203	Design of Farm Implements and Machinery	3	0	0	3	25	75	100	PC
4	16AG5204	Post Harvest Technology	3	0	0	3	25	75	100	PC
5	16AG53XX	Professional Elective – I	3	0	0	3	25	75	100	PE

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PRACTICAL										
6	16AG5001	Operation and Maintenance of Farm Machinery Laboratory	0	0	4	2	50	50	100	PC
7	16AG5002	Post-Harvest Engineering Laboratory	0	0	4	2	50	50	100	PC
		Total	**18**	**2**	**8**	**19**			**800**	

SEMESTER VI

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16AG6201	Soil and Water Conservation Engineering	3	0	0	3	25	75	100	PC
2	16AG6202	Food and Dairy Engineering	3	0	0	3	25	75	100	PC
3	16AG6203	Precision Farming and Protected Cultivation	3	0	0	3	25	75	100	PC
4	16AG6204	Bio-Energy Resource Technology	3	0	0	3	25	75	100	PC
5	16AG63XX	Professional Elective – II	3	0	0	3	25	75	100	PE
6	16XX64XX	Open Elective-I	3	0	0	3	25	75	100	OE
PRACTICAL										
7	16AG6001	CAD for Agricultural Engineering	0	0	4	2	50	50	100	PC
8	16AG6002	Drawing of Farm Structures	0	0	4	2	50	50	100	PC
9	16AG6003	Food and Dairy Engineering Laboratory	0	0	4	2	50	50	100	PC
		Total	**18**	**0**	**12**	**24**			**900**	

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SEMESTER VII

Sl.No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16AG7201	Groundwater and Well Engineering	3	0	0	3	25	75	100	PC
2	16AG7202	Remote Sensing and Geographical Information System	3	0	0	3	25	75	100	PC
3	16AG7203	Solar and Wind Energy Engineering	3	0	0	3	25	75	100	PC
4	16AG7204	Agricultural Extension	3	0	0	3	25	75	100	PC
5	16AG73XX	Professional Elective -III	3	0	0	3	25	75	100	PE
6	16AG73XX	Professional Elective -IV	3	0	0	3	25	75	100	PE
7	16XX74XX	Open Elective - II	3	0	0	3	25	75	100	OE
PRACTICAL										
8	16AG7001	GIS Laboratory for Agricultural Engineers	0	0	2	1	50	50	100	PC
9	16AG7002	Renewable Energy Laboratory	0	0	4	2	50	50	100	PC
10	16AG7003	ICT in Agricultural Engineering	0	0	4	2	50	50	100	PC
11	16AG7701	Industrial Training / Technical Seminar	0	0	0	2	0	100	100	EEC
		Total	**18**	**4**	**10**	**28**			**1000**	

SEMESTER VIII

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16AG83XX	Professional Elective – V	3	0	0	3	25	75	100	PE
2	16AG83XX	Professional Elective-VI	3	0	0	3	25	75	100	OE

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PRACTICAL										
3	16AG8901	Project Work	0	0	20	10	100	100	200	EEC
		Total	**6**	**0**	**20**	**16**			**400**	

CREDITWISE SPILT-UP

Category	SEM I	SEM II	SEM III	SEM IV	SEM V	SEM VI	SEM VII	SEM VIII	Total credit
Humanities	5	5							10
Basic science	11	8	4	4					27
Engineering Science	11	7	18	3					39
Professional core		5	3	16	16	18	17		75
Professional Elective					3	3	6	6	18
Open Elective						3	3		6
Project work							2	10	12
Total	**27**	**25**	**25**	**23**	**19**	**24**	**28**	**16**	**187**

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LIST OF PROFESSIONAL ELECTIVES

SEMESTER V **Professional Elective -I**

COURSE CODE	COURSE TITLE
16AG5301	Systems Analysis and Soft Computing in Agricultural Engineering
16AG5302	Sustainable Agriculture and Food Security
16AG5303	CDM and Carbon Trading Technology
16AG5304	IT in Agricultural Systems
16AG5305	Evapotranspiration and Smart Irrigation

SEMESTER VI **Professional Elective-II**

COURSE CODE	COURSE TITLE
16AG6301	Climate Change and Adaptation
16AG6302	Heat and Mass Transfers for Agricultural Engineers
16AG6303	Disaster Management
16AG6304	Horticultural Crop Processing

SEMESTER VII **Professional Elective-III**

COURSE CODE	COURSE TITLE
16AG7301	Industrial Waste Water Management
16AG7302	Ergonomics and Safety in Agricultural Engineering
16AG7303	On Farm Water Management
16AG7304	Watershed Hydrology and Management

SEMESTER VII **Professional Elective-IV**

COURSE CODE	COURSE TITLE
16AG7305	Application of Drone Technology in Agriculture
16AG7306	Dairy Process Technology
16AG7307	Storage and Packaging Technology
16AG7308	Process Engineering of Fruits and Vegetables

SEMESTER VIII **Professional Elective-V**

COURSE CODE	COURSE TITLE
16AG8301	Agricultural Business Management and Entrepreneurship

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16AG8302	Agricultural Economics and Farm Managements
16AG8303	Intellectual Property Rights
16AG8304	Agricultural Waste Management

SEMESTER VIII **Professional Elective-VI**

COURSE CODE	COURSE TITLE
16AG8305	Special Farm Equipment
16AG8306	Mechanics of Tillage and Traction
16AG8307	Micro Irrigation System
16AG8308	Automation in Irrigation

LIST OF OPEN ELECTIVES

SEMESTER VI **Open Elective-I**

COURSE CODE	COURSE TITLE
16AG6401	Nanotechnology in Agriculture

SEMESTER VII **Open Elective-II**

COURSE CODE	COURSE TITLE
16AG7401	Emerging Technologies in Food Process Engineering

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HUMANITES

S.No.	SEM	COURSE CODE	COURSE TITLE	CREDIT
1	I	16HE1101	Essential English for Engineers –	4
2	I	16HE1003	Value Added Course I- Language Competency Course-I	1
3	II	16HE2102	Essential English for Engineers - II	4
4	II	16HE	Value Added Course II- Language Competency Course-II	1
			TOTAL	**10**

BASIC SCIENCES

S.No.	SEM	COURSE CODE	COURSE TITLE	CREDIT
1	**I**	19MA1101	Engineering Mathemeatics-I Matrices and Calculus	**4**
2	**I**	16PH1101	Engineering Physics	**3**
3	**I**	16CY1101	Engineering Chemistry	**3**
4	**I**	16PH1001	Physical Sciences Lab-I	**1**
5	**II**	16MA2102	Engineering Mathematics-II (Vector Calculus, Complex Variables and Laplace Transforms)	**4**
6	**II**	16CY2102	Environmental Science	**3**
7	**II**	16PS2001	Physical Sciences Laboratory II	**1**
8	**III**	16MA3111	Fourier analysis and Z transforms	**4**
9	**IV**	16MA4112	Applied Statistics and Numerical methods	**4**
			TOTAL	**27**

ENGINEERING SCIENCE

S.No.	SEM	COURSE CODE	COURSE TITLE	CREDIT
1	**I**	16GE1102	Engineering Graphics	**4**
2	**I**	16GE1103	Problem Solving and Python Programming	**3**
3	**I**	16GE1004	Problem Solving and Python Programming Lab	**2**
4	**I**	16GE1002	Engineering Practices Lab	**2**
5	**II**	16EE2201	Basics of Electrical and Electronics Engineering	**3**
6	**II**	16GE2101	Engineering Mechanics	**4**
7	**III**	16CE3206	Fluid Mechanics and Hydraulics	**4**
8	**III**	16ME3232	Theory of Machines	**3**
9	**III**	16CE3207	Surveying and Leveling	**3**

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10	**III**	16ME3233	Thermodynamics	**4**
11	**III**	16CE3003	Fluid Mechanics Laboratory	**2**
12	**III**	16CE3004	Surveying and Leveling Laboratory	**2**
13	**IV**	16ME4231	Strength of Materials	**3**
			TOTAL	**39**

PROFESSIONAL CORE

S.No.	SEM	**COURSE CODE**	**COURSE TITLE**	**CREDIT**
1	II	16AG2201	Principles and Practices of Crop Production	**3**
2	II	16AG2001	Crop Husbandry laboratory	**2**
3	III	16AG3201	Soil Science and Engineering	**3**
4	IV	16AG4201	Unit Operations in Agricultural Processing	**3**
5	IV	16AG4202	Farm Tractors	**3**
6	IV	16AG4203	Hydrology and Water Resources Engineering	**3**
7	IV	16AG4204	Irrigation and Drainage Engineering	**3**
8	IV	16AG4001	Soil Science Laboratory	**2**
9	IV	16AG4002	Irrigation Field Laboratory	**2**
10	V	16AG5201	Refrigeration and Cold chain management	**3**
11	V	16AG5202	Farm Machinery and Equipment	**3**
12	V	16AG5203	Design of Farm Implements and Machinery	**3**
13	V	16AG5204	Post Harvest Technology	**3**
14	V	16AG5001	Operation and Maintenance of Farm Machinery Lab	**2**
15	V	16AG5002	Post Harvest Engineering Laboratory	**2**
16	VI	16AG6201	Soil and Water Conservation Engineering	**3**
14	VI	16AG6202	Food and Dairy Engineering	**3**
15	VI	16AG6203	Precision Farming and Protected Cultivation	**3**
16	VI	16AG6204	Bi-Energy Resource Technology	**3**
17	VI	16AG6001	CAD for Agricultural Engineering	**2**
18	VI	16AG6002	Drawing of Farm Structures	**2**
19	VI	16AG6003	Food and Dairy Engineering Laboratory	**2**
20	VII	16AG7201	Groundwater and Well Engineering	**3**
21	VII	16AG7202	Remote Sensing and Geographical Information System	**3**
22	VII	16AG7203	Solar and Wind Energy Engineering	**3**
23	VII	16AG7204	Agricultural Extension	**3**
24	VII	16AG7001	GIS Laboratory for Agricultural Engineers	**1**
25	VII	16AG7002	Renewable Energy Laboratory	**2**
26	VII	16AG7003	ICT in Agricultural Engineering Lab Exercises	**2**
			Total	**75**

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PROFESSIONAL ELECTIVE

S.No.	SEM	COURSE CODE	COURSE TITLE	CREDIT
24	V	16AG53XX	Professional Elective – I	**3**
25	VI	16AG63XX	Professional Elective – II	**3**
26	VII	16AG73XX	Professional Elective-II	**3**
27	VII	16AG73XX	Professional Elective – III	**3**
28	VIII	16AG83XX	Professional Elective – V	**3**
29	VIII	16AG83XX	Professional Elective-VI	**3**
			Total	**18**

OPEN ELECTIVE

S.No.	SEM	**COURSE CODE**	**COURSE TITLE**	**CREDIT**
1	VI	16XX64XX	Open Elective-I	3
2	VII	16XX74XX	Open Elective-II	3
			Total	**6**

PROJECT WORK

S.No.	SEM	COURSE CODE	COURSE TITLE	CREDIT
1	VII	16AG7701	Industrial Training	2
2	VIII	16AG8901	Project Work	10
			TOTAL	**12**

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

SEMESTER I

Programme	Course code	Name of the course	L	T	P	C
B.E/B.Tech	**16HE1101**	**ESSENTIAL ENGLISH FOR ENGINEERS – I**	**3**	**1**	**0**	**4**

COURSE OBJECTIVES	• It fulfills the necessary skills needed in today's global workplaces.
	• Student will be able to interpret and illustrate formal communication.
	• It empowers students in choosing right lexical techniques for effective presentation
	• It equips the learner to analyze and list out things in logical order
	• The learner develops the ability to create and integrate ideas in a professional way.

UNIT	DESCRIPTION	Instructional Hours
I	Getting to know people – Introduction – Talking about jobs (Present Simple) – Talking about working conditions(Adverb of Frequency) - Talking about company history and structure (Past simple, Prepositions of Time) – Talking about company activities (Connectors of addition and contrast, Present Continuous) – Focus on language – Parts of Speech – Gerund and Infinitives – Instruction-General Vocabulary.	12
II	Vocabulary practice – (Telephoning Leaving and taking messages) – requests and obligation – Describing trends (Adjectives and Adverbs) – Talking about company performance (present perfect and past simple, Reasons and consequences) – Reading Test Practice Describing products Dimensions, (Comparatives and Superlatives, Question formation) – Talking about product development (Sequencing words, Present continuous and going to) – Articles – Prepositions- Synonyms – Antonyms- Recommendations-Interpretation of a chart.	12
III	Talking about business equipment (Giving Instruction) – Letter Phrases-Writing Test Practice- Talking about facilities(Asking for and giving direction)- Presentation on a general topic -Talking about traffic and transport(making predictions)-Discussion on current affairs– Tenses- Present –Past-Future-Forms of verbs- Word techniques- Formation-Prefixes-Suffixes.	12
IV	Talking about conference arrangement(checking and confirming) – Talking about a conference before, after, when, until etc. – Listening Test Practice-talking about production process – passive- Talking about quality control Conditional 1 (real) (Making suggestions) – Itinery- Jumbled sentences-Paragraph writing- Essay writing – Checklist- Letter to Inviting Dignitaries – Accepting invitation- Declining Invitation.	12
V	Talking about call centers, insurance and changes in working practices (future possibility/probability)- Talking about banking- Speaking Test practice – Talking about delivery services (preposition of Time)- Talking about trading (Tense review)- Talking about recruitment conditional 2 (hypothetical) – talking	12

	about job applications (indirect questions) – Reading, Writing and Listening Test – Job application Letter and Resume Writing- Permission letters.	
	Total Instructional Hours	**60**

COURSE OUTCOMES	CO1: Recognize different parts of speech for better usage.
	CO2: Interpret and illustrate formal communication
	CO3: Choosing right lexical techniques for effective presentation.
	CO4: Analyze and list out things in logical order.
	CO5: Create and integrate ideas in a professional way.

TEXT BOOKS

T1 - Norman Whitby, Cambridge English: Business BENCHMARK Pre-intermediate to Intermediate 2nd Edition. 2014.

T2 - Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2013.

REFERENCE BOOKS

R1 - Meenakshi Raman and Sangeetha Sharma. "Technical Communication-Principles and Practice", Oxford University Press, 2009.

R2 - Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi. 2005R3 - Kamalesh Sadanan "A Foundation Course for the Speakers of Tamil-Part-I &II", Orient Blackswan, 2010.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course code	Name of the course	L	T	P	C
B.E. / B.Tech	**16MA1101**	**ENGINEERING MATHEMATICS – I (Matrices and Calculus) (COMMON TO ALL BRANCHES)**	**3**	**1**	**0**	**4**

COURSE OBJECTIVES	• Develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.
	• Find curvature, evolutes and envelopes using the concept of differentiation.
	• Solve ordinary differential equations of certain types using Wronskian technique.
	• Familiarize the functions of several variables which are needed in many branches of engineering.
	• Understand the concept of double and triple integrals

UNIT	DESCRIPTION	Instructional Hours
I	**MATRICES** Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) – Cayley - Hamilton Theorem (excluding proof) – Orthogonal matrices – Diagonalization of matrices by orthogonal transformation–Reduction of a quadratic form to canonical form by orthogonal transformation.	12

II	**DIFFERENTIAL CALCULUS** Curvature in cartesian co-ordinates – Radius and Centre of curvature - Circle of curvature – Involutes and Evolutes(parabola, ellipse, cycloid, asteroid) – Envelopes - single parameter and two parameter family of curves.	12
III	**ORDINARY DIFFERENTIAL EQUATIONS** Second and higher order linear differential equations with constant coefficients and with RHS of the form e^{ax} , x^n, sinax or cosax , $e^{ax}f(x)$ and xf(x) where f(x) is sinbx or cosbx – Method of variation of parameters – Linear differential equations with variable coefficients (Euler's equation)	12
IV	**FUNCTIONS OF SEVERAL VARIABLES** Total differentiation (excluding implicit functions) - Partial derivatives of composite functions - Taylor's series for functions of two variables- Maxima and minima of functions of two variables - Lagrange's method of undetermined multipliers – Jacobians.	12
V	**MULTIPLE INTEGRALS** Double integrals in Cartesian coordinates – Change of order of integration – Area enclosed by the plane curves (excluding surface area) – Triple integrals in Cartesian co-ordinates – Volume of solids using Cartesian co-ordinates.	12
	Total Instructional Hours	**60**

COURSE OUTCOMES	CO1: Calculate Eigen values and Eigen vectors for a matrix which are used to determine the natural frequencies (or Eigen frequencies) of vibration and the shapes of these vibrational modes
	CO2: Apply the concept of differentiation to find the radius, center and circle of curvature of any curve
	CO3: Develop sound knowledge of techniques in solving ordinary differential equations that model engineering problems
	CO4: Identify the maximum and minimum values of surfaces.
	CO5: Computation of area of a region in simpler way by changing the order of integration and evaluation of triple integrals to compute volume of three dimensional solid structures

TEXT BOOKS

T1- Ravish R Singh, Mukul Bhatt, "Engineeing Mathematics", McGraw Hill education (India) Private Ltd.,Chennai,2017.

T2- Veerarajan T, "Engineering Mathematics–I", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016

REFERENCE BOOKS

R1-Bali N.P & Manish Goyal, "A Text book of Engineering Mathematics", 8th Edition, Laxmi Pub. Pvt. Ltd. 2011.

R2- Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.

R3- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning,2012.

R4-Sivarama Krishna Das P and Rukmangadachari E., "Engineering Mathematics" Vol I, Second Edition, Pearson publishing, 2011.

CHAIRMAN/BOARD OF STUDIES **PRINCIPAL/DEAN ACADEMIC**

Programme	Course code	Name of the course	L	T	P	C
BE	**16PH1101**	**Engineering Physics**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES	• Illustrate the fundamental knowledge in mechanical properties of matter and thermal physics.
	• Gain knowledge about laser and their applications.
	• Conversant with principles of optical fiber, types and applications of optical fiber.
	• Discuss the architectural acoustics and applications of Ultrasonics.
	• Extend dual nature of matter and the Necessity of quantum mechanics to explore the behavior of sub atomic particles.

UNIT	DESCRIPTION	Instructional Hours
I	**PROPERTIES OF MATTER AND THERMAL PHYSICS** Elasticity – Hooke‘s law – Stress-strain diagram - Relation between three modulii of elasticity (qualitative) — Poisson‘s ratio – Bending moment – Depression of a cantilever – Derivation of Young‘s modulus of the material of the beam by Uniform bending – I-shaped girder. Modes of heat transfer – Thermal conductivity – Newton’s law of cooling - Lee’s disc method - Conduction through compound media (series and parallel).	9
II	**LASER AND APPLICATIONS** Spontaneous emission and stimulated emission – Population inversion – Pumping methods – Derivation of Einstein‘s coefficients (A&B) – Types of lasers – Nd:YAG laser, CO2 laser, Semiconductor lasers:(homojunction and heterojunction) – Laser Applications – Industrial applications: laser welding, laser cutting, laser drilling – Holography – Construction and reconstruction of images.	9
III	**FIBER OPTICS AND APPLICATIONS** Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index, modes and materials) – Crucible-crucible technique for fiber fabrication – Sources (LED and LASER) and detectors (p-i-n photodiode and avalanche photodiode) for fiber optics - Fiber optical communication link –Fiber optic sensors – Temperature and displacement sensors.	9
IV	**ACOUSTICS AND ULTRASONICS** Classification of sound – Weber–Fechner law – Sabine‘s formula (no derivation) - Absorption coefficient and its determination –Factors affecting acoustics of buildings and their remedies. Ultrasonic Production – Magnetostrictive generator – Piezoelectric generator – Determination of velocity using acoustic grating – Non destructive testing – Ultrasonic pulse echo system.	9
V	**QUANTUM PHYSICS AND APPLICATIONS** Black body radiation – Planck‘s theory (derivation) –Compton effect	9

	experimental verification only - Matter waves – Physical significance of wave function – Schroedinger‘s wave equations – Time independent and time dependent wave equations –Particle in a box (One dimensional) – Scanning electron microscope – Transmission electron microscope.	
	TOTAL INSTRUCTIONAL HOURS	**45**

COURSE OUTCOMES	CO1: Enhance the fundamental knowledge in Properties of Matter and Thermal Physics.
	CO2: Uunderstand the advanced technology of LASER in the field of Engineering and medicine.
	CO3: Exposed the fundamental knowledge of Optical fiber in the field of communication Engineering.
	CO4: Understand the production of ultrasonics and its applications in NDT.
	CO5: Impart the fundamental knowledge on Quantum Physics.

TEXT BOOKS

T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011.

T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2013.

REFERENCE BOOKS

R1 - Arthur Beiser “Concepts of Modern Physics” Tata McGraw Hill, New Delhi – 2010

R2 - M.N Avadhanulu and PG Kshirsagar “A Text Book of Engineering physics” S. Chand and Company ltd., New Delhi 2014

R3 - Dr. G. Senthilkumar “Engineering Physics – I” VRB publishers Pvt Ltd., 2013

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Programme	Course code	Name of the course	L	T	P	C
BE	16CY1101	**ENGINEERING CHEMISTRY**	3	0	0	3

COURSE OBJECTIVES	• The student should be conversant with boiler feed water requirements, related problems and water treatment techniques.
	• The student should be conversant with the principles of polymer chemistry and engineering applications of polymers and composites
	• The student should be conversant with the principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
	• To acquaint the student with important concepts of spectroscopy and its applications.
	• To acquaint the students with the basics of nano materials, their properties and applications

UNIT	DESCRIPTION	Instructional Hours
I	**WATER TECHNOLOGY** Hard water and soft water- Disadvantages of hard water- Hardness: types	9

	of hardness, calculations, estimation of hardness of water – EDTA method - scales and sludges – boiler corrosion – priming and foaming – caustic embrittlement; Conditioning methods of hard water – External conditioning - demineralization process- Internal conditioning - domestic water treatment: screening, sedimentation, coagulation, filtration, disinfection – chlorine – UV method; desalination: definition, reverse osmosis.	
II	**POLYMER & COMPOSITES** Polymerization – types of polymerization – addition and condensation polymerization – mechanism of free radical addition polymerization – copolymers – plastics: classification – thermoplastics and thermosetting plastics, preparation, properties and uses of commercial plastics – PVC, Teflon – moulding of plastics (extrusion and compression); rubber: vulcanization of rubber, synthetic rubber – butyl rubber, SBR; composites: definition, types of composites – polymer matrix composites – FRP.	9
III	**ENERGY SOURCES AND STORAGE DEVICES** Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator- classification of nuclear reactor- light water reactor- breeder reactor- solar energy conversion- solar cells- wind energy. Batteries and fuel cells: Types of batteries- alkaline battery lead storage battery- nickel-cadmium battery- lithium battery- fuel cell H_2 -O_2 fuel cell applications.	9
IV	**ANALYTICAL TECHNIQUES** Beer-Lambert's law – UV-visible spectroscopy and IR spectroscopy – principles – instrumentation (block diagram only) – estimation of iron by colorimetry – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – interferences - estimation of nickel by atomic absorption spectroscopy.	9
V	**NANOMATERIALS** Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: definition, carbon nanotubes (CNT), types of carbon nano tubes – single walled and multi walled carbon nanotubes – synthesis of carbon nanotubes: chemical vapour deposition – laser ablation – arc-discharge method; properties of CNT: mechanical, electrical, thermal and optical properties; applications of carbon nanotubes in chemical field, medicinal field, mechanical field and current applications.	9
	TOTAL INSTRUCTIONAL HOURS	**45**

COURSE OUTCOMES	• Illustration of the basic parameters of water, different water softening processes and effect of hard water in industries.
	• Knowledge on basic properties and application of various polymers and composites as an engineering material
	• Summarize the various energy sources and energy storage devices
	• Analyze various analytical skills in handling various machines, instruments, apart from understanding the mechanism involved.
	• Describe the basic properties and application of nanomaterials.

TEXT BOOKS

T1 - P.C.Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi (2015).
T2 - O.G.Palanna, "Engineering chemistry" McGraw Hill Education India (2017).

REFERENCES

R1 - B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2008).
R2 - B.K.Sharma "Engineering Chemistry" Krishna Prakasan Media (P) Ltd., Meerut (2005).
R3 - S.S.Dara "A Text book of Engineering Chemistry" S.Chand & Co.Ltd., New Delhi (2010).

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Programme	Course code	Name of the course	L	T	P	C
B.E	**16GE1102**	**ENGINEERING GRAPHICS (FOR AERO AUTO CIVIL MECH MECTS AGIR BIO MEDI & FOOD TECH)**	**2**	**0**	**4**	**4**

COURSE OBJECTIVES	• To provide drafting skills for communicating the Engineering concepts and ideas.
	• To expose to BIS and International standards related to engineering drawings

UNIT	DESCRIPTION	Instructional Hours
I	**PLANE CURVES** Importance of engineering drawing, drafting instruments, drawing sheets – layout and folding, Lettering and dimensioning, BIS standards and scales. Geometrical constructions, Construction of ellipse, parabola and Hyperbola by eccentricity method, construction of cycloids and involutes of square and circle – Drawing of tangents and normal to the above curves.	15
II	**PROJECTIONS OF POINTS, LINES AND PLANE SURFACES** Introduction to Orthographic projections- Projection of points. Projection of straight lines inclined to both the planes, Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) inclined to both the planes by rotating object method (First angle projections only).	15
III	**PROJECTIONS OF SOLIDS** Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is perpendicular and inclined to one plane and objects inclined to both the planes by rotating object method.	15
IV	**SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES** Sectioning of simple solids with their axis in vertical position when the cutting plane is inclined to one of the PRINCIPAL/DEAN ACADEMIC planes and perpendicular to the other – Obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinder and cone. Development of lateral surfaces of truncated solids. Intersection of solids-cylinder vs cylinder.	15
V	**ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS** Isometric views and projections of simple and truncated solids such as -	15

	Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. Free hand sketching of multiple views from a pictorial drawing. Perspective projection of solids in simple position using visual ray method.	
	TOTAL INSTRUCTIONAL HOURS	**75**

COURSE OUTCOMES	CO1: Draw the orthographic and isometric views of regular solid objects including sectional views.
	CO2:Recognize the International Standards in Engineering Drawing practices.

TEXT BOOKS

T1 - K.Venugopal, V.Prabu Raja, "Engineering Drawing, AutoCAD, Building Drawings", 5th Edition New Age International Publishers, New delhi 2016.
T2 - K.V.Natarajan, "A textbook of Engineering Graphics", Dhanalaksmi Publishers, Chennai.

REFERENCE BOOKS

R1 - BasantAgrawal and C.M.Agrawal, "Engineering Drawing", Tata McGraw Hill Publishing Company Limited,New Delhi 2008.
R2 - K. R. Gopalakrishnan, "Engineering Drawing" (Vol. I & II), Subhas Publications, Bangalore, 1998.
R3 - M.B.Shah and B.C.Rana, "Engineering Drawing", Pearson Education, India, 2005.
R4 - N.S. Parthasarathy, Vela Murali, "Engineering Drawing", Oxford University press, India 2015.

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Programme	Course code	Name of the course	L	T	P	C
B.E /B.TECH	**16GE1103**	**PROBLEM SOLVING AND PYTHON PROGRAMMING (COMMON TO ALL BRANCHES)**	**3**	**0**	**0**	**3**

COURSE OBJECTIVES	• To know the basics of algorithmic problem solving
	• To read and write simple Python programs.
	• To develop Python programs with conditionals and loops.
	• To define Python functions and call them.
	• To use Python data structures – lists, tuples, dictionaries.

UNIT	DESCRIPTION	Instructional Hours
I	**ALGORITHMIC PROBLEM SOLVING** Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudocode, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems:To find the greatest among three numbers, prime numbers,find minimum in a list, Towers of Hanoi.	9
II	**DATA, EXPRESSIONS, STATEMENTS** Python interpreter and interactive mode; values and types: int, float, boolean, string, and list;variables, expressions, statements, tuple assignment, precedence	9

	of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, compute Simple interest for a given amount, Factorial of a given number ,distance between two points.	
III	**CONTROL FLOW, FUNCTIONS** Conditionals: Boolean values and operators, conditional (if), alternative (if -else), chained conditional (if –elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values,parameters, local and global scope, function composition, recursion; Strings: string slices,immutability, string functions and methods, string module; Lists as arrays. Illustrative programs:square root, gcd, exponentiation, sum an array of numbers, linear search,binary search.	9
IV	**LISTS, TUPLES, DICTIONARIES** Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing -list comprehension; Illustrative programs: selection sort, insertion sort,histogram.	9
V	**FILES, MODULES, PACKAGES** Files and exception: text files, reading and writing files, format operator; command line arguments,errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count,copy file.	9
	TOTAL INSTRUCTIONAL HOURS	**45**

COURSE OUTCOMES	Upon completion of the course, students will be able to
	CO1:Develop algorithmic solutions to simple computational problems
	CO2:Structure simple Python programs for solving problems.
	CO3:Decompose a Python program into functions.
	CO4:Represent compound data using Python lists, tuples, dictionaries.
	CO5:Read and write data from/to files in Python Programs.

TEXT BOOKS

T1 –Ashok Namdev Kamthane ,Amit Ashok Kamthane ," Programming and Problem solving with Python" McGrawHill Education

T2-Sheetal Taneja, "Python Programming A Modular Approach With Graphics,Database,Mobile and Web Applications, PEARSON .

REFERENCE BOOKS

R1 - Reema Thareja " Python Programming Using Problem Solvimg Approach " OXFORD.

R2-E.Balagurusamy, "Problem solving and Python Programming" McGrawHill Education.

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Programme	Course code	Name of the course	L	T	P	C
B.E	**16PH1001**	**PHYSICAL SCIENCES LABORATORY-I** **(Common to All Branches)**	**0**	**0**	**2**	**1**

COURSE	1. Evaluate the particle size of micro particles and acceptance angle of fibres.

OBJECTIVES	2. Employ instrumental method to determine Young's modulus of a beam of metals.
	3. Apply the concept of diffraction and getting ability to calculate the wavelength of the mercury spectrum

Expt. No.	Description of the Experiments
1.	Determination of Wavelength, and particle size using Laser
2.	Determination of acceptance angle and numerical aperature in an optical fiber.
3.	Determination of velocity of sound and compressibility of liquid – Ultrasonic Interferometer.
4.	Determination of wavelength of mercury spectrum – spectrometer grating
5.	Determination of thermal conductivity of a bad conductor – Lee's Disc method
6.	Determination of Young's modulus by Non uniform bending method
7.	Determination of specific resistance of a given coil of wire – Carey Foster's Bridge.
8.	Post office box Measurement of an unknown resistance
TOTAL PRACTICAL HOURS	**30**

COURSE OUTCOMES	CO1: Point out the particle size of micro particles and acceptance angle of fibres using diode laser.
	CO2: Assess the Young's modulus of a beam using non uniform bending methods.
	CO3: Illustrate the concept of diffraction and getting ability to calculate the wavelength of the mercury spectrum Using spectrometer.
	CO4: Identify the velocity of ultrasonic's in the given liquid.
	CO5: Illustrate phenomena of thermal conductivity of a bad conductor.

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Programme	Course code	Name of the course	L	T	P	C
B.TECH		**CHEMISTRY LABORATORY**	**0**	**0**	**2**	**1**

COURSE OBJECTIVES	1. Acquire practical skills in the determination of water quality parameters.
	2. Acquaint the students with the determination of molecular weight of a polymer by viscometry.
	3. Acquaint the students with the estimation of chemical substances using instrumental

Expt. No.	Description of the Experiments
1.	Preparation of molar and normal solutions and their standardization.
2.	Estimation of total, permanent and temporary hardness of Water by EDTA
3.	Determination of chloride content of water sample by argentometric method.

4.	Determination of available chlorine in bleaching powder.
5.	Conductometric titration of strong acid vs strong base (HCl vs NaOH).
6.	Conductometric titration (Mixture of weak and strong acids)
7.	Conductometric precipitation titration using $BaCl_2$ and Na_2SO_4
8.	Determination of molecular weight and degree of polymerization using viscometry.
9.	Estimation of iron content of the water sample using spectrophotometer.(1,10 phenanthroline / thiocyanate method).
TOTAL INTRUCTIONAL HOURS	**30**

COURSE OUTCOMES	CO1: Estimate the different types of hardness in a water sample.
	CO2: Determine the chloride content of water sample.
	CO3: Calculate the strength of acid using conductometric titrations.
	CO4: Calculate the strength of strong and weak acid using conductometric titrations.
	CO5: estimate the amount of salt using conductometric precipitation titrations.

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Programme	Course code	Name of the course	L	T	P	C
B.E	**18GE1004**	**PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY (COMMON TO ALL BRANCHES ,EFFECTIVE FROM THE ACADEMIC YEAR 2018-2019)**	**0**	**0**	**4**	**2**

COURSE OBJECTIVES	• To write, test, and debug simple Python programs.
	• To implement Python programs with conditionals and loops.
	• Use functions for structuring Python programs.
	• Represent compound data using Python lists, tuples, dictionaries.
	• Read and write data from/to files in Python

Ex. No.	**Description**	**Total Instructional Hours**
1.	Compute the GCD of two numbers.	3
2.	Find the square root of a number	3
3.	Exponentiation (power of a number)	3
4.	Find the factorial of a given number	3
5.	Print prime numbers from 1 to n numbers	3
6.	Find the maximum of a list of numbers	3
7.	Linear search , Binary search	3
8.	Selection sort, Insertion sort	3
9.	First n prime numbers	3
10	Multiply matrices	3

11	Programs that take command line arguments(word count)	3
12	Find the most frequent words in a text read from a file	3
13	Simulate bouncing ball using Pygame	3
	TOTAL INSTRCTIONAL HOURS	**45**

COURSE OUTCOMES	**CO1**: Write, test, and debug simple Python programs.
	CO2: Implement Python programs with conditionals and loops.
	CO3:Develop Python programs step-wise by defining functions and calling them.
	CO4:Use Python lists, tuples, dictionaries for representing compound data.
	CO5:Read and write data from/to files in Python

PLATFORM NEEDED: Python 3 interpreter for Windows/Linux

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Programme	Course code	Name of the course	L	T	P	C
B.E	16GE1002	**ENGINEERING PRACTICES LAB** (Common to all Branches)	0	0	4	2
COURSE OBJECTIVES	To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.					

GROUP A (CIVIL & MECHANICAL)

Expt. No.	**Description of the Experiments**	**Instructional Hours**
I CIVIL ENGINEERING PRACTICE Study of plumbing and carpentry components of Residential and Industrial buildings. **(A) PLUMBING WORKS**:		
1	Study on pipe joints, its location and functions: Valves, taps, couplings, unions, reducers, elbows in household fittings.	
2	Study of pipe connection requirements for pumps.	
3	Preparation of plumbing line sketches for water supply and sewage works.	
4	Hands-on-exercise: Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.	
5	Demonstration of plumbing requirements of high-rise buildings.	
(B) CARPENTRY USING POWER TOOLS ONLY:		
1	Study of the joints in roofs, doors, windows and furniture.	
2	Hands-on-exercise in wood works by sawing, planning and cutting.	
II MECHANICAL ENGINEERING **(A) Welding:**		
1	Preparation of arc welding of Butt joints, Lap joints and Tee joints	
(B) Machining:		

1	Practice on Simple step turning and taper turning	
2	Practice on Drilling Practice	
(C) Sheet Metal Work:		
1	Practice on Models– Trays, cone and cylinder.	
DEMONSTRATION **(D) Smithy**		
	➢ Smithy operations: Upsetting, swaging, setting down and bending. ➢ Demonstration of – Production of hexagonal headed bolt.	
(E)Gas welding		
(F) Foundry Tools and operations.		
	TOTAL INSTRCTIONAL HOURS	**45**

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SEMESTER II

Programme	Course Code	Name of the Course	L	T	P	C
B.E/B.Tech	16HE2102	**ESSENTIAL ENGLISH FOR ENGINEERS – II**	3	1	0	4

Course Objective	✓ The learner will be introduced to global corporate culture and professional communication. ✓ It helps the students to focus on organizing professional event and documentation. ✓ The student will be able to describe the events and process in an effective way. ✓ It trains the student to analyze the problems and to find solution to it. ✓ The learner will be familiar with business communication.

Unit	Description	Instructional Hours
I	Introduction- talking about teamwork- Making arrangements- Improving Communication in spoken language – Taking and leaving Voice mail messages (present Tense, Past Tense and Present Perfect) Talking about Business Hotel- (Speaking Activity) Talking about Corporate Hospitality- Formal and Informal Language – Making accepting and declining invitations (Auxiliary Verb, Countable or Uncountable Nouns) – Focus on Language – Definitions and Extended Definitions- **Reading comprehension.**	12

II	Talking about orders – Clarity Written Language – Phone and Letter Phrases – Talking about Company Finances – Conditional 1 and 2 – Managing Cash Flow (Intention and Arrangements Conditional 1 and 2) – Talking about Brands and Marketing – Ethical Banking- Talking about Public Relations – Organizing a PR Event – Describing Duties and Responsibilities – (Future Tense and Articles) – Reported Speech – Modal Verbs and Passive, Impersonal Passive Voice-**interpretation of posters or advertisements.**	12
III	Talking about relocation – Report Phrases – Talking about Similarity and difference- Giving Directions- Asking for Information and Making Suggestions – Talking about Location (Comparatives and Superlatives, Participles) – Talking about Company Performances- Describing Trends – Describing Cause and Effect – Talking about Environmental Impact – Discussing Green Issues – Language of Presentations (Adjectives and Adverbs, Determiners)- Homophones – Homonyms- Acronyms- Abbreviations- British and American words.	12
IV	Talking about Health and Safety – Expressing Obligation- Discussing Regulations- Talking about personnel Problems – Passives – Talking about Problem at Work (modal Verbs, Passives)- Talking about Expenses Claims- Talking about Air Travel (Relative Pronoun, Indirect Questions) – E-mail Writing - Note completion- Transcoding.	12
V	Talking about staff Benefits- Talking about Appraisal Systems (gerunds and Infinitives, Reported Speech) – Talking about Marketing Disasters – Expressing hypothetical Situations- Talking about entering Foreign Market (Conditional 3, Grammar review) – Letter for calling quotations, Replying for quotations – Placing an order and Complaint and **reply to a complaint**.	12
	Total Instructional Hours	**60**

Course Outcome	CO1: Introduced corporate culture and professional communication. CO2: It focused on organizing a professional event and its documentation. CO3: Improved the ability to describe the events and process in an effective way CO4: Trained to analyze the problems and to find solution to it. CO5: Practiced to make business communication.

TEXT BOOKS

T1 - Norman Whitby, Cambridge English: Business BENCHMARK Pre-intermediate to Intermediate 2nd Edition. 2014.

T2 - Ian Wood and Anne Willams. "Pass Cambridge BEC Preliminary", Cengage Learning press 2013.

REFERENCE BOOKS

R1 - Communication Skills for Engineers, Sunitha Misra & C.Murali Krishna, Pearson Publishers

R2 - Technical Communication, Daniel G. Riordan, Cengage learning publishers.

R3 - Kamalesh Sadanan "A Foundation Course for the Speakers of Tamil-Part-I &II", Orient Blackswan,2010.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E. / B.Tech	**16MA2102**	**ENGINEERING MATHEMATICS – II (Vector Calculus, Complex variables and Laplace transforms) (COMMON TO ALL BRANCHES)**	**3**	**1**	**0**	**4**

Course Objective	• Learn the basics of vector calculus comprising gradient, divergence, Curl and line, surface, volume integrals. • Understand analytic functions of complex variables and conformal mappings. • Know the basics of residues, complex integration and contour integration. • Apply Laplace transform techniques to solve linear differential equations. • Know the effective mathematical tools for the solutions of partial differential equations that model several physical problems in mathematical physics

Unit	Description	Instructional Hours
I	**VECTOR CALCULUS** Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.	12
II	**ANALYTIC FUNCTIONS** Analytic function - Cauchy-Riemann equations - sufficient conditions (excluding proof) – Harmonic - conjugate harmonic functions– Construction of analytic functions (Milne-Thompson method) – Conformal mapping: w = z+c, cz, 1/z and bilinear transformation without problems related to the concept of conformal mapping.	12
III	**COMPLEX INTEGRATION** Complex integration – Statements of Cauchy's integral theorem – Taylor's and Laurent's series expansions - Singular points – Residues – Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle.	12
IV	**LAPLACE TRANSFORM** Laplace transform –Basic properties – Transforms of derivatives and integrals of functions - Transforms of unit step function and impulse function – Transform of periodic functions. Inverse Laplace transform - Convolution theorem (with out proof) – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.	12
V	**PARTIAL DIFFERENTIAL EQUATIONS** Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions-Solution of standard types of first order partial differential equations of the form f(p,q) = 0, Clairaut's type: z = px + qy + f(p, q) – Lagrange's linear equation-Linear homogeneous partial differential equations of second and higher order with constant coefficient.	12
	Total Instructional Hours	**60**

Course Outcome	CO1: Know the gradient, divergence and curl of vectors useful for engineering application like fluid flow, electricity and magnetism. CO2: Test the analyticity to construct the analytic function and transform complex functions from one plane to another plane graphically. CO3: Evaluate real and complex integrals over suitable closed paths or contours. CO4: Know the applications of Laplace transform and its properties and to solve certain linear differential equations using Laplace transform technique. CO5: Solve the engineering problems using Partial Differential Equations.

TEXT BOOKS

T1- Ravish R Singh, Mukul Bhatt, "Engineeing Mathematics", McGraw Hill education (India) Private Ltd.,Chennai,2017.

T2- Veerarajan T, "Engineering Mathematics–II", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016

REFERENCE BOOKS

R1-Bali N.P & Manish Goyal, "A Text book of Engineering Mathematics", 8th Edition, Laxmi Pub. Pvt. Ltd. 2011.

R2- Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.

R3- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning,2012.

R4-Sivarama Krishna Das P and Rukmangadachari E., "Engineering Mathematics" Vol II, Second Edition, Pearson publishing, 2011.

R5- Wylie & Barett, "Advanced Engineering Mathematics", McGraw Hill Education, 6th edition, 2003

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Programme	Course Code	Name of the Course	L	T	P	C
BE	**16CY2102**	**ENVIRONMENTAL SCIENCE (EXCEPT CIVIL)**	**3**	**0**	**0**	**3**

Course Objective	1. To gain knowledge on the importance of environmental education, ecosystem and biodiversity. 2. To acquire knowledge about environmental pollution – sources, effects and control measures of environmental pollution. 3. To find and implement scientific, technological, economic and political solutions to environmental problems. 4. To study about the natural resources, exploitation and its conservation 5. To be aware of the national and international concern for environment and its protection.

Unit	Description	Instructional Hours
I	**ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY** Importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers- energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.	9
II	**ENVIRONMENTAL POLLUTION** Definition – causes, effects and control measures of: Air pollution – Air pollution standards – control methods- Water pollution – Water quality parameters- Soil pollution - Marine pollution - Noise pollution- Thermal pollution - Nuclear hazards–role of an individual in prevention of pollution – pollution case studies**.**	9
III	**NATURAL RESOURCES** Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and Desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.	9
IV	**SOCIAL ISSUES AND THE ENVIRONMENT** From unsustainable to sustainable development – urban problems related to energy- energy conversion – electrical energy calculations- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- Current Environmental issues at Country level – management of municipal sewage, municipal solid waste, Hazardous waste and Bio-medical waste – Global issues – Climatic change, Acid rain, greenhouse effect and Ozone layer depletion. Disaster management: floods, earthquake, cyclone and landslides.	9
V	**HUMAN POPULATION AND THE ENVIRONMENT** Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- GIS-remote sensing-role of information technology in environment and human health – Case studies.	9
	Total Instructional Hours	**45**

Course Outcome	CO1: Understand the natural environment and its relationships with human activities. CO2: Characterize and analyze human impacts on the environment CO3: Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes CO4: Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world. CO5: Understand and implement scientific research strategies, including collection, management, evaluation, and interpretation of environmental data.

TEXT BOOKS

T1- Anubha Kaushik and C. P. Kaushik, "Environmental Science and Engineering", Fourth edition, New Age International Publishers, New Delhi, 2014.

T2 – Deeksha Dave and S.S.Katewa, "Textbook of Environmental Studies", Second Edition, Cengage Learning, 2012.

REFERENCES

R1 - Trivedi R.K. "Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards", Vol. I and II, Enviro Media.

R2 - G.Tyler Miller, Jr and Scott E. Spoolman"Environmental Science" Thirteenth Edition, Cengage Learning, 2010.

R3 - Gilbert M. Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2004

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Programme	Course code	Name of the course	L	T	P	C
B.E	16EE2201	Basics of Electrical and Electronics Engineering (**AGRI**, AUTO,AERO, CIVIL, MECH & MECHAT)	3	0	0	3

Course Objective	1. To apply the basic laws used in Electrical circuits and the different components. 2. To impart knowledge on construction and working of DC and AC machines 3. To provide knowledge on the fundamentals of semiconductor devices and their applications. 4. To impart knowledge on digital electronics and its principles. 5. To develop block diagrams for satellite and optical fiber communications.

Unit	Description	Instructional hours
I	**ELECTRICAL CIRCUITS AND MEASUREMENTS** Ohm's Law – Kirchoff's Laws – Steady State Solution of DC Circuits – Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase circuits - Three Phase Balanced Circuits. Operating Principles of Moving Coil and Moving Iron Instruments - Ammeters and Voltmeters, Dynamometer type Watt meters	9

	and Energy meters.	
II	**ELECTRICAL MACHINES** Construction, Principle of Operation of DC Generators - EMF Equation - Construction, Principle of Operation of DC shunt and series Motors, Single Phase Transformer - EMF Equation, Single phase capacitor start - capacitor run – Construction, Principle of Operation of Three Phase Induction Motor – Applications - (Qualitative Approach only).	9
III	**SEMICONDUCTOR DEVICES AND APPLICATIONS** Characteristics of PN Junction Diode – Zener Diode and its Characteristics – Zener Effect – Half wave and Full wave Rectifiers – Voltage Regulation. Bipolar Junction Transistor (BJT) – CB, CE, CC Configurations and Characteristics – FET – Characteristics.	9
IV	**DIGITAL ELECTRONICS** Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops (RS, JK, T & D), A/D and D/A Conversion (Dual Slope, SAR, Binary-weighted and R-2R).	9
V	**FUNDAMENTALS OF COMMUNICATION ENGINEERING** Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations - Satellite and Optical Fibre communications (Block Diagram Approach only).	9
	TOTAL INSTRUCTIONAL HOURS	**45**
Course Outcome	CO1: Apply the KVL and KCL in Electrical circuits CO2: Explain the constructional features of AC and DC machines. CO3: Identify electronics components and use of them to design circuits. CO4: Use appropriate logic gates in circuit design. CO5: Construct block diagram and explain satellite and optical Fibre communication systems.	

TEXT BOOKS

T1 Mittle N., “Basic Electrical Engineering”, Tata McGraw Hill Edition, New Delhi, 1990.

T2 dha R.S., “Applied Electronics”, S. Chand & Co., 2006.

T3 ıthusubramanian R, Salivahanan S and Muraleedharan K A, “Basic Electrical, Electronics and Computer Engineering”, Tata McGraw Hill, Second Edition, 2006.

REFERENCE BOOKS

R1- T K and Sukhija M S, “Basics of Electrical Engineering”, Oxford press 2005

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Programme	Course code	Name of the course	L	T	P	C
B.E	**16GE2101**	**ENGINEERING MECHANICS (FOR AERO AUTO CIVIL MECH MECTS AGRI & BIO TECH)**	**3**	**1**	**0**	**4**

COURSE OBJECTIVES	• The main objectives of the course are to:
	• Understand the vector and scalar representation of forces and moments
	• Understand the static equilibrium of particles and rigid bodies both in two dimensions.
	• Understand the principle of work and energy.
	• Comprehend the effect of friction on equilibrium.

Unit	Description	Instructional hours
I	**BASICS & STATICS OF PARTICLES** Introduction – Units and Dimensions – Laws of Mechanics – Lame's theorem, Parallelogram and triangular Law of forces – Vectors – Vector representation of forces and moments – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle –Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.	12
II	**EQUILIBRIUM OF RIGID BODIES** Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis– Scalar component of a moment – Varignon's theorem – Single equivalent force – Equilibrium of Rigid bodies in two dimensions.	12
III	**PROPERTIES OF SURFACES AND SOLIDS** Determination of Areas and Volumes – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, - Angle section, Hollow section by using standard formula – Second and product moments of plane area – Rectangle, triangle, circle from integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – PRINCIPAL/DEAN ACADEMIC moments of inertia of plane areas.	12
IV	**DYNAMICS OF PARTICLES** Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies. Co-efficient of restitution.	12
V	**FRICTION** Frictional force – Laws of Coloumb friction – Simple contact friction – Rolling resistance – Wedge friction - Belt friction, Applications of friction.	12
	Total Instructional Hours	**60**

Course Outcome	The outcomes of the course are the students shall have the ability: CO1: To solve engineering problems dealing with force, displacement, velocity and acceleration. CO2: To analyze the forces in any structure. CO3: To solve rigid body subjected to dynamic forces.

TEXT BOOKS:

1. F.P.Beer, and Jr. E.R.Johnston., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).

REFERENCE BOOKS:

1. R.C.Hibbeller, and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
2. S.Rajasekaran and G.Sankarasubramanian, "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.
3. S.S.Bhavikatti, and K.G.Rajashekarappa, "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.

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Programme	Course code	Name of the course	L	T	P	C
BE	**18AG2201**	**PRINCIPLES AND PRACTICES OF CROP PRODUCTION (FOR AGRI)**	**3**	**0**	**0**	**3**

Course Objective	1. To introduce the students to principles of agricultural and horticultural crop production and to introduce the production practices of crops. 2. To delineate the role of agricultural and irrigation engineers in relation to various crop production practices.

Unit	Description	Instructional Hours
I	**AGRICULTURE AND CROP PRODUCTION** Introduction to agriculture and its crop production sub-sectors - field crop production and horticulture; Factors affecting crop growth and production: genetic (internal) and environmental (external) factors; Crop management through environmental modification and adaptation of crops to the existing environment through crop cultural practices.	12
II	**CROP SELECTION AND ESTABLISHMENT** Regional and seasonal selection of crops; Systems of crop production; Competition among crop plants; Spacing and arrangement of crop plants; Field preparation for crops including systems of tillage; Establishment of an adequate crop stand and ground cover, including selection and treatment of seed, and nursery growing.	12

III	**CROP MANAGEMENT** Crop water Management; Crop nutrition management - need for supplementation to soil supplied nutrients, sources, generalized recommendations, methods and timing of application of supplemental nutrients including fertigation scheduling; Crop protection including management of 20 weeds, pests and pathogens; Integrated methods of managing water, nutrients and plant protection; Types and methods of harvest.	12
IV	**PRODUCTION PRACTICES OF AGRICULTURAL CROPS** Generalized management and cultivation practices for important groups of field crops in TamilNadu: cereal crops, grain legumes, oil seed crops, sugarcane, and fiber crops, and special purpose crops such as those grown for green manure and fodder.	12
V	**PRODUCTION PRACTICES OF HORTICULTURAL CROPS** Important groups of horticultural crops in Tamil Nadu such as vegetable crops, fruit crops, flower crops; Cultivation practices of representatives of each group; Special features of production of horticultural crops - green house cultivation.	12
	Total Instructional Hours	**60**

Course Outcome	• Students completing this course would have acquired knowledge on crop selection, crop production crop management. • The students will have the required knowledge in the area of production of agricultural and horticultural crops.

TEXT BOOKS

T1-Rajendra Prasad, Text Book of Field Crop Production. Directorate of Information and Publication, Krishi Anusandhan Bhavan, Pusa, New Delhi, 2015.
T2-Reddy T. Sankara G.H. Yellamanda Reddi, Principles of Agronomy, Kalyani Publishers, New Delhi, 2005.
Handbook of Agriculture. ICAR Publications, New Delhi, 2011..

REFERENCES

R1-Bose T. K. and L.P.Yadav. Commercial Flowers, Naya Prakash, Calcutta.1989.
R2-Crop Production Guide, Tamil Nadu Agricultural University Publication, Coimbatore. 2005
R3-Kumar, N., Abdul Khader, M. Rangaswami, P. and Irulappan, I. Introduction to spices, plantation crops, medicinal and aromatic plants. Rajalakshmi Publications, Nagercoil. 1993.
R4-Kumar, N.,"Introduction to Horticulture", Rajalakshmi Publications. Nagercoil, 7th edition, 2015.
R5-Shanmugavel, K.G. Production Technology of Vegetable Crops. Oxford India Publications, New Delhi. 1989.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16PS2001**	**PHYSICAL SCIENCES LABORATORY – II (COMMON TO ALL BRANCHES)**	**0**	**0**	**2**	**1**

Course	

Objective	1. Evaluate the band gap of a semiconductor. 2. Apply the concept of interference and calculate the thickness of thin wire. 3. Acquire the practical skills in Young's modulus by uniform bending method.

Expt. No.	Description of the Experiments	
1.	Determination of Young's modulus by uniform bending method	
2.	Determination of band gap of a semiconductor	
3.	Determination of Coefficient of viscosity of a liquid –Poiseuille's method	
4.	Determination of Dispersive power of a prism – Spectrometer	
5.	Determination of thickness of a thin wire – Air wedge method	
6.	Determination of Rigidity modulus – Torsion pendulum	
7.	Magnetic hysteresis experiment	
8.	Calibration of ammeter using potentiometer	
	TOTAL PRACTICAL HOURS	**30**

Course Outcome	CO1: Experiment involving the physical phenomena of the Rigidity modulus of wire. CO2: Determine the band gap of a semiconductor and variation of Energy Gap (E_g) with temperature. CO3: Assess the Young's modulus of a beam using non uniform bending method. CO4: Explain the concept of interference and calculate the thickness of thin wire and other fine objects. CO5: Experiment provides a unique opportunity to validate Dispersive power of a prism using Spectrometer.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	18AG2001	**CROP HUSBANDRY LABORATORY** (FOR AGRI)	0	0	4	2

Course Objective	1. To introduce the different crop production practices in wet land, dry land and garden land through hands on experience and demonstrations.

S.No	Description Of The Experiments	Instructional Hours
1	Field preparation studies	
2	Seed selection and seed treatment procedures	
3	Seed bed and nursery preparation	
4	Sowing / Transplanting	

5	Biometric observation for crops	
6	Nutrient management studies	
7	Water management and irrigation scheduling	
8	Weed management studies	
9	Integrated Pest Management studies	
10	Harvesting	
	Total Instructional Hours	60

Course Outcome	➢ A wet land / garden land for a minimum of 5 cents area for each / group of students. ➢ An open / borewell as water source to support cultivation

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SEMESTER III

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**18 MA 3111**	**FOURIER ANALYSIS AND Z TRANSFORMS (AGRI, BIO MEDICAL & FOOD TECHNOLOGY)**	**3**	**1**	**0**	**4**

Course Objective	1. Introduce Fourier series which is central to many applications in engineering. 2. Apply the effective tools for the solutions of one dimensional boundary value problems. 3. Apply the effective tools for the solutions of two dimensional heat equations. 4. Acquaint with Fourier transform techniques used in wide variety of situations. 5. Develop Z transform techniques for discrete time systems.

Unit	Description	Instructional Hours
I	**FOURIER SERIES** Dirichlet's conditions- General Fourier Series – Odd and Even Functions – Half range sine and cosine series – Change of Interval - Parseval's Identity - Harmonic analysis.	12
II	**BOUNDARY VALUE PROBLEMS** Classification of PDE - Solutions of one dimensional wave equation - One dimensional equation of heat conduction (excluding insulated edges).	12

III	**TWO DIMENSIONAL HEAT EQUATIONS** Steady state solution of two dimensional equation of heat conduction in infinite plate and semi circular plate.	12
IV	**FOURIER TRANSFORMS** Fourier Transform Pairs - Fourier sine and cosine transforms – Properties - Transforms of Simple functions – Convolution Theorem – Parseval's identity.	12
V	**Z - TRANSFORMS AND DIFFERENCE EQUATIONS** Z- Transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem(excluding proof)– Solution of difference equations using Z – transform.	12
	Total Instructional Hours	**60**

Course Outcome	CO1: Understand the principles of Fourier series which helps them to solve physical problems of engineering. CO2: Obtain the knowledge of Fourier series in solving the boundary value problems. CO3: Familiar with the application of Fourier series in solving the two dimensional heat equations. CO4: Acquire the knowledge of Fourier transform techniques which extend its applications. CO5: Illustrate the Z- transforms for analyzing discrete-time signals and systems.

TEXT BOOKS

T1 - Veerarajan. T.,"Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd.,
Second reprint, New Delhi, 2012.

T2 - Bali. N.P and Manish Goyal & Watkins, "Advanced Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007

REFERENCE BOOKS

R1 - C.Roy Wylie " Advance Engineering Mathematics" Louis C. Barret, 6th Edition, Mc Graw Hill Education India Private Limited, New Delhi 2003.

R2 - Kandasamy P., Thilagavathy K. and Gunavathy K.,"Engineering Mathematics Volume III", S.Chand & Company Ltd., New Delhi, 1996.

R3 - Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, Delhi,2018.

R4 - Ramana. B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2018.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG3201	**Soil Science and Engineering**	3	0	0	3

Course Objective	To expose the students to the fundamental knowledge on Soil physical parameters, Permeability – Compaction, Bearing Capacity and types and methods of soil survey and interpretative groupings

Unit	Description	Instructional Hours
I	INTRODUCTION AND SOIL PHYSICS Soil - definition - major components –Soil forming minerals and processes- soil profile -Physical properties - texture –density-porosity-consistence-colour- -specific gravity - capillary and non-capillary -plasticity. Soil air - soil temperature - soil water - classification of soil water- Movement soil water. Soil colloids – organic and inorganic matter-Ion exchange- pH – Plant nutrient availability	**9**
II	SOIL CLASSIFICATION AND SURVEY Soil taxonomy – Soils of Tamil Nadu and India. Soil survey - types and methods of soil survey – Field mapping- mapping units - base maps -preparation of survey reports - concepts and uses - land capability classes and subclasses - soil suitability -Problem soils – Reclamation.	**9**
III	PHASE RELATIONSHIP AND SOIL COMPACTION Phase relations- Gradation analysis- Atterberg Limits and Indices-Engineering Classification of soil – Soil compaction- factors affecting compaction- field and laboratory methods.	**9**
IV	ENGINEERING PROPERTIESOF SOIL Shear strength of cohesive and cohesionless - Mohr-Coulomb failure theory- Measurement of shear strength, direct shear, Triaxial and vane shear test- -Permeability- Coefficient of Permeability-Darcy's law-field and lab methods - Assessment of seepage - Compressibility.	**9**
V	BEARING CAPACITY AND SLOPE STABILITY Bearing capacity of soils - Factors affecting Bearing Capacity-Shallow foundations-Terzaghi‟s formula- BIS standards - Slope stability-Analysis of infinite and finite slopes- friction circle method- slope protection measures.	**9**
	Total Instructional Hours	**45**

Course Outcome	Upon successful completion of the course, students shall have ability to CO1: Fundamental knowledge of soil physical parameters. CO2: The procedures involved in soil survey, soil classification. CO3: The phase relationship and soil compaction. CO4: Understand the Engineering properties of soil CO5: Concepts of bearing capacity and slope stability.

TEXT BOOKS:

T1 - Nyle C. Brady, "The Nature and Properties of Soil", Macmillan Publishing Company, 10th Edition, New York, 2008.

T2 - Punmia, B.C., "Soil Mechanics and Foundation "Laxmi Publishers, New Delhi, 2007.

REFERENCE BOOKS:

R1 – Edward J. Plaster., "Soil Science", Cengage Learning India Ltd, New Delhi, 2009.

R2 – Arora, K.R. "Soil Mechanics and Foundation Engineering", Standard Publishers and Distributors, New Delhi, 2007.

R3 -. Murthy, V.N.S. "Soil Mechanics and Foundation Engineering", UBS Publishers and Distributors, New Delhi, 2007

R4- Sehgal, S.B., "Text Book of Soil Mechanics", CBS Publishers and Distributors New Delhi, 2007.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG3202	**FLUID MECHANICS AND HYDRAULICS**	3	1	0	4

Course Objective	1. To understand the properties of fluids 2. To acquire knowledge on fluid flow 3. To understand the behavior of fluid flow through pipes 4. To gain knowledge on open channel flows 5. To gather knowledge on dimensional analysis and study the various types of pumps

Unit	Description	Instructional Hours
I	**PROPERTIES OF FLUIDS** Properties of fluids – definition – units of measurement - Mass density – specific weight, specific volume – specific gravity - equation of state – perfect gas - Viscosity – vapour pressure – compressibility and elasticity - surface tension – capillarity. Fluid pressure and measurement – simple, differential and micro manometers - Mechanical gauges – calibration. Hydrostatic forces on surfaces – total pressure and centre of pressure – Horizontal - Vertical and Inclined plane surface - Pressure diagram – total pressure on curved surface. Archimedes principles –buoyancy - metacentre – metacentric height.	**12**
II	**FLUID FLOW ANALYSIS** Types of fluid flow – velocity and acceleration of a fluid particle - Rotational – irrotational circulation and vorticity - Flow pattern – stream line – equipotential line – stream tube path line – streak line – flow net – velocity potential – stream function. Principles of conservation of mass – energy – momentum – continuity equation in Cartesian co-ordinates - Euler's equation of motion.	**12**
III	**FLOW MEASUREMENT** Bernoulli's equation – applications - Venturimeter – orifice meter – nozzle meter - rotameter – elbow meter - pitot tube – Orifice – sharp edged orifice	**12**

	discharging free – submerged orifice – mouth piece - Flow through orifice under variable head – time of emptying a tank with and without inflow. Flow through pipes – laminar and turbulent flow in pipes - Reynold's experiment - Darcy – Weisbach equation for friction head loss – Chezy's formula – Manning's formula – Hazen-William's formula - Major and minor losses in pipes – hydraulic gradient line – energy gradient line. Siphon – water hammer in pipes – gradual and sudden closure of valves	
IV	**OPEN CHANNEL FLOW** Types of flow in channel – uniform flow – most economical section of channel – rectangular – trapezoidal. Specific energy and critical depth - momentum in open channel flow – specific force – critical flow – computation. Flow measurement in channels – notches – rectangular, Cipolletti and triangular – float method - Flow measurement in rivers/ streams/ canals – weirs – free and submerged flow – current meter – Parshall flume.	**12**
V	**DIMENSIONAL ANALYSIS AND PUMPS** Dimensional analysis – Fundamental dimensions – dimensional homogeneity – Rayleigh's method and Buckingham Pi-Theorem - concept of geometric, kinematic and dynamic similarity. Important non dimensional numbers – Reynolds, Froude, Euler, Mach and Weber - Pump terminology – suction lift, suction head, delivery head, discharge, water horse power – selection of pump capacity. Centrifugal pumps – components – working – types of pumps and impellers - Priming – cavitation – specific speed – characteristic curves - submersible pumps - Jet pump – jet assembly - Other pumps – Air lift pump - reciprocating pump - sludge pump and vacuum pump- Hydraulic ram.	**12**
	Total Instructional Hours	**60**

Course Outcome	Upon successful completion of the course, students shall have ability to CO1: Comprehend the properties of fluids CO2: Understand the various types of fluid flow CO3: Calculate the discharge and compute energy losses in pipe flow CO4: Classify open channel flows and also design the most economical sections for open channel flows CO5: Select appropriate model to provide solution to a real time problem related to hydraulics and also assess the performance of pumps

TEXT BOOKS:

T1 – Streeter V.L., Wylie E. B. and Bedford K. W., "Fluid Mechanics", Tata McGraw Hill Publishing Co. Ltd., 2017.

T2 - Modi P. N. and Seth S M., "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House, New Delhi, 2013

T3 - Bansal R.K., "Fluid Mechanics & Hydraulic Machines", Laxmi Publications, 2015.

REFERENCE BOOKS

R1 - Garde, R. J., "Fluid Mechanics through problems", New Age International Publishers (P) Ltd., New Delhi, 2002.

R2 - Kumar .K.L, "Engineering Fluid Mechanics", Eurasia Publishing House, 2002.

R3 – Jagdish Lal, "Hydraulic Machines". Metropolitan Book House, New Delhi, 2000.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	16ME3232	**THEORY OF MACHINES**	3	0	0	3

Course Objective	1. To understand the purpose of kinematics, Kinematic joint and mechanism and to study the relative motion of parts in a machine without taking into consideration the forces involved. 2. To understand the theories and applications of cams and Flywheels. 3. To understand applications of different types of gears and gear profiles and its efficiency and gear trains. 4. To understand principles of friction applied to screw threads, clutches, brakes, belt and rope drives. 5. To know principles of governors.

Unit	Description	Instructional Hours
I	**BASICS OF MECHANISMS** Introduction - Links - Pairs - Chain - Mechanism - Machine structure - Degrees of freedom - Four bar chains - Terminology and definition - Planar, Spherical and Spatial Mechanisms - Grashoff's law - Kutzback criterion - Grubler's criterion for plane mechanism. Inversion of mechanisms - Four bar, single slider crank and double slider crank mechanisms.	9
II	**CAM AND FLYWHEEL** Types of cams and followers - Follower motion - Uniform, Parabolic, SHM and cycloidal. Cam terminology - Cam profiles construction for roller, flat faced and knife edge follower. Flywheels of engines and punching press- Turning moment diagrams – Fluctuation of energy, speed.	9
III	**GEARS AND GEAR TRAINS** Law of toothed gearing – Involutes and cycloidal tooth profiles – Spur Gear terminology and definitions – Gear tooth action – contact ratio – Interference and undercutting – Non–standard gear teeth – Helical, Bevel, Worm, Rack and Pinion gears – Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains – Differentials – Automobile gear box.	9
IV	**FRICTION AND FRICTION DRIVES** Surface contacts –Friction in screw threads -Friction clutches -Belt and rope drives, Friction aspects in Brakes.	9
V	**GOVERNORS** Governors - Types - Centrifugal governors – Porter & Proell governor, Hartnell, Hartung – Characteristics.	9
	Total Instructional Hours	**45**

Course Outcome	CO1: Classify mechanisms and inversions and determine mobility of a mechanism. CO2: Construct cam profiles for various followers and turning moment diagram for flywheel. CO3: Classify various gear trains and apply to automation. CO4: Apply friction principles to clutches, belt, brake and screw. CO5: Evaluate the sensitivity of governor.

TEXT BOOKS

T1 -Ratan.S.S, "Theory of Machines", Tata McGraw Hill Publishing company Ltd., 2nd Edition, 2005.

T2 -Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 3rd Edition, 1984.

REFERENCE BOOKS

R1 -Shigley.J.E, and Uicker.J.J, "Theory of Machines and Mechanisms", McGraw Hill, 1995.

R2 -Ghosh.A, and Mallick.A.K, "Theory of Mechanisms and Machines" , Affiliated East-West Pvt Ltd.,New Delhi, 1988.

R3 -Rao.J.S, and Dukkipati.R.V, " Mechanism and Machine Theory" , Wiley-Eastern Ltd., New Delhi,1995

R4 - Khurmi R.S., "Theory of Machines" Khanna Publishers, Delhi, 2006.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16CE3207	**SURVEYING AND LEVELLING**	3	0	0	3

Course Objective	1. To gain knowledge on basic principle and concepts of different surveying methods. 2. To learn how to use compass to carryout land surveying. 3. To learn the basics of leveling and its applications. 4. To explore the types and characteristics of contours. 5. To understand the concepts of Theodolite survey in linear and angular measurements.

Unit	Description	Instructional Hours
I	**FUNDAMENTALS AND CHAIN SURVEYING** Definition- Classifications - Basic principles – Equipment and accessories for ranging and chaining – Methods of ranging - well conditioned triangles - computation of cross sectional areas (Simpon's rule and Trapezoidal rule) Aligning, Ranging and Chaining Computation of area of the plot using Chain traversing	**9**
II	**COMPASS AND PLANE TABLE SURVEYING** Compass – Basic principles - Types - Bearing systems and conversions – Sources of Errors - Local attraction - applications - Plane table and its accessories - Merits and demerits. Computation of included angle between stations using Compass Traversing Plane table Surveying - Radiation Method Plane table Surveying – Intersection Method	**9**
III	**LEVELLING** Levelling- Principles and theory of Levelling - Datum - Bench Marks – Temporary and Permanent Adjustments- Methods of Levelling - Sources of errors in Levelling Fly levelling using Dumpy Level (Height of Instrument and Rise & Fall method).	**9**

IV	**CONTOURING** Contouring - Methods – Characteristics and uses of contours - Plotting – Methods of interpolating contours – Earthwork calculations - Capacity of reservoirs - Mass haul diagrams. Grid Contouring.	**9**
V	**THEODOLITE AND MODERN SURVEYING** Theodolite – components of theodolite - Temporary and permanent adjustments - Heights and distances by single plane and double method. Computation of area by Theodolite Traverse Introduction to Total Station- Global Positioning System (GPS)	**9**
	Total Instructional Hours	**45**

Course Outcome	Upon successful completion of the course, students shall have ability to CO1: Carryout preliminary surveying to prepare a layout of a given area. CO2: Apply compass surveying and plane table surveying. CO3: Understand the basics of leveling and measure the elevations. CO4: Plot contours and also calculate the capacity of reservoirs. CO5: To carry out linear and angular measurements using theodolite

TEXT BOOKS

T1 - Punmia, B. C., “Surveying”, Vol.1, Laxmi Publications, New Delhi. 2015.
T2 - Chandra A.M., “Plane Surveying”, New Age International Publishers, 2015.

REFERENCE BOOKS

R1 - Alak De, “Plane Surveying”, S. Chand & Company Ltd., 2000.
R2 - Bannister and S. Raymond, R. Baker "Surveying", 7th Edition, Pearson Education Ltd., 2009.
R3 - Roy S.K., "Fundamentals of Surveying", 2nd Edition, Prentice Hall of India, 2010.

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	Course Code	Name of the Course	L	T	P	C
B.E	16ME3233	**THERMODYNAMICS**	3	1	0	4

Course Objective

1. To learn about the energy conversion.
2. To study the energy degradation in thermodynamic systems.
3. To learn the behavior of pure substances and working principle of steam power cycles.
4. To study the properties of atmospheric air and its applications.
5. To study the concepts, laws and methodologies and integrate it into analysis of cyclic processes and IC engines.

Unit	Description	Instructional Hours
I	**FIRST LAW OF THERMODYNAMICS** Basic concepts- Zeroth law of thermodynamics, First law of thermodynamics –application to closed and open systems – steady and unsteady flow processes. Simple problems on closed and open systems.	12
II	**SECOND LAW OF THERMODYNAMICS** Heat Reservoir, source and sink. Heat Engine, Refrigerator, and Heat pump. Statements of second law and its corollaries. Carnot cycle, Clausius inequality. Concept of entropy. Simple problems on efficiency and Performance.	12
III	**PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE** Formation of steam and its thermodynamic properties. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Estimation of steam properties. Rankine cycle, Reheat Cycle and its calculations.	12
IV	**GAS MIXTURES AND PROPERTIES OF AIR** Properties of Ideal and real gases, Equations of state, Gas laws and Gas mixtures. Psychrometric properties, process and Applications. Property calculations of air using psychrometric chart and expressions.	12
V	**GAS POWER CYCLES AND IC ENGINES** Otto, Diesel and Brayton cycles. Simple problems on cycle analysis. IC Engines - Classification - Components and their functions. Working of four stroke SI and CI engines.	12
	Total Instructional Hours	**60**

Course Outcome

Upon completion of this course, the students will be able to:

CO1: Understand the thermodynamic principles and its applications.
CO2: Quantify the energy conversion in various thermal systems.
CO3: Apply the thermodynamic principles for predicting the properties of steam, gas and gas mixtures.
CO4: Apply the psychrometric principles for design of air conditioning systems.
CO5: Understand the process of air standard cycles and IC engine working.

TEXT BOOK:

T1 - Nag.P.K., “Engineering Thermodynamics”, 4th Edition, Tata McGraw-Hill, New Delhi, 2008.
T2 - Cengel. Y. and MBoles, "Thermodynamics - An Engineering Approach",7th Edition, TataMcGraw Hill, 2010.

REFERENCES:

R1 - Natarajan E., "Engineering Thermodynamics: Fundamentals and Applications", Anuragam Publications, 2012.
R2 - Holman.J.P., "Thermodynamics", 3rd Edition. McGraw-Hill, 1995.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E	16ME3232	THEORY OF MACHINES	3	0	0	3

Course Objective

1. To understand the purpose of kinematics, Kinematic joint and mechanism and to study the relative motion of parts in a machine without taking into consideration the forces involved.
2. To understand the theories and applications of cams and Flywheels.
3. To understand applications of different types of gears and gear profiles and its efficiency and gear trains.
4. To understand principles of friction applied to screw threads, clutches, brakes, belt and rope drives.
5. To know principles of governors.

Unit	Description	Instructional Hours
I	**BASICS OF MECHANISMS** Introduction - Links - Pairs - Chain - Mechanism - Machine structure - Degrees of freedom - Four bar chains - Terminology and definition - Planar, Spherical and Spatial Mechanisms - Grashoff's law - Kutzback criterion - Grubler's criterion for plane mechanism. Inversion of mechanisms - Four bar, single slider crank and double slider crank mechanisms.	9
II	**CAM AND FLYWHEEL** Types of cams and followers - Follower motion - Uniform, Parabolic, SHM and cycloidal. Cam terminology - Cam profiles construction for roller, flat faced and knife edge follower. Flywheels of engines and punching press- Turning moment diagrams – Fluctuation of energy, speed.	9
III	**GEARS AND GEAR TRAINS** Law of toothed gearing – Involutes and cycloidal tooth profiles – Spur Gear terminology and definitions – Gear tooth action – contact ratio – Interference and undercutting – Non–standard gear teeth – Helical, Bevel, Worm, Rack and Pinion gears – Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains – Differentials – Automobile gear box.	9
IV	**FRICTION AND FRICTION DRIVES** Surface contacts –Friction in screw threads -Friction clutches -Belt and rope drives, Friction aspects in Brakes.	9
V	**GOVERNORS** Governors - Types - Centrifugal governors – Porter & Proell governor, Hartnell, Hartung – Characteristics.	9
	Total Instructional Hours	**45**

Course Outcome

CO1: Classify mechanisms and inversions and determine mobility of a mechanism.
CO2: Construct cam profiles for various followers and turning moment diagram for flywheel.
CO3: Classify various gear trains and apply to automation.
CO4: Apply friction principles to clutches, belt, brake and screw.
CO5: Evaluate the sensitivity of governor.

TEXT BOOKS:

T1 -Ratan.S.S, “Theory of Machines”, Tata McGraw Hill Publishing company Ltd., 2nd Edition, 2005.
T2 -Thomas Bevan, “Theory of Machines”, CBS Publishers and Distributors, 3rd Edition, 1984.

REFERENCE BOOKS :

R1 -Shigley.J.E, and Uicker.J.J, “Theory of Machines and Mechanisms”, McGraw Hill, 1995.
R2 -Ghosh.A, and Mallick.A.K, “Theory of Mechanisms and Machines” , Affiliated East-West Pvt Ltd., New Delhi, 1988.
R3 -Rao.J.S, and Dukkipati.R.V, “ Mechanism and Machine Theory” , Wiley-Eastern Ltd., New Delhi, 1995
R4 - Khurmi R.S., “Theory of Machines” Khanna Publishers, Delhi, 2006.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG3001	**FLUID MECHANICS LABORATORY**	0	0	4	2

Course Objective	1. Students should be able to verify the principles studied in theory by performing the experiments in lab.

LIST OF EXPERIMENTS

1. **Flow Measurement**
   - Calibration of Rotameter
   - Flow through Venturimeter
   - Flow through a circular Orifice
   - Determination of mean velocity by Pitot tube
   - Flow through a Triangular Notch
   - Flow through a Rectangular Notch
2. **Losses in Pipes**
   - Determination of friction coefficient in pipes
   - Determination of losses due to bends, fittings and elbows
3. **Pumps**
   - Characteristics of Centrifugal pump
   - Characteristics of Submersible pump
   - Characteristics of Reciprocating pump

OUTCOMES:

1. The students will be able to measure flow in pipes and determine frictional losses.
2. The students will be able to develop characteristics of pumps and turbines.

LIST OF EQUIPMENTS REQUIRED

- Rotameter – 1 no.
- Venturimeter – 1 no.
- Orificemeter – 1 no.
- Pitot tube – 1 no.
- Bernoulli‟s therorem apparatus – 1 no.
- Triangular notch and Rectangular notch – 1 each (with a lined open channel setup)
- Coefficient of friction apparatus
- Pipe setup with bends, fittings and elbows for estimating minor losses
- Centrifugal pump, Reciprocating pump, Submersible pump, Jet pump – 1 each

Collecting tank, Stop watch – 1 no. for each experiment

REFERENCES:

1. Hydraulic Laboratory Manual, Centre for Water Resources, Anna University, 2004.
2. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics. Standard Book House, New Delhi, 2000.
3. Subramanya, K. Flow in Open Channels, Tata McGraw - Hill Pub. Co.1992.
4. Subramanya, K. Fluid Mechanics, Tata McGraw- Hill Pub. Co., New Delhi, 1992.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16CE3004	**SURVEYING AND LEVELLING LABORATORY**	0	0	4	2

Course Objective	To train the student to acquire skill in operation various surveying and leveling instruments

CHAIN SURVEYING

Ranging, Chaining and Pacing Chain traversing

COMPASS SURVEYING Triangulation Problem Compass traversing

- **PLANE TABLE SURVEYING**
  Radiation
  Intersection - Triangulation problem Plane table traversing
- **THEODOLITE SURVEYING**
  Measurement of horizontal & vertical angles Tangential & Stadia Tacheometry
- **LEVELLING**
  Fly levelling using Dumpy level Fly levelling using Tilting level Check levelling
  Block Levelling Radial Contouring

- **DEMONSTRATION OF TOTAL STATION AND GP**

OUTCOME:

- Students completing this course would have acquired practical knowledge on handling basic survey instruments including leveling and development of contour map of given area.

TOTAL: 60 PERIODS

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

Sl.No.	Description of Equipment	Quantity
1.	Total Station	3 Nos
2.	Theodolites	Atleast 1 for every 5 students
3.	Dumpy level / Filling level	Atleast 1 for every 5 students
4.	Pocket stereoscope	1
5.	Ranging rods	1 for a set of 5 students
6.	Levelling staff	
7.	Cross staff	
8.	Chains	
9.	Tapes	
10.	Arrows	
11.	Prismatic Compass	10 nos
12.	Surveyor Compass	2 nos
13.	Survey grade or Hand held GPS	3 nos

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SEMESTER IV

Programme/Sem	Course Code	Name of the Course	L	T	P	C
BE/IV	**16MA4112**	**APPLIED STATISTICS & NUMERICAL METHODS** (AGRI, BIO MEDICAL & FOOD TECHNOLOGY)	3	0	2	4

Course Objective	1. Determine the measures of central tendency and dispersion along with R studio. 2. Employ some basic concepts of statistical methods for testing the hypothesis together with R studio. 3. Analyze the design of experiment techniques to solve various engineering problems accompanying with R studio. 4. Apply various methods to find the intermediate values for the given numerical data. 5. Explain concepts of numerical differentiation and numerical integration of the unknown functions.

Unit	Description	Instructional Hours
I	**MEASURE OF CENTRAL TENDENCY AND DISPERSION** Measure of central tendency – mean, median, mode –Measure of dispersion – range – Quartile deviation – Standard deviation – Coefficient of Variation.	9
II	**HYPOTHESIS TESTING** Large sample test based on Normal distribution – test of significance for single mean and difference of means -Small sample test – t test for single mean and difference of mean - F distribution for variance, Chi – Square test for independence of attributes – Goodness of fit.	9
III	**ANALYSIS OF VARIANCE** Introduction, assumptions of analysis of variance, Completely randomized design, Randomized block design, Latin square design.	9
IV	**INTERPOLATION** Interpolation: Newton's forward and backward difference formulae Lagrangian interpolation for unequal intervals – Divided difference for unequal intervals : Newton's divided difference formula.	9
V	**NUMERICAL DIFFERENTIATION AND INTEGRATION** Differentiation using interpolation formula – Newton's forward and backward interpolation formulae for equal intervals – Newton's divided difference formula for unequal intervals - Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules.	9
	Total Instructional Hours	**45**

LAB COMPONENTS USING R-STUDIO

1. Introduction to R programming
2. Application of descriptive statistics – Mean, Median, Mode, variance

3. Applications of Box plot, Pie chart, Histogram
4. Application of Student t- test
5. Application of F test
6. Application of Chi – square test
7. ANOVA – completely randomized design
8. ANOVA – randomized block design

Instructional Hours - Lab 15

Course Outcome	CO1: Familiar with Measures of Central Tendency and Measures of Dispersion. CO2: Understand the concepts of statistical methods for testing the hypothesis. CO3: Apply Design of Experiment techniques to solve various engineering problems CO4: Understand the concept of interpolation in both cases of equal and unequal intervals. CO5: Identify various methods to perform numerical differentiation and integration.

TEXT BOOKS

- T1-Gupta, S.C., & Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, Reprint 2011.
- T2 - M.K.Jain,S.R.K.Iyengar, R.K.Jain "Numerical methods for Scientific and Computation", Fifth Edition,
- New Age International publishers 2010.

REFERENCE BOOKS

- R1 - Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.
- R2 - Grewal B.S. and Grewal J.S. " Numerical Methods in Engineering and Science ", 6th Edition , Khanna publishers, New Delhi 2014.
- R3 - S.K.Gupta, Numerical Methods for Engineers" , New Age Internationalm Pvt.Ltd Publishers,2015.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG4201	**UNIT OPERATIONS IN AGRICULTURAL PROCESSING**	3	0	0	3

Course Objective	The students would be exposed to the fundamental knowledge in Evaporation,
	To understand Filtration, Sedimentation, Processing, Sieve analysis,
	To learn Crystallization and Distillation in processing of agricultural produce.

UNIT I
EVAPORATION AND CONCENTRATION 9

Unit operations in food processing –conservation of mass and energy – overall view of an engineering process-dimensions and units – dimensional and unit consistency – dimensionless ratios-evaporation – definition – liquid characteristics – single and multiple effect evaporation- performance of evaporators and boiling point elevation – capacity – economy and heat balance- types of evaporators – once through and circulation evaporators – short tube evaporators and long tube evaporators – agitated film evaporator

UNIT II
MECHANICAL SEPARATION 9

Filtration – definition –filter media – types and requirements-constant rate filtration – constant pressure filtration – filter cake resistance-filtration equipment – rotary vacuum filter – filter press- sedimentation – gravitational sedimentation of particles in a fluid – Stoke‟s law, sedimentation of particles in gas-cyclones – settling under sedimentation and gravitational sedimentation-centrifugal separations – rate of separations – liquid – liquid separation – centrifuge equipment.

UNIT III
SIZE REDUCTION
9

Size reduction – grinding and cutting – principles of comminuting – characteristics of comminuted products – particle size distribution in comminuted products-energy and power requirements in comminuting – crushing efficiency – Rittinger‟s, Bond‟s and Kick‟s laws for crushing-size reduction equipments – crushers – jaw crusher, gyratory crusher-crushing rolls – grinders – hammer mills – rolling compression mills - attrition, rod, ball and tube mills – construction and operation.

UNIT IV
CONTACTEQUILIBRIUM SEPARATION 9

Contact equilibrium separation processes – concentrations – gas-liquid and solid-liquid equilibrium equilibrium concentration relationships – operating conditions-calculation of separation in contact equilibrium processes-gas absorption – rate of gas absorption – stage – equilibrium gas – absorption equipment-properties of tower packing – types – construction – flow through packed towers-extraction – rate of extraction – stage equilibrium extraction-equipment for leaching coarse solids – intermediate solids – basket extractor-extraction of fine material – Dorr agitator – continuous leaching – decantation systems – extraction towers-washing – equipments

UNIT V
CRYSTALLISATION AND DISTILLATION 9

Crystallization-Equilibrium –Rate of crystal growth stage-Equilibrium crystallization-Crystallizers-Equipment-Classification- Construction and operation – Crystallizers-Tank-Agitated batch- Swenson-Walker and Vacuum crystallizers-Distillation-Binary mixtures-Flash and differential distillation-Steam distillation –Theory-Continuous distillation with rectification –Vacuum distillation - Batch distillation-Operation and process-Advantages and limitation-Distillation equipments- Construction and operation-Factors influencing the operation.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

At the end of the study the student will have knowledge on

- Fundamentals of various unit operations of Agricultural Processing.
- Material handling equipment's

TEXTBOOKS

1. Earle, R.L., "Unit operations in Food Processing", Pergamon Press, Oxford, U.K, 1985.
2. McCabe, W.L., and Smith, J.C., "Unit Operations of Chemical Engineering", Mc-Graw-Hill Inc.,

Kosaido Printing Ltd., Tokyo, 1990.
3. Geankoplis, C.J. “Transport Processes and Separation Process Principles”, 4th Edition, Prentice Hall, 2003.

REFERENCES

1. Coulson, J.M and J.F. Richardson. Chemical Engineering. Volume I to V. The Pergamon Press. New York, 1999.
2. Albert Ibarz and Gustavo V. Barbosa-Cánovas. Unit Operations in Food Engineering. CRC Press LLC, Florida, 2003..

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG4202	**FARM TRACTORS**	3	0	0	3

Course Objective	To introduce the students to the different systems and working principles of tractor, power tiller, makes of tractors and power tillers.
	To learn classification of tractors, various components, hydraulic systems
	To acquire knowledge on Power tiller, Bull dozers, testing of tractors, performance of various machines

UNIT I

TRACTORS **9**

Classification of tractors - Tractor engines – construction of engine blocks, cylinder head and crankcase - features of cylinder, piston, connecting rod and crankshaft – firing order combustion chambers.

UNIT II

ENGINE SYSTEMS **9**

Valves-inlet and outlet valves – valve timing diagram. Air cleaner- exhaust – silencer. Cooling systems - lubricating systems - fuel system – governor- electrical system.

UNIT III

TRANSMISSION SYSTEMS **9**

Transmission - clutch - gear box - sliding mesh - constant mesh - synchro mesh. Differential, final drive and wheels. Steering geometry - steering systems - front axle and wheel alignment. Brake - types - system.

UNIT IV

HYDRAULIC SYSTEMS **9**

Hydraulic system - working principles, three point linkage - draft control - weight transfer, theory of traction - tractive efficiency – tractor chassis mechanics - stability - longitudinal and lateral. Controls - visibility - operators seat.

UNIT V

POWER TILLER, BULLDOZER AND TRACTOR TESTING 9

Power tiller - special features - clutch - gear box - steering and brake. Makes of tractors, power tillers and bulldozers. Bulldozer- salient features – turning mechanism, track mechanism, components – operations performed by bulldozers. Types of tests- test procedure - need for testing & evaluation of farm tractor -

Test code for performance testing of tractors and powertillers.

TOTAL: 45 PERIODS

Course Outcomes:

- The students will be able to understand the various equipments and mechanizations used in the farm.
- The students will have the knowledge on earth moving machinaries, tractor classification and tillage implements.

TEXTBOOK:

1. Jain, S.C. and C.R. Rai. Farm tractor maintenance and repair. Standard publishers and distributors, New Delhi, 1999.

REFERENCES:

1. Barger, E.L., J.B. Liljedahl and E.C. McKibben, Tractors and their Power Units. Wiley Eastern Pvt. Ltd., New Delhi, 1997.
2. Domkundwar A.V. A course in internal combustion engines. Dhanpat Rai & Co. (P) Ltd., Educational and Technical Publishers, Delhi,1999.
3. Black, P.O. Diesel engine manual. Taraporevala Sons& Co., Mumbai, 1996.
4. Grouse, W.H. and Anglin, D.L. Automative mechanics. Macmillan McGraw- Hill, Singapore, Indian Standard Codes for Agricultural Implements Published by ISI, New Delhi, 1993.
5. Jagadeeshwar Sahay, Elements of Agricultural Engineering, Standard Publishers Co., New Delhi, 2010.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG4203	**HYDROLOGY AND WATER RESOURCES ENGINEERING**	3	0	0	3

Course Objective	To introduce the student to the concept of hydrological aspects of water availability and requirements
	The students will be be able to quantify, control and regulate the water resources.
	To develop analytical skills on spatial analysis, rainfall data and designing water reservoirs

UNIT I

PRECIPITATION AND ABSTRACTIONS **10**

Hydrological cycle- Meteorological measurements – Requirements, types and forms of precipitation - Rain gauges-Spatial analysis of rainfall data using Thiessen and Isohyetal methods-Interception - Evaporation. Horton's equation, pan evaporation measurements and evaporation suppression - Infiltration-Horton's equation - double ring infiltrometer, infiltration indices.

UNIT II

RUNOFF **8**

Watershed, catchment and basin - Catchment characteristics - factors affecting runoff - Run off

estimation using empirical - Strange's table and SCS methods – Stage discharge relationships- flow measurements- Hydrograph – Unit Hydrograph – IUH

UNIT III

FLOOD AND DROUGHT **9**

Natural Disasters-Flood Estimation- Frequency analysis- Flood control- Definitions of droughts- Meteorological, hydrological and agricultural droughts- IMD method-NDVI analysis- Drought Prone Area Programme (DPAP)

UNIT IV

RESERVOIRS **8**

Classification of reservoirs, General principles of design, site selection, spillways, elevation – area capacity - storage estimation, sedimentation - life of reservoirs – rule curve

UNIT V

GROUNDWATER AND MANAGEMENT **10**

Origin- Classification and types - properties of aquifers- governing equations – steady and unsteady flow - artificial recharge - RWH in rural and urban areas

TOTAL: 45 PERIODS

COURSE OUTCOMES:

The students completing the course will have

- an understanding of the key drivers on water resources, hydrological processes and their integrated behaviour in catchments,
- ability to construct and apply a range of hydrological models to surface water and groundwater problems including Hydrograph, Flood/Drought management, artificial recharge
- ability to conduct Spatial analysis of rainfall data and design water storage reservoirs
- Understand the concept and methods of ground water management.

TEXTBOOKS:

1. Subramanya .K. "Engineering Hydrology"- Tata McGraw Hill, 2010
2. Jayarami Reddy .P. "Hydrology", Tata McGraw Hill, 2008.
3. Linsley, R.K. and Franzini, J.B. "Water Resources Engineering", McGraw Hill International Book Company, 1995.

REFERENCES:

1. David Keith Todd. "Groundwater Hydrology", John Wiley & Sons, Inc. 2007
2. Ven Te Chow, Maidment, D.R. and Mays, L.W. "Applied Hydrology", McGraw Hill International Book Company, 1998.
3. Raghunath .H.M., "Hydrology", Wiley Eastern Ltd., 1998.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG4204	**IRRIGATION AND DRAINAGE ENGINEERING**	3	0	0	3

Course Objective	• At the completion of the course the students should be able to understand the necessity of planning an irrigation system to provide water at the right time and right place.
	• To understand the basic concepts for planning, design and management of land drainage works in cultivated areas

UNIT I

WATER RESOURCES AND IRRIGATION REQUIREMENT 9

Water Resources- River basins-Development and Utilization in India and Tamil Nadu-Irrigation – duty and delta - Rooting characteristics - Moisture use of crop, Evapotranspiration - ET plot - Crop water requirement - Effective rainfall - Scheduling - Irrigation requirement - Irrigation frequency, Irrigation efficiencies.

UNIT II

METHODS OF IRRIGATION 9

Methods of Irrigation – Surface and Subsurface methods – Drip and Sprinkler - Hydraulics and design - Erodible and non-erodible, Kennedy‟s and Lacey‟s theories, Materials for lining water courses and field channel, Water control and diversion structure - Underground pipeline irrigation system

UNIT III

DIVERSION AND IMPOUNDING STRUCTURES 9

Head works –Weirs and Barrage –Types of impounding structures - Factors affecting, location of dams - Forces on a dam -Design of Gravity dams- Earth dams, Arch dams – Spillways -Energy dissipaters.

UNIT IV CANAL IRRIGATION AND COMMAND AREA DEVELOPMENT 9

Classification of canals- Alignment of canals – Design of irrigation canals– Regime theories - Canal Head works – Canal regulators - Canal drops – Cross drainage works – Canal Outlet, Escapes –Lining and maintenance of canals - Excess irrigation and waterlogging problem - Command area - Concept, Components of CADP - On Farm Development works, Farmer‟s committee - its role for water distribution and system operation - rotational irrigation system.

UNIT V

AGRICULTURAL DRAINAGE 9

Agricultural drainage - Drainage coefficient; principles of flow through soils, Darcy‟s law – infiltration theory, Surface drainage systems - Subsurface drainage - Design of subsurface drainage - Pipe materials - mole drains, drainage wells, Leaching requirements - irrigation and drainage water quality - recycling of drainage water for irrigation.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will have knowledge and skills on Planning, design, operation and management of reservoir system.
- The student will gain knowledge on different methods of irrigation including canal irrigation.

TEXTBOOKS

1. Dilip Kumar Majumdar., “Irrigation Water Management”, Prentice-Hall of India, New Delhi, 2008.
2. Michael, A.M., “Irrigation Engineering”, Vikas Publishers, New Delhi, 2008.
3. Garg, S.K., “Irrigation Engineering,” Laxmi Publications, New Delhi, 2008.
4. Ritzema, H.P., “Drainage Principles and Applications”, Publication No. 16, International Institute of Land Reclamation and Improvement, Netherlands, 1994.

REFERENCES:

1. Basak, N.N., “Irrigation Engineering”, Tata McGraw-Hill Publishing Co, New Delhi, 2008.
2. Murthy, V.V.N. Land and water management, Kalyani publishing, New Delhi, 1998.
3. Bhattacharya, A.K., and Michael, A.M., “Land Drainage – Principles, Methods and Applications”, Konark Publishers Pvt. Ltd., New Delhi, 2003.
4. Irrigation water Management, Training Manual No 6, Drainage of Irrigated Lands, Food and Agriculture Organisation, Rome 1996
5. Kessler, J., “Drainage Principles and Applications”, Vol. II and IV, International Institute of Land Reclamation and Improvement, Netherlands, 1979.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG4231	**STRENGTH OF MATERIALS**	3	0	0	3

Course Objective	To understand the stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.
	To understand deformation of solids, learn deflection of beams, torsion formula

UNIT I

STRESS, STRAIN AND DEFORMATION OF SOLIDS **9**

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains - Thin shells - circumferential and longitudinal stresses in thin cylinders - deformation of thin cylinder – stresses in spherical shells – Deformation of spherical shells.

UNIT II

ANALYSIS OF PLANE TRUSSES **9**

Determinate and indeterminate plane trusses – determination of member forces by method of joints, method of sections and method of tension coefficient.

UNIT III

TRANSVERSE LOADING AND STRESSES IN BEAM **9**

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over-hanging beams. Theory of simple bending– bending stress distribution – Shear stress distribution - Flitched beams – carriage springs.

UNIT IV

TORSION **9**

Torsion formula - stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs - carriage springs.

UNIT V

DEFLECTION OF BEAMS **9**

Computation of slopes and deflections in determinate beams - Double Integration method – Macaulay‟s method – Area moment method – Conjugate beam method.

TOTAL : 45 PERIODS

OUTCOMES:

- Upon completion of this course, the students can able to apply mathematical knowledge to calculate the deformation behavior of simple structures.
- Critically analyse problem and solve the problems related to structural elements and analyse the deformation behavior for different types of loads.

TEXTBOOKS

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2007

REFERENCES

1. Egor. P.Popov “Engineering Mechanics of Solids” Prentice Hall of India, New Delhi, 2001
2. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series,2007.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2007
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing „co. Ltd., New Delhi, 2005.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG4001	**SOIL SCIENCE LABORATORY**	0	0	4	2

Course Objective	• Students should be able to verify various quality aspects of soil and water studied in theory by performing experiments in lab. 1. Identification of rocks and minerals 2. Collection and processing of soil samples 3. Determination of soil moisture, EC and pH 4. Field density determination by Core Cutter and Sand Replacement method 5. Specific gravity determination by Pycnometer 6. Textural analysis of soil by International Pipette method 7. Grain size analysis by using Mechanical shaker 8. Determination of Organic carbon 9. Estimation of Gypsum requirements

TOTAL : 30 PERIODS

COURSE OUTCOME:

- Students know the techniques to determine various physical and chemical properties of soil that are applicable for agriculture and irrigation by conducting appropriate tests.

REFERENCES:

1. Punmia, B.C, "Soil Mechanics and Foundation Engineering", Laxmi Publishers, New Delhi. 2007.
2. Laboratory Manual, Centre for Water Resources, Anna University, Chennai. 2012.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG4002	**IRRIGATION FIELD LABORATORY**	0	0	4	2

Course Objective	To expose the students in various meteorological instruments
	To study various aspects of soil moisture dynamics
	To evaluate surface irrigation systems and design modern irrigation systems like drip, sprinkler irrigation systems
	To determine various irrigation efficiencies, distribution uniformity

LIST OF EXPERIMENTS

1. To study various instruments in the Meteorological Laboratory
2. Determination of infiltration rate using double ring and digital infiltrometer
3. Determination of soil moisture wetting pattern for irrigation scheduling
4. Design of Drip irrigation system
5. Design of sprinkler irrigation system
6. Measurement of flow properties in open irrigated channels (flumes, notches)
7. Evaluation of surface irrigation
8. Determination of uniformity coefficient for drip irrigation system
9. Determination of uniformity coefficient for sprinkler system (catch can method)
10. To conduct experiment on disc filter for micro irrigation systems

TOTAL: 60 PERIODS

LIST OF EQUIPMENTS REQUIRED

1. Meteorological lab with Cup counter anemometer, Sunshine recorder, Open pan

vaporimeter, Stevenson's screen - Dry bulb, wet bulb thermometers, recording and non-recording type rain gauge etc. – each 1 no.

2. Double ring infiltrometer – 1 no.
3. Digital infiltrometer – 1 no.
4. Parshall flume, cut throat flume – 1 no. each
5. V notch, Rectangular notch and trapezoidal notch – 1 no. each
6. Drip irrigation system with all accessories
7. Sprinkler irrigation system with all accessories
8. Required number of stop watches
9. Weighing balance – 1 no.
10. Catch cans, measuring jars – required numbers

COURSE OUTCOME:

- On the completion of the course the student will have the knowledge on various meteorological instruments and understanding the concept of different irrigational systems in the laboratory tests.

REFERENCES:

1. Michael, A.M., "Irrigation Theory and Practice", Vikas Publishing House, New Delhi, 1999.
2. Asawa, G.L., "Irrigation Engineering", New Age International Private Limited, New Delhi, 1996.
3. Laboratory Manual, Centre for Water Resources, Anna University, Chennai.

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SEMESTER V

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16AG5201	Refrigeration and Cold chain management	3	0	0	3	25	75	100	PC
2	16AG5202	Farm Machinery and Equipment	3	0	0	3	25	75	100	PC
3	16AG5203	Design of Farm Implements and Machinery	3	0	0	3	25	75	100	PC
4	16AG5204	Post Harvest Technology	3	0	0	3	25	75	100	PC
5	16AG53XX	Professional Elective –I Evapotranspiration and Smart Irrigation.	3	0	0	3	25	75	100	PE
PRACTICAL										
6	16AG5001	Operation and Maintenance of Farm	0	0	4	2	50	50	100	PC

		Machinery Lab								
7	16AG5002	Post Harvest Engineering Laboratory	0	0	4	2	50	50	100	PC
		Total	**18**	**2**	**8**	**19**			**800**	

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5201**	**REFRIGERATION AND COLD CHAIN MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objective	• To understand the principles of unit operations involved in different Refrigeration and cold storage systems and its components. • To impart basic knowledge on design and maintenance aspects related to cold storage systems

Unit	Description	Instructional Hours
I	**REFRIGERATION PRINCIPLES** Refrigeration – principles - refrigeration effect – coefficient of performance – units of refrigeration - simple vapour compression cycle – T-S diagram – P-H chart - application of refrigeration	**6**
II	**VAPOUR COMPRESSION REFRIGERATION AND COMPONENTS** Vapour compression system - refrigeration components – compressor and condenser – types, construction and working - expansion device and evaporators – types, construction and working	**6**
III	**REFRIGERANTS AND VAPOUR ABSORPTION CYCLE** Refrigerants – properties – classification – comparison and advantages – chloroflouro carbon (CFC) refrigerants - effect on environmental pollution - alternate refrigerants - vapour absorption cycle – theoretical - deviation in practice - Electrolux refrigerator – construction and principles.	**9**
IV	**SHELF – LIFE OF FOOD PRODUCTS** Defining overall Shelf-life, remaining shelf life in the context of Chilled & Frozen foods; - Deterioration modes of food items; Models of quality deteriroration- Kinetic model; shelf-life model; Q10/q10 model; TTT model for the remaining shelf – life; General procedure for shelf – life testing – the 11 steps procedure. Storage of frozen foods; - Basic design requirements of storage to uphold the shelf –life – size , insulation, entry –exit position, palletization, proper disk-space for air-circulation, automatic door – closing, proper lighting, temperature monitoring and recording facility; stacking systems, emergency exits, material handling devices like fork-lifts, pallet trucks, etc floor heaters, vapour barriers, etc.	**12**
V	**COLD CHAIN MANAGEMENT** The premises of cold chain - Need for the chain for chilled / frozen food item, various links of the chain; importance of shelf- life; just – in-time deliveries;	**12**

	Temperature limits;-in various countries-Europe, US, Australia etc; Chilling and freezing;- Chilling injury, cook-chilling systems; cold – shortening; PPP and TTT concepts; Temperature monitoring; -Critical temperatures; Temperature –time indicators(TTI); Time –temperature –correlation-the kinetic approach, effective temperature; Transportation regulations; Role of packaging in cold chain– MAS, MAP, CAS, CAP etc; Thaw indicators.	
	Total Instructional Hours	**45**

Course Outcome	• Upon completion of this course, the students will be able to demonstrate the operations in different Refrigeration & cold storage systems • They will also able to design Refrigeration & Cold storage systems.

TEXT BOOKS:	
T1	Anand, M.L. "Refrigeration& Air-Conditioning". Asian Books Pvt., Ltd., 2002.
T2	Sun, Da-Wen. "Advances in Food Refrigeration". Leatherhead Publishing, 2001.
T3	Kennedy, Christopher J. "Managing Frozen Foods". CRC / Woodhead Publishing, 2000.
T4	James, S.J. and C. James. "Meat Refrigeration". CRC / Woodhead Publishing, 2002. 61
T5	Stringer, Mike and C. Dennis. "Chilled Foods: A Comprehensive Guide". 2nd Edition, CRC / Woodhead Publishing, 2002.
REFERENCE BOOKS:	
R1	Evans, Judith. "Frozen Food Science and Technology". Wiley-Blackwell, 2008.
R2	Hui, Y.H. etal., "Handbook of Frozen Foods". Marcel Dekker, 2004.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5202**	**FARM MACHINERY AND EQUIPMENT**	**3**	**0**	**0**	**3**

Course Objective	• To introduce the students to the working principles of farm Machinery tillage implements. (Primary and Secondary) • To expose the students to farm mechanization prospects and constraints alongside Cooperative farming for shared usage of machinery.

Unit	Description	Instructional Hours
I	**FARM MECHANIZATION** Farm mechanization – objectives - Tillage - objectives - methods – primary tillage implements - secondary tillage implements - animal drawn ploughs –	9

	construction- Types of farm implements – trailed, mounted. Field capacity - forces acting on tillage tool.	
II	**PRIMARY AND SECONDARY TILLAGE IMPLEMENTS** Mould board plough- attachments – mould board shapes and types. Disc plough – force representation on disc – Types of disc ploughs – Subsoiler plough - Rotary plough. Cultivators - types - construction. Disc harrows - Bund former - ridger – leveller. Basin lister-Wetland preparation - Puddling and Trampling implements.	9
III	**SOWING AND FERTILIZING EQUIPMENT** Crop planting - methods - row crop planting systems - Devices for metering seeds – furrow openers – furrow closers- types – Types of seed drills and planters – calibration-fertilizer metering devices - seed cum fertilizer drills – paddy transplanters – nursery tray machines.	9
IV	**WEEDING AND PLANT PROTECTION EQUIPMENT** Weeding equipment – hand hoe – long handled weeding tools – dryland star weeder – wetland conoweeder and rotary weeder – Engine operated and tractor weeders Sprayers –types-classification – methods of atomization, spray application rate, droplet size determination – volume median diameter, numerical median diameter – drift control.	9
V	**HARVESTING MACHINERY** Principles of cutting crop, types of harvesting machinery, vertical conveyor reaper, combine harvesters, threshers, tractor on top combine harvester, combine losses.	9
	Total Instructional Hours	45

Course Outcome	• The students will be able to perceive the role and significance of mechanization in sustaining agricultural production • The students will get acquainted the contextual usage of various equipment used in the farm for different field operations.

TEXT BOOKS:	
T1	Jagdishwar Sahay. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 6.,2010.
T2	Michael and Ohja. Principles of Agricultural Engineering. Jain brothers, New Delhi., 2005
REFERENCE BOOKS:	
R1	Kepner, R.A., *et al*. Principles of farm machinery. CBS Publishers and Distributers, Delhi. 99, 1997.
R2	Harris Pearson Smith *et al*. Farm machinery and equipment. Tata McGraw-Hill pub., New Delhi.,1996.
R3	Srivastava, A.C. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi, 1990.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5203**	**DESIGN OF FARM IMPLEMENTS AND MACHINERY**	**3**	**0**	**0**	**3**

Course Objective	• To impart the students with a knowledge base on the design principles of farm machinery, equipments and tillage implements. • To expose the students to the updated trends of machinery design using appropriate software for getting the drawings as guidelines for production.

Unit	Description	Instructional Hours
I	**STRESSES IN MACHINE MEMBERS** Introduction to design parameters of agricultural machines & design procedure - Characteristics of farm machinery design - factor influencing the machine design, selection of material based on mechanical properties- Direct, bending and torsional stress equations- calculation of PRINCIPAL/DEAN ACADEMIC stresses for combined loading. Design of curved beams- factor of safety – theories of failure- stress concentration- design of variable loading- Soderberg and Goodman relations	9
II	**DESIGN OF POWER TRANSMISSION SYSTEMS** Design of standard power transmission components used in agricultural machines: mechanical & hydraulic units - Selection of V-Belts and pulleys- selection of flat belts and pulleys- wire ropes and pulleys- selection of transmission chains and sprockets - Design of pulleys and sprockets- safety in power transmission- Application of design principles to the systems of selected farm machines.	9
III	**DESIGN OF SHAFTS AND COUPLINGS** Design of solid and hollow shafts based on strength and rigidity- Design of keys, keyways and splines- Design of rigid and flexible couplings. Design of bolts and nuts - knuckle and cotter joints - Critical appraisal in production of Agricultural Machinery; Advances in material used for agricultural machinery. Cutting tools including CNC tools and finishing tools. Advanced manufacturing techniques including powder metallurgy, EDM (Electro-Discharge Machining).	9
IV	**DESIGN OF ENERGY STORING ELEMENTS** Design of helical, leaf, disc and torsional springs under constant loads and varying loads – Concentric torsion springs - Heat Treatment of steels including pack carburizing, shot pining process, etc. Limits, Fits &Tolerances, Jigs & Fixtures.	9
V	**DESIGN OF GEARS AND BEARINGS** Gears - spur gear and helical gear - terminology - strength of gear teeth - Lewis equation - Buckingham equation. - Failure of gear teeth. Design of bearings – sliding contact and rolling contact types. – Cubic mean load – Design of journal bearings – Mckees equation – Lubrication in journal	9

	bearings – calculation of bearing dimensions.	
	Total Instructional Hours	45

Course Outcome	• At the end of the course the student will have the knowledge on agricultural machineries and detailed design and drawing of various components.

TEXT BOOKS:	
T1	Khurmi R.S and Gupta J.K, A Textbook of Machine Design, Euarsia publication house, 2005.
T2	Bhandari V.B, "Design of Machine Elements", Tata McGraw-Hill Book Co, 2003.
REFERENCE BOOKS:	
R1	Norton R.L, Machine Design – An Integrated Approach, Pearson Publications, 3rd Edition, 2006.
R2	Srivastava A.K., Goering.C.E. and Rohrbach R.P. Engineering Principles of Agricultural Machines. Revised Printing by American Society of Agricultural Engineers. 1993.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5204**	**POST HARVEST TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objective	• The students would be exposed to fundamental knowledge in engineering properties of agricultural materials, different Post Harvest operations and processing methods of harvested crops and storage of produces.

Unit	Description	Instructional Hours
I	**BASICS OF POST HARVEST OPERATIONS** Post harvest technology – introduction –objectives –post harvest losses of cereals, pulses and oilseeds – importance - optimum stage of harvest. Threshing – traditional methods mechanical threshers – types-principles and operation-moisture content –measurement –direct and indirect methods – moisture meters – equilibrium moisture content.	**9**
II	**PSYCHROMETRY AND DRYING** Psychrometry – importance – Psychrometric charts – Drying – principles and theory of drying – Moisture Content expressions - thin layer and deep bed drying – Hot air drying – methods of producing hot air – Types of grain dryers – selection – construction, operation and maintenance of dryers – Design of dryers	**9**
III	**CLEANING AND GRADING** Principles of Cleaning - air screen cleaners – adjustments - cylinder separator - spiral separator – magnetic separator - colour sorter - inclined belt separator – length separators - effectiveness of separation and performance index.	**9**

IV	**SHELLING AND HANDLING** Principles and operation – maize sheller, husker sheller for maize – groundnut decorticator –castor sheller – material handling – belt conveyor –screw conveyor – chain conveyor – bucket elevators – pneumatic conveying.	**9**
V	**CROP PROCESSING** Paddy processing – parboiling of paddy – methods – merits and demerits dehusking of paddy –methods – merits and demerits – rice polishers –types – constructional details – polishing –layout of modern rice mill - wheat milling – pulse milling methods – oil seed processing – millets processing.	**9**
	Total Instructional Hours	**45**

Course Outcome	1. At the end of the study the student will have knowledge on material handling equipments 2. Different Post Harvest operations and processing methods of harvested crops. 3. Fundamentals of various unit operations of Agricultural Processing.

TEXT BOOKS:	
T1	Chakraverty, A.Post harvest technology for Cereals, Pulses and oilseeds. Oxford & IBH publication Pvt Ltd, New Delhi, Third Edition, 2000.
T2	Sahay, K.M., and Singh, K.K. Unit operations of Agricultural Processing. Vikas publishing house Pvt. Ltd., New Delhi, 1994.
REFERENCE BOOKS:	
R1	Pande, P.H. Principles of Agriculture Processing. Kalyani Publishers, Ludhiana, 1994.
R2	Henderson, S.M. and R.L. Perry. Agricultural Process Engineering. John Wiley and Sons, New York. 1955.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5301**	**SYSTEMS ANALYSIS AND SOFT COMPUTING IN AGRICULTURAL ENGINEERING**	**3**	**0**	**0**	**3**

Course Objective	1. To introduce the students to the application of systems concept to agricultural engineering problems, planning and management. 2. Soft computing techniques for modeling different problems in the field agricultural engineering

Unit	Description	Instructional

		Hours
I	**SYSTEM CONCEPTS** Definition, classification, and characteristics of systems – Scope and steps in systems engineering – Need for systems approach to water resources and irrigation.	9
II	**LINEAR PROGRAMMING & DYNAMIC PROGRAMMING** Introduction to operations research – Linear programming, problem formulation, graphical solution, solution by simplex method – Sensitivity analysis – application - Bellman‟s optimality criteria, problem formulation and solutions – application.	9
III	**SIMULATION** Basic principles and concepts – Random variate and random process – Monte Carlo techniques – Model development – Inputs and outputs – Deterministic and stochastic simulation – Irrigation Scheduling - application.	9
IV	**NEURAL NETWORKS** Neuron, Nerve structure and synapse, Artificial Neuron and its model, Neural network architecture: networks, Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory- Architecture: model, solution, single layer and multilayer perception model; back propagation learning methods, applications.	9
V	**FUZZY LOGIC AND GENETIC ALGORITHM** Basic concepts of fuzzy logic, Fuzzy set theory and operations, Properties of fuzzy sets, Membership functions, interference in fuzzy logic, Fuzzy implications and Fuzzy algorithms, Fuzzy Controller, Industrial applications. Genetic Algorithm (GA) - Basic concepts, working principle, procedures, flow chart, Genetic representations, encoding, Initialization and selection, Genetic operators, Mutation - applications	9
	Total Instructional Hours	45

Course Outcome	• Upon completion of the course, the student will have the knowledge on system concepts and will be able to apply the optimization techniques like LP, DP, FL and GA for problems in agriculture.

TEXT BOOKS:	
T1	Vedula, S., and Majumdar, P.P. Water Resources Systems – Modeling Techniques and Analysis Tata McGraw Hill, New Delhi, Fifth reprint, 2010.
T2	Robert M Peart and W David Shoup, Agricultural Systems Management – Optimizing efficiency and performance, CRC Press, 2013.
T3	Gupta, P.K., and Man Mohan, “Problems in Operations Research”, (Methods and Solutions), Sultan Chand and Sons, New Delhi, 1995.
REFERENCE BOOKS:	
R1	Chaturvedi, M.C., “Water Resources Systems Planning and Management”, Tata McGraw Hill, New Delhi, 1997.
R2	Taha, H.A., “Operations Research”, McMillan Publication Co., New York, 1995.

R3	Hiller, F.S., and Liebermann, G.J., "Operations Research", CBS Publications and Distributions, New Delhi, 1992.
R4	Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.
R5	S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks,Fuzzy Logic and Genetic Algorithm: Synthesis and Applications" Prentice Hall of India.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5302**	**SUSTAINABLE AGRICULTURE AND FOOD SECURITY**	**3**	**0**	**0**	**3**

Course Objective	• To study the importance of sustainable agriculture for the growing population, various resources required and their sustainability. • Importance of science, food security and ecological balance.

Unit	Description	Instructional Hours
I	**POTENTIAL LAND RESOURCES** Land Resources of India - Population and land - Land utilization Patterns - Net Area Sown - changes in cropping pattern – Monocropping – Multiple Cropping – Mixed Cropping - land degradation – causes and effects – delineation of Agricultural Lands – Lands for non-agricultural purposes – Forests and Wild Life areas – Coastal buffers – Usable Waste Lands – Industrial Zones – Sand dunes and Deserts – Urban space for Greenery and crop production – Terrace Cultivation prospects – Heat Island effects.	**9**
II	**SUSTAINABLE WATER RESOURCES** Rainfall forecasting - Adequacy of Rainfall for crop growth – Rainfall Analysis - Lands with buffer zones for Surface water resources - Drought and production instability – Irrigation potential – Available, created and utilized – River basins; Watersheds and Utilizable surface water – Utilizable water in future – Augmentation of Groundwater – Rainfall Runoff water harvesting – Lakes and Ponds – System and non-system Tanks – Farm Ponds, Check Dams and Percolation Ponds – Water Quality Indexing	**9**
III	**SUSTAINABLE RURAL AND URBAN FARMING** Agro-ecosystems - Impact of climate change on Agriculture, Effect on crop yield, effect on Soil fertility – Food grain production at State Level – Indicators of Sustainable food availability – Indicators of food production sustenance – Natural Rural Farming principles – Sustainability in rainfed farming – organic farming – principles and practices – Urban Farming –	**9**

	Protected Cultivation Structures – Terrace and Kitchen Gardening – Hydroponics and Aquaponics - domestic food processing units	
IV	**CROP PRODUCTION AND FOOD SECURITY** Performance of Major Food Crops over the past decades – trends in food production – Decline in total factor productivity growth – Demand and supply projections – Impact of market force – Rural Land Market – Emerging Water market – Vertical farming - Sustainable food security indicators and index – Indicator of sustainability of food Security – Path to sustainable development.	**9**
V	**POLICIES AND PROGRAMMES** Food and Crop Production polices – Agricultural credit Policy – Crop insurance –Policies of Natural Resources Use – Policies for sustainable Livelihoods – Virtual water and trade - Sustainable food Security Action Plan – Regulations of Terrace Gardening product Market – Rainwater Harvesting – Biomechanical Filters – Water Quality Indexing for domestic and agricultural usage – Wastewater treatment and recycling procedures.	**9**
	Total Instructional Hours	**45**

Course Outcome	• Upon completion of this course, the students will gain knowledge on the need for sustainable agriculture • They will be able to comprehend the need for food security on global level and the Nutritional Security. • The students will be able to demonstrate how ecological balance is required for sustainability of agriculture.

TEXT BOOKS:	
T1	M.S.Swaminathan, Science and sustainable food security, World Scientific Publishing Co., Singapore, 2010.
T2	B.K.Desai and Pujari, B.T. Sustainable Agriculture : A vision for future, New India Publishing Agency, New Delhi, 2007.
REFERENCE BOOKS:	
R1	Swarna S.Vepa etal., Atlas of the sustainability of food security. MSSRF, Chennai, 2004.
R2	Sithamparanathan, J., Rengasamy, A., Arunachalam, N. Ecosystem principles and sustainable agriculture, Scitech Publications, Chennai, 1999.
R3	Tanji, K. K., and Yaron, B. Management of water use in agriculture, Springer Verlag, Berlin, Germany, 1994.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Program	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5303**	**CDM AND CARBON TRADING TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objective	• To know the basics, importance of clean development mechanism (CDM) • To know the concept of carbon trading

Unit	Description	Instructional Hours
I	**GREEN HOUSE GASES AND ENVIRONMENTAL CHANGE** Global Environmental changes-United nations framework convention on climate change-United (UNFCC)-ozone layer depletion -land degradation-air and water pollution-sea-level rise-loss of biodiversity-climatic change problem GHG emissions by different countries-developing country responsibilities - India's Greenhouse gas emissions - The conference of parties	**9**
II	**KYOTO PROTOCOL AND CDM PROJECTS** Kyoto protocol and clean development mechanism-CDM and cooperative mechanism-CDM overview administration -participation-CDM institutions-procedures CDM project cycle-project design and formulation - eligibility-additionally. Approval of (DNA) Designated National Authority. Validation and registration-monitoring-validation and certification through the source of Certified Emission Reduction (CER)	**9**
III	**TYPES AND FEATURES OF CDM** Types of CDM-topology -project activity -small scale CDM project categories-access station and cater station projects. PDO- project design document -General description of project activity-baseline methodology-monitoring methodology-auditing period-technical aspects	**9**
IV	**MONITORING OF CDM** Monitoring and verification-verification process principles of verification-report preparation-pitfalls. Joint implementation (JI)-institutions and procedures-guidelines-JI or small scale projects-JI Land Use, Land Use Change and Forestry (LULUCF) projects	**9**
V	**SUSTAINABLE ENERGY DEVELOPMENT** Low carbon technologies-low carbon building-alternative approaches-energy efficiency projects- sustainable energy policy concepts-mitigating energy related GHG emissions through renewable energy- carbon trading	**9**
	Total Instructional Hours	**45**

Course Outcome	• Examine the effects of greenhouse gas emission and explain the responsibilities of countries in GHG emission • Outline the KYOTO PROTOCOL and develop clean development mechanism (CDM) projects • Explain the features of CDM and employ monitoring and auditing techniques on CDM projects • Develop guidelines for small scale and Land Use, Land Use Change and Forestry (LULUCF) CDM projects

	• Compare the alternate techniques for lowering carbon emission

TEXT BOOKS:	
T1	MyungKyoon Lee, Baseline Methodologies for clean Development Mechanism Projects- A Guide Book-Vol.1, UNEP publication, 2005
T2	Myungkyoon Lee, Information and Guide Book - the UNEP project CD4CDM-UNEP publication, June 2004.
REFERENCE BOOKS:	
R1	Manual for project developers and policy makers-UNFCCC Publication, 2007
R2	Aukland L, Bass S, Hug S, Landell Mals N, Tipper R, Laying the Foundations for clean Development, Preparing the Land use sector London, 2002
R3	Carbon sequestration in dryland soils, World Soil Resources report No.102, Food and Agriculture Organization, Rome, 2004.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Program	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5304**	**IT IN AGRICULTURAL SYSTEMS**	**3**	**0**	**0**	**3**

Course Objective	• To impart the knowledge of electronic devices for the purpose automation in agricultural practice. • To develop AI to control agricultural system and its management.

Unit	Description	Instructional Hours
I	**BASIC ELECTRONICS CIRCUITS** Passive devices -semi conductor devices - transistors - diode circuits - amplifier circuits- oscillator circuits- thyristor circuits-Integrated circuits and operational amplifier - logic gates - flip flop – counters digital to analog - analog to digital converters microprocessor introduction	**9**
II	**PRECISION FARMING** Precision agriculture and agricultural management-Ground based sensors, Remote sensing, GPS, GIS and mapping software, Yield mapping systems, Crop production modeling.	**9**

III	**ENVIRONMENT CONTROL SYSTEM** Artificial light systems, management of crop growth in greenhouses, simulation of CO2 consumption in greenhouses, on-line measurement of plant growth in the greenhouse, models of plant production and expert systems in horticulture. Understanding and predicting world's climate system	**9**
IV	**AGRICULTURAL SYSTEMS MANAGEMENT** Agricultural systems - managerial overview, Reliability of agricultural systems, Simulation of crop growth and field operations, Optimizing the use of resources, Linear programming, Project scheduling, Artificial intelligence and decision support systems**.**	**9**
V	**E-GOVERNANCE IN AGRICULTURAL SYSTEMS** Concept of Information Technology (IT) and its application potential. Role of IT in natural resources management. Expert systems, decision support systems, Agricultural and biological databases, e-commerce, e-business systems & applications, Technology enhanced learning systems and solutions, e-learning, Rural development and information society. Internet application tools and web technology.	**9**
	Total Instructional Hours	**45**

Course Outcome	The students shall be able to understand the IT applications in environmental control systems, precision farming, agricultural systems management and weather prediction models.

TEXT BOOKS:	
T1	Hammer, G.L., Nicholls, N., and Mitchell, C., Applications of Seasonal Climate, Springer, Germany, 20
T2	Peart, R.M., and Shoup, W. D., Agricultural Systems Management, Marcel Dekker, New York, 2004.
REFERENCE BOOKS:	
R1	National Research Council, Precision Agriculture in the 21st Century, National Academies Press, Canada, 1997.
R2	H. Krug, Liebig, H.P. International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation, 1989.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5305**	**EVAPOTRANSPIRATION AND SMART IRRIGATION**	**3**	**0**	**0**	**3**

Course Objective	• To make the students understand the basic processes involved in the Evapo-transpiration (ET) routine of Crop Production. • To expose the students to the learning of field and laboratory methods in arriving at reliable values of ET for Irrigation Scheduling. • To impart the students with the fundamental understanding on different derived and empirical formulae involved in computing ET.

Unit	Description	Instructional Hours
I	**EVAPORATION AND TRANSPIRATION CONCEPTS** Conceptualization – Evaporation from Soil Surface and Water Bodies –Soil, Water and Plant Relationships - Transpiration through Vegetation – Metabolic Water Requirement – Consumptive Use – Factors affecting ET- weather parameters – Crop factors – Management and Environmental conditions – Reference Crop ET – standard and non-standard ET conditions – Potential ET	**9**
II	**MEASUREMENT OF EVAPOTRANSPIRATION** Direct Measurements - Evaporimeters – Open Pan Evaporimeter –Sunken Screen Pan Evaporimeter – Pichie's Evaporimeter – Weighing type Lysimeters – Non-weighing type (soil moisture depletion) Lysimeters – Leaf Area Index method – Air Temperature and Radiation method – Daylight length method –- Empirical formulae – Blaney-Criddle method – Christiansen method – Lowry-Johnson method – Hargreave's method – Neutron Probe calibration and field usage.	**12**
III	**PENMAN-MONTEITH SEQUENCE OF ET** Reference Crop ET – Potential ET - Energy Balance method (Penman - Monteith fundamental formula) – Modified FAO Penman methods – data collection and interpretations – software development and usage – Crop oriented predictions – comparisons with open water bodies – solution to field based problems.	**9**
IV	**WATER PRODUCTION FUNCTIONS** Field Experimental Plots – curve fitting techniques – yield as function of PET and actual ET – point of inflection – point of tolerance –regressions – evaporation suppression – production boosting – effects of soil salinity	**9**
V	**WATER BALANCE AND WATER BUDGET** Book keeping procedure – hydrological water balance – onfarm water balance – on farm water budgeting – irrigation planning – Yield Vs moisture stress – management strategies.	**6**
Total Instructional Hours		**45**

Course Outcome	• The student gets an exposure to the environmental implications due to evapotranspiration losses in farm irrigation systems

TEXT BOOKS:

T1	Michael, A.M., “Irrigation Theory and Practice”, Vikas Publishing House, New Delhi, 1999.
T2	Asawa, G.L., “Irrigation Engineering”, New Age International Private Limited, New Delhi,1996.
REFERENCE BOOKS:	
R1	Laboratory Manual, Centre for Water Resources, Anna University, Chennai
R2	Crop evapotranspiration-Guidelines for computing crop water requirements-FAO Irrigation and drainage paper 56

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG5001**	**OPERATION AND MAINTENANCE OF FARM MACHINERY LABORATORY**	**0**	**0**	**4**	**2**

Course Objective	• The students will be introduced to the practice of different farm machinery in the field on • Tillage, sowing, plant protection, harvesting and threshing • Fits and tolerances and replacements • Adjustments of farm machines • Dismantling and reassembling of a disc harrow, seed-cum fertilizer drill, and sprayer and engine pumps.

S.NO	LIST OF EXPERIMENTS
1	Identification of major systems of a tractor and general guidelines on preliminary check measures before starting a tractor - procedure for starting, running and stopping the tractor.
2	Identification of components of power tiller, their maintenance and study on preliminary check measures and safety aspects before starting a power tiller procedure for starting, running and stopping the power tiller.
3	Field operation and adjustments of ploughs
4	Field operation and adjustments of harrows
5	Field operation and adjustments of cultivators
6	Field operation of sowing and planting equipment and their adjustments
7	Field operation of plant protection equipment
8	Field operation on mowers and reapers
9	Field operation of combine and determination of field losses
10	Field operation of threshers and their performance evaluation
11	Studies on methods of repair, maintenance and off-season storage of farm equipment
12	Opening and reassembly of disc harrows, determination and adjustment of tilt and disc angles
13	Hitching of agricultural implements and trailers

14	Study and operation of bulldozer
15	Visit to agro-manufacturers

Course Outcome	During this course, students have an ability • To identify farm equipment's • To calculate and predict the actual field problem during the operation. • To trained to do adjustments of farm implements and Hitching of agricultural implements and trailers.

S.NO	LIST OF EQUIPMENTS	REQUIRED QUANTITY
1	Tractor	1
2	Power tiller	1
3	Disc plough	1
4	Disc harrow	1
5	Multi tyne cultivator	1
6	Paddy Transplanter	1
7	Seed drill	1
8	Sprayer	1
9	Mower	1
10	Weeder	1
11	Combine harvester (optional) – can be had as demonstration	1

REFERENCES

R1	Jain, S.C. and C.R. Rai. Farm Tractor Maintenance and Repair. Standard publishers and Distributors, New Delhi, 1999.
R2	Herbert L.Nichols Sr., Moving the Earth, D. Van Nostrand company Inc. Princeton, 1959.
R3	John A Havers and Frank W Stubbs, Hand book of Heavy Construction, McGraw – Hill book Company, New York, 1971.
R4	Barger, E.L., J.B. Liljedahl and E.C. McKibben, Tractors and their Power Units. Wiley Eastern Pvt. Ltd., New Delhi, 1997.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG5002	POST HARVEST ENGINEERING LABORATORY	0	0	4	2

Course Objective	• End of this lab, students will be able to determine various engineering properties of grains test and evaluate different post harvesting machineries.

S.NO	LIST OF EXPERIMENTS
1	Determination of moisture content of grains by oven method and moisture meter.
2	Determination of porosity of grains.
3	Determination of coefficient of friction and angle of repose of grains.
4	Testing of paddy thresher & paddy winnower.
5	Testing of groundnut decorticator & maize sheller
6	Evaluation of thin layer drier
7	Evaluation of L.S.U. drier.
8	Determining the efficiency of bucket elevator and screw conveyor
9	Evaluation of shelling efficiency of rubber roll sheller
10	Determining the oil content of oil seeds.
11	Visit to modern rice mill
12	Visit to pulse milling industry

Course Outcome	

S.NO	LIST OF EQUIPMENTS REQUIRED	REQUIRED QUANTITY
1	Hot air oven, Grain moisturemeter	1
2	Porosity apparatus	1
3	Coefficient of friction apparatus	1
4	Angle of repose – round type and L type	1
5	Paddy thresher	1
6	Groundnut decorticator and maize sheller	1
7	Thin layer dryer	1
8	LSU dryer	1
9	Bucket elevator and screw conveyor	1
10	Rubber roll sheller	1
11	Oil expeller	1

REFERENCES	
R1	Chakraverty, A. Post harvest technology for Cereals, Pulses and Oilseeds. Oxford & IBH Publication Pvt Ltd, New Delhi, Third Edition, 2000.
R2	Sahay, K.M., and Singh, K.K. Unit operations of Agricultural Processing, Vikas Publishing House Pvt. Ltd., New Delhi, 1994.
R3	Pande, P.H. Principles of Agriculture Processing. Kalyani Publishers, Ludhiana, 1994.
R4	Henderson, S.M. and R.L. Perry. Agricultural Process Engineering. John Wiley and Sons, New York. 1955.
R5	Mohsenin, N.N. Physical Properties of Plant and Animal Materials Gordon and Breach Publishers, Ludhiana, 1970.

CHAIRMAN/BOARD OF STUDIES	PRINCIPAL/DEAN ACADEMIC

SEMESTER VI

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16AG6201	Soil and Water Conservation Engineering	3	0	0	3	25	75	100	PC
2	16AG6202	Food and dairy Engineering	3	0	0	3	25	75	100	PC
3	16AG6203	Precision Farming and Protected Cultivation	3	0	0	3	25	75	100	PC
4	16AG6204	Bio-Energy Resource Technology	3	0	0	3	25	75	100	PC
5	16AG63XX	Professional Elective – II	3	0	0	3	25	75	100	PE
6	16XX64XX	Open Elective-I	3	0	0	3	25	75	100	OE
PRACTICAL										
7	16AG6001	CAD for Agricultural Engineering	0	0	4	2	50	50	100	PC
8	16AG6002	Drawing of Farm Structures	0	0	4	2	50	50	100	PC
9	16AG6003	Food and Dairy Engineering	0	0	4	2	50	50	100	PC

		Laboratory								
		Total	**18**	**0**	**12**	**24**			**900**	

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6201**	**Soil and Water Conservation Engineering**	**3**	**0**	**0**	**3**

Course Objective	• To impart a thorough knowledge and understanding of the basic causes of soil erosion and the relevant mitigation strategies. • To enable the students to design appropriate watershed based soil conservation structures and rainwater harvesting systems.

Unit	**Description**	**Instructional Hours**
I	**MECHANICS OF WATER AND WIND EROSION** Soil Erosion – Causes and Conservation status in India - Mechanics of water erosion – Raindrop Splash erosion - Kinetic Energy of Raindrops - usage of Automatic Rain Gauge Chart - Sheet erosion, Rill erosion, Gully erosion and Ravines - Stream bank erosion – Classification of Gully - Mechanics of Wind Erosion - sand dunes and desertification – Special forms of Erosion – Landslides – Mass movements – Pedestal Erosion – Pinnacle Erosion – Soil Piping.	9
II	**ESTIMATION OF SOIL LOSS** Rainfall and Runoff Erosivity – Soil Erodibility - Runoff computation for soil conservation: SCS-CN method –Rational Formula - Universal Soil Loss Equation (USLE) – standard plot – Modified Universal Soil Loss Equation (MUSLE) – Revised Universal Soil Loss Equation (RUSLE)- Tolerance limit (T Value) of soil loss– Land use capability classification - Wind drift losses.	9
III	**WATERSHED BASED SOIL CONSERVATION** Agronomic practices: contour cultivation - strip cropping – tillage practices – Soil management practices – Mechanical Measures – Gully Control Structures: Drop Spillway, Drop Inlet, Chute Spillways – Contour, Graded and Compartmental Bunding – Bench Terracing for hill slopes – Broad based Terracing – Grassed waterways: Location, construction and maintenance — wind breaks and shelter belts- Landslide control measures - Afforestation	9

IV	**RAINWATER HARVESTING MEASURES** In-situ soil moisture conservation : Micro catchments, - Continuous Contour Trenching – Staggered Trenching – Random Tie Ridging – Crescent bunds - Farm ponds: Hydrologic, Hydraulic and Structural designs - , Construction and Protection – Check dams and Percolation Ponds - Earthen dam – Retaining wall – Recharge Wells	9
V	**SEDIMENT TRANSPORT AND YIELD** Sediment: Sources – Types of sediment load – Mechanics of sediment transport – Suspension, Saltation and surface Creep-Estimation of bed load – Sediment Graph - Reservoir sedimentation: Basics - Factors affecting sediment distribution pattern, Rates of reservoir sedimentation - Silt Detention Tanks – Wind Erosion Sand Dunes and Desertification.	9
	Total Instructional Hours	45

Course Outcome	• The students will be able to gain fundamental knowledge on the concepts of erosion and sedimentation. • They get enriched with knowledge on Hydrologic, Hydraulic and Structural designs of soil and water conservation measures and Rainwater harvesting systems.

TEXT BOOKS:	
T1	Suresh, R., “Soil and Water Conservation Engineering”, Standard Publication, New Delhi, 2007.
T2	Ghanshyam Das, “Hydrology and Soil Conservation Engineering”, Prentice Hall of India Private Limited, New Delhi, 2000.
T3	“Sedimentation Engineering”, 2006, ASCE manual and Report on Engineering Practice No. 54, Edited by Vito A. Vanoni. ASCE publishing.
REFERENCE BOOKS:	
R1	Murthy, V.V.N., “Land and Water Management Engineering”, Kalyani Publishers, Ludhiana, 1998.
R2	Gurmail Singh, “A Manual on Soil and Water Conservation”, ICAR Publication, New Delhi, 1982.
R3	Mal, B.C., “Introduction to Soil and Water Conservation Engineering”, Kalyani Publishers, New Delhi, 2002

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6202**	**Food and Dairy Engineering**	**3**	**0**	**0**	**3**

Course Objective	• To introduce the students to dairy industry, properties and processing of milk, manufacture of dairy products , sanitation and effluent treatment in dairy industry • To expose the students to the fundamental knowledge of food, its properties and different methods of food processing.

Unit	Description	Instructional Hours
I	**PROPERTIES AND PROCESSING OF MILK** Dairy Industry – importance and status – Milk Types – Composition and properties of milk - Production of high quality milk - Method of raw milk procurement and preservation - Processing –Staining - Filtering and Clarification - cream separation – Pasteurization – Homogenization -sterilization, UHT processing and aseptic packaging – emulsification - Fortification.	9
II	**DAIRY PRODUCTS** Manufacture of Milk Powder - Processing of Milk Products - Condensed Milk - Skim milk – Buttermilk - Flavoured Milk, whey, casein, yoghurt and paneer - Manufacture of Butter - Cheese Ghee, ice creams and frozen desserts - standards for milk and milk products - Packaging of Milk and Milk Products - Cleaning and Sanitation - Dairy effluent treatment and disposal .	9
III	**FOOD AND ITS PROPERTIES, REACTION AND KINETICS** Constituents of food - thermal processing of foods - cooking, blanching, sterilization, pasteurization, canning - Interaction of heat energy on food components, reaction kinetics, Arrhenius equation, TDT curves - water activity, sorption behaviour of foods – isotherm models - monolayer value, BET isotherms, Raoult‟s law, Norrish, Ross, Salwin - Slawson equations.	9
IV	**PROCESSING AND PRESERVATION OF FOODS** Coffee, Tea processing - Concentration of foods, freeze concentration - osmotic and reverse osmotic concentration - drying and dehydration of food - Tray, tunnel, belt, vacuum and freeze dryers - rehydration of dehydrated foods - Fat and oil processing, sources, extraction, methods and equipment, refining of oils, hydrogenation, manufacture of margarine - Food preservation	10

	methods - preservation by irradiation, microwave and dielectric heating of food.	
V	**PACKAGING AND QUALITY CONTROL** Food packaging, importance, flexible pouches - retort pouches - aseptic packaging, granules, powder and liquid packaging machines - nanotechnology – principles - applications in food processing – food plant location - Quality control of processed food products - Factors affecting quality.	8
	Total Instructional Hours	45

Course Outcome	• The students will gain knowledge about Dairy and Food process engineering • Understand the process of manufacturing of dairy products and thermal processing of food. • Students will understand the importance of quality control and food preservation and packaging.

TEXT BOOKS:	
T1	Chandra Gopala Rao. Essentials of Food Process Engineering. B.S. Publications,
T2	Hyderabad, 2006.
T3	Walstra. P., Jan T. M. Wouters., Tom J. Geurts “Dairy Science and Technology”, CRC press, 2005.
REFERENCE BOOKS:	
R1	Subbulakshmi.G., and Shobha A. Udipi, Food Processing and Preservation, New Age International Publications, New Delhi, 2007.
R2	Toledo, R.T., “Fundamentals of Food Process Engineering”, CBS Publishers and Distribution, New Delhi, 1997.
R3	Tufail Ahmed., “Dairy Plant Engineering and Management”, Kitab Mahal Publishers, Allahabad, 1997.
R4	Dairy Science and Technology Handbook, Volumes 1-3, John Wiley & Sons,1993.
R5	Charm, S.E., “Fundamentals of Food Engineering”, AVI Pub.Co.Inc, New York, 1997.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6203**	**Precision Farming and Protected Cultivation**	**3**	**0**	**0**	**3**

Course Objective	• To impart knowledge on the protected all season confined space cultivation strategies for vegetables, fruits and flower crops • To sensitize the students on hi-tech production technology under open field Precision Farming applications.

Unit	Description	Instructional Hours
I	**PROTECTED CULTIVATION FEATURES** Conceptual features of protected cultivation in horticultural crops - Importance and scope of protected cultivation – different growing structures of protected culture viz., green house, polyhouse, net house, poly tunnels, screen house, protected nursery house - study of environmental factors influencing green house production – cladding / glazing / covering material – ventilation systems – cultivation systems including nutrient film technique / hydroponics / aeroponic culture growing media and nutrients – canopy management – micro irrigation and fertigation systems.	9
II	**PROTECTED CULTIVATION OF VEGETABLE CROPS** Protected cultivation technology for vegetable crops - Hi-tech protected cultivation techniques for tomato, capsicum nursery, cucumber, gherkins strawberry and melons – integrated pest and disease management – post harvest handling.	9
III	**PROTECTED CULTIVATION OF FLOWER CROPS** Protected cultivation technology for flower crops - Hi-tech protected cultivation of cut roses, cut chrysanthemum, carnation, gerbera, asiatic lilies, anthurium, orchids, cut foliages and fillers – integrated pest and disease management – postharvest handling.	9
IV	**PRECISION FARMING TECHNIQUES** Concept and introduction of precision farming – Importance, definition, principles and concepts – Role of GIS and GPS - Mobile mapping system and its application in precision farming – design, layout and installation of drip and fertigation – georeferencing and photometric correction –Sensors for information gathering – UAV - geostatistics – robotics in horticulture – postharvest process management (PPM) – Remote sensing.	9
V	**PRECISION FARMING OF HORTICULTURAL CROPS**	9

	Precision farming techniques for horticultural crops - Precision farming techniques for tomato, chilli, bhendi, bitter gourd, bottle gourd, cauliflower, cabbage, grapes, banana, rose, jasmine, chrysanthemum, marigold, tuberose, china aster, turmeric, coriander, coleus and gloriosa.	
	Total Instructional Hours	45

Course Outcome	• The students will be able to appreciate the different methods of protected cultivation practices available for vegetable crops and flowers. • A clear understanding of precision farming techniques and its application to horticultural crops is possible.

TEXT BOOKS:	
T1	Joe.J.Hanan. 1998. Green houses: Advanced Technology for Protected Horticulture, CRC Press, LLC. Florida.
T2	Paul V. Nelson. 1991. Green house operation and management. Ball publishing USA.
REFERENCE BOOKS:	
R1	Lyn. Malone, Anita M. Palmer, Christine L. VIoghat Jach Dangeermond. 2002. Mapping out world: GIS lessons for Education. ESRI press.
R2	David Reed. 1996. Water, media and nutrition for green house crops. Ball publishing USA.
R3	Adams, C.R. K.M. Bandford and M.P. Early. 1996. Principles of Horticulture. CBS publishers and distributors. Darya ganj, New Delhi.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6204**	**Bio-Energy Resource Technology**	**3**	**0**	**0**	**3**

Course Objective	• To impart the fundamental knowledge on the importance of Bio resources, Bio energy and reactors • Alcohol and ethanol production and Energy and Environment.

Unit	Description	Instructional Hours

I	**BIO RESOURCE - AN INTRODUCTION** Biochemical characteristics of bio-resources- Bio resource – origin – biomass types and characteristics- biomass conversion technology.	9
II	**BIOMETHNATION** Biodegradation - steps in biogas production- parameters affecting gas production- Types of biogas plants- Construction details- operation and maintenance. Slurry handling- enrichment and utilization – Biogas appliances- Bioenergetics –Biocatalysis –Kinetics of product formation.	9
III	**BIO REACTORS AND FERMENTORS** Bio reactors/ fermentors – Batch type – continuous stirred tank reactors- Biological waste water treatment- Activated sludge process- Downstream processing Recovery and purification of products.	9
IV	THERMOCHEMICAL CONVERSION Principles of thermochemical conversion – combustion - pyrolysis- Gasification – types of gasifiers. Alcohol ethanol production - Acid hydrolysis - enzyme hydrolysis-Methanol synthesis – Antibiotics enzymes.	9
V	**ENERGY AND ENVIRONMENT** Principles of operation- chemical reaction- cleaning and cooling - Utilization- Improved wood burning stove - Energy plantations- Biomass briquetting - co generation- Impact on Environment – Bioenergy policy.	9
	Total Instructional Hours	45

Course Outcome	• The students will be able to understand the concepts of bio energy sources and its applications.

TEXT BOOKS:	
T1	Rai G.D,Non-conventional sources of Energy, Khanna publishers, New Delhi, 1995.
T2	Bouley James .E & David Follis - Biochemical Engineering Fundamentals Mc Graw-Hill publishing company, Tokyo.1986
REFERENCE BOOKS:	
R1	Chawla O.P, Advances in Biogas Technology ICAR publication New Delhi 1986

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6301**	**Climate Change and Adaptation**	**3**	**0**	**0**	**3**

Course Objective	• To know the basics, importance of global warming • To know the concept of mitigation measures against global warming • To learn about the global warming and climate change.

Unit	Description	Instructional Hours
I	**EARTH'S CLIMATE SYSTEM** Role of ozone in environment - ozone layer - ozone depleting gases - Green House Effect - Radioactive effects of Greenhouse Gases - Hydrological Cycle - Green House Gases and Global Warming – Carbon Cycle.	9
II	**ATMOSPHERE AND ITS COMPONENTS** Importance of Atmosphere - Physical Chemical Characteristics of Atmosphere - Vertical structure of the atmosphere-Composition of the atmosphere-Atmospheric stability - Temperature profile of the atmosphere-Lapse rates-Temperature inversion - inversion on pollution dispersion.	9
III	**IMPACTS OF CLIMATE CHANGE** Causes of Climate change : Change of Temperature in the environment - Melting of ice Pole-sea level rise-Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.	9
IV	**OBSERVED CHANGES AND ITS CAUSES** Climate change and Carbon credits- CDM- Initiatives in India-Kyoto Protocol Intergovernmental Panel on Climate change- Climate Sensitivity and Feedbacks – The Montreal Protocol – UNFCCC– IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India .	9
V	**CLIMATE CHANGE MITIGATION MEASURES** Clean Development Mechanism –Carbon Trading- examples of	9

	future Clean Technology – Biodiesel – Natural Compost – Eco-Friendly Plastic – Alternate Energy – Hydrogen – Bio-fuels – Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding - Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry – Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) - Waste (MSW) & Bio waste - Biomedical, Industrial waste – International and Regional cooperation.	
	Total Instructional Hours	45

Course Outcome	• After successful completion of this course students are expected to be able to: • Demonstrate an understanding of how the threats and opportunities of predicted climate change will influence specific sectors at global and regional scale • Critically evaluate the relative opportunities and needs for mitigation and adaptation (including vulnerability assessments) in a variety of sectoral contexts • Understand and critically evaluate the scientific insights underlying the assessment reports of the IPCC, with a focus on impacts, adaptation and mitigation.

TEXT BOOKS:	
T1	Dash Sushil Kumar, "Climate Change – An Indian Perspective", Cambridge University Press India Pvt. Ltd, 2007.
REFERENCE BOOKS:	
R1	Adaptation and mitigation of climate change-Scientific Technical Analysis. Cambridge University Press, Cambridge, 2006.
R2	Atmospheric Science, J.M. Wallace and P.V. Hobbs, Elsevier / Academic Press 2006.
R3	Jan C. van Dam, Impacts of "Climate Change and Climate Variability on Hydrological Regimes", Cambridge University Press, 2003.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6302**	**HEAT AND MASS TRANSFER FOR AGRICULTURAL ENGINEERS**	**3**	**0**	**0**	**3**

Course Objective	• To impart the knowledge on heat transfer mechanisms in fluids and solids, and their applications in various heat transfer equipment • To introduce non-dimensional numbers and their effects in governing various modes of mass transfer • To analyze heat exchangers and methods of evaluating the performance

Unit	Description	Instructional Hours
I	**CONDUCTION** Basic concepts - Mechanism of Heat transfer. Conduction - Fourier"s Law, General differential equation in Cartesian and cylindrical coordinates, one dimensional steady state heat conduction, conduction through plane wall, cylinders and spherical systems.	9
II	**CONVECTION** Basic Concepts - Heat transfer coefficients, boundary layer concept. Types of convection - Forced convection, dimensional analysis, non-dimensional numbers, external flow, flow over plates, cylinders and spheres, internal flow, laminar and turbulent flow, combined laminar and turbulent.	9
III	**RADIATION** Radiation heat transfer - concept of black and grey body-Laws of Radiation - Stefan-Boltzmann Law, Kirchhoff's Law Black body radiation - Grey body radiation - Shape factor algebra - Radiation shields	9
IV	**HEAT EXCHANGERS** Heat exchangers - Types, heat exchanger analysis, fouling factor, LMTD (Logarithmic mean temperature difference) and Effectiveness-NTU (number of transfer units) Method - Overall Heat Transfer Coefficient	9
V	**MASS TRANSFER** Mass transfer- introduction - Fick law for molecular diffusion - molecular diffusion in gases - equimolar counters diffusion in gases- diffusion through a varying cross sectional area- diffusion coefficients for gases - molecular diffusion in liquids.	9
Total Instructional Hours		45

Course Outcome	• Understand conduction, students will able to in different geometries • Asses the concepts and types of conversion in heat transfer mechanism • Recognize the radiation problems in various geometries • Analyze the performance of heat exchangers and evaporators • Understand the various modes of mass transfer and apply them in engineering problems

TEXT BOOKS:	
T1	R. C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New AgeInternational private limited, New Delhi, 2010
T2	Yunus A. Cengel, Heat and Mass Transfer: a Practical Approach, Tata McGraw Hillpublishing Company private limited, New Delhi, 2007
REFERENCE BOOKS:	
R1	J. P. Holman, Heat Transfer, Tata McGraw Hill publishing Company private limited, NewDelhi, 2009
R2	C. P. Kothandaraman and S. Subramanyan, Fundamentals of Heat and Mass Transfer, NewAge International private limited, New Delhi, 2014
R3	Heat and Mass Transfer, S Chand and Company, New Delhi, 2009

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6303**	**Disaster Management**	**3**	**0**	**0**	**3**

Course Objective	• To provide students an exposure to disasters, their significance and types. • To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction • To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR) • To enhance awareness of institutional processes in the country and develop rudimentary ability to respond to their surroundings with potential disasters.

Unit	Description	Instructional Hours
I	**SITUATIONAL DISASTERS** Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social,economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms ofcaste, class, gender, age, location, disability - Global trends	9

	in disasters: urban disasters,pandemics, complex emergencies, Climate change- Dos and Don‟ts during various types of Disasters.	
II	**DISASTER RISK REDUCTION (DRR)** Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.	9
III	**VULNERABILITIES, IMPACTS AND DEVELOPMENTS** Factors influencing Disaster Vulnerabilities - differential impacts - Development projects - dams, embankments, Highways - Land use – Electricity Power Lines - Industrialization - Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.	9
IV	**DISASTER RISK MANAGEMENT** Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, and Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment	9
V	**CATEGORICAL CASE STUDIES** Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.	9
	Total Instructional Hours	45

Course Outcome	• The students will be able to • Differentiate the types of disasters, causes and their impact on environment and society • Assess vulnerability and various methods of risk reduction measures as well as mitigation.

	• Draw the hazard and vulnerability profiles and Scenarios in the Indian context for Disaster damage assessment and management.

TEXT BOOKS:	
T1	Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
T2	Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]
T3	Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011
T4	Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.
REFERENCE BOOKS:	
R1	Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
R2	Government of India, National Disaster Management Policy,2009.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6304**	**Horticultural Crop Processing**	**3**	**0**	**0**	**3**

Course Objective	• To impart knowledge and skill to the students on different unit Operations in processing of horticultural crops • To make the students understand the working principles of different machineries used for processing of fruits, vegetables and spices • To prompt them get sufficient knowledge in the basics of selection of appropriate machines/ equipment.

Unit	Description	Instructional Hours
I	**PROCESSING OF HORTICULTURAL CROPS** Characteristics and properties of horticultural crops - Importance of processing - fruits and vegetables - spices and condiments - important for processing; Preservation Technology: General methods	9

	of preservation- physical/ chemical and other methods of preservation – advantages and limitations – Nutritive values and Health factors.	
II	**PRELIMINARY PROCESSING SEQUENCES** Flowcharts for preparation of different finished products - Food supply chain - Sorting and grading equipments - Peeling: Different peeling methods and devices (manual peeling, mechanical peeling, chemical peeling, and thermal peeling) - Slicing of horticultural crops: equipment for slicing, shredding, crushing, chopping, juice extraction, etc. - Blanching: Importance and objectives - blanching methods - effects on food (nutrition, colour, pigment,texture)	9
III	**CHILLING AND FREEZING PRELUDES** Chilling and freezing: Application of refrigeration in different perishable food products - Thermophilic, mesophilic & Psychrophilic micro-organisms - Chilling requirements of different fruits and vegetables - Freezing of food - freezing time calculations – slow paced and fast freezing - Equipment for chilling and freezing (mechanical & cryogenic) - Effect on food during chilling and freezing, Cold Storage - heat load calculations - cold storage design - refrigerated vehicle and cold chain system.	9
IV	**DRYING AND PACKAGING** Dryers for fruits and vegetables, Osmo-dehydration; Handling and transportation of fruits and vegetables, Pack house technology, Minimal processing; Common methods of storage, Low temperature storage, evaporative cooled storage, Controlled atmospheric storage, Modified atmospheric packaging; Post harvest management and equipment for spices; Packaging of horticultural commodities, Packaging requirements (in terms of light transmittance, heat, moisture and gas proof, micro organisms, mechanical strength), Different types of packaging materials commonly used for raw and processed fruits and vegetables products, bulk and retail packages and packaging machines.	9
V	**GRADES AND QUALITY CONTROL** Quality control in Fruit and vegetable processing industry - Study of fruit graders, Study of peeler and slicer, Study of juicer and pulper - Study of blanching equipment, Testing adequacy of blanching - Study of cold storage and its design - Study of CAP and MAP storage - Minimal processing of vegetables - Preparation of value added products.	9
	Total Instructional Hours	45

Course	• By the end of the course the students will be able to

Outcome	• Use the different types of sorting, grading, peeling, slicing, blanching and other equipment for processing of fruits and vegetables • Identify the suitable equipment, materials and methods for storage, processing, packaging and value addition of fruits and vegetables • Develop at least 4 types of value added products from fruits and vegetables • Understand the technical and management aspects of operation of fruits and vegetable processing industries.

TEXT BOOKS:	
T1	Pandey, R.H. 1997. Post harvest Technology of fruits and vegetables (Principles and practices). Saroj Prakashan, Allahabad
T2	Sudheer, K P. and Indira, V. 2007. Post Harvest Engineering of horticultural crops. New india Publishing House.
REFERENCE BOOKS:	
R1	Lal Giridhari, Siddappa and Tondon. 2001. Preservation of fruits and vegetables. ICAR, New Delhi
R2	Srivastava and Sanjeev Kumar. 2008. Fruit and vegetable preservation: principles and practices. Kalyani Publishers
R3	Fellows, P. 2008. Food Processing Technology. Woodhead

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6401**	**Nanotechnology in Agriculture**	**3**	**0**	**0**	**3**

Course Objective	• To understand the application of nano technology in Agriculture and food technology

Unit	Description	Instructional Hours
I	**Nanotechnology** Nanotechnology - Introduction, History, potential of nanotechnology,	9

	Current status of Nanotechnology in the food market; Nanotechnology in Agriculture - Precision Farming, Smart Delivery Systems, Other Developments in the Agricultural Sector due to Nanotechnology; Nanotechnology in the Food Industry - Packaging and Food Safety, Food Processing.	
II	**Nanotechnology in Agriculture** Nanotechnology in pesticides and fertilizers - Control of plant pests, Nanoinsicticidal potential, Antimicrobial activity, Nanotechnology application as nanofungicides, Nanotechnology for controlling plant virus , nanoformulations of agrochemicals for applying pesticides and fertilizers for crop improvement; the application of nanosensors in crop protection for the identification of diseases and residues of agrochemicals, nanodevices for the genetic engineering of plants, plant disease diagnostics, animal health, animal breeding, poultry production and postharvest management.	9
III	**Nano - Food System** Introduction and scope of Nanotechnology in food processing - Bio active compounds, Source – importance – isolation techniques - Nano-nutraceuticals – nano-cochleates – nano-clusters. Nano-laminates – materials used, properties – preparation and application - Nano emulsion, Encapsulation, Nano filtration, Nano filters - construction and working principle – efficiency calculation, Nano composites – bio-nano composites - Fabrication process – equipments used - Nano films – nano bottles – characteristics – testing standards - Usage of nano material in food packaging – solid and liquid food – overall migration - Safety issues of nano food systems	9
IV	**Application of Biosensors in Agriculture** Principles of Biosensor- working mechanism, Parts of biosensors; Sensor technologies; importance of sensitivity, specificity, reproducibility, detection limit and response time in biosensors. Applications- Biosensor for food analysis, Biosensors for toxins, pest and pathogens-Aflatoxin, biosensor for moisture and pesticide content- organophosphorous pesticides- nutrient content in soil – microbes- Environmental monitoring.	9
V	**Toxicology, ethics and regulation of nanomaterials**	9

	Toxicology- introduction, dose relationship, factors affecting toxicity - Detoxification mechanisms- Hazard classification-Risk assessment and management - Mode of action of pesticides - Bioaccumulation of toxic materials - Health effects of nanoparticles- factors determine the toxicity of nanoparticles - Nanoparticles Interactions with Biological Systems - Dermal Effects of Nanomaterials.	
	Total Instructional Hours	45

Course Outcome	• The student will be familiarized with the concept of nanotechnology and its application in food and agriculture sector.

TEXT BOOKS:

T1	A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
T2	N John Dinardo, "Nanoscale Charecterisation of surfaces & Interfaces", 2nd edition, Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCE BOOKS:

R1	Frieder Schelfer And Florian Schubert, "Biosensors" Techniques And Instrumentation In Analytical Chemistry -Volume 11, Elsevier Science Publishers B.V., (1992), Amsterdam, The Netherlands (ISBN 0-444-98783-5)
R2	Ajit Sadana, Engineering Biosensors: Kinetics And Design, Applications, Academic Press, (2002), USA.(ISBN: 0-12-613763-3)
R3	Brian R. Eggins, Chemical Sensors And Biosensors, John Wiley & Sons, Ltd, (2004) England.(ISBN: 0 471 89914 3)

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG6001**	**CAD FOR AGRICULTURAL ENGINEERING**	**0**	**0**	**4**	**2**

Course Objective	• To draft the agricultural engineering related machineries and structures manually and also by computer aided methods.

S.NO	LIST OF EXPERIMENTS

1	Design and Drawing of Underground pipeline system
2	Design and Drawing of Check dam
3	Design and Drawing of Mould board plough
4	Design and Drawing of Disk plough
5	Design and Drawing of Post harvest technology units (threshers and winnowers)
6	Design and Drawing of Biogas plant.
7	Introduction & demonstration on 3D modeling software's like Pro/E, Creo, Solid works, Solid Edge etc.

Course Outcome	• The student will be able to understand the plan and layout of underground pipes, post harvesting units and check dams. • The students also will be able to design and draw the components using computer aided methods.

S.NO	LIST OF EQUIPMENTS REQUIRED	REQUIRED QUANTITY
1	Computers	30
2	Licensed Software like CAD, Solid work and Pro E	1

REFERENCES:

R1	Michael, A.M. "Irrigation Theory and Practice", Vikas Publishing House, New Delhi, 1999.
R2	Rai, G.D. "Nonconventional Sources of Energy", Khanna publishers, New Delhi, 1995.
R3	Srivastava, A.C."Elements of Farm Machinery", Oxford and IBH Publications Co., New Delhi, 1990.
R4	Vijay Duggal. "A general guide to Computer Aided Design & Drafting, Mailmax Publications, 2000
R5	Tadeusz Stolarski et al. "Engineering Analysis with ANSYS Software", Butterworth Heinemann Publications, 2006
R6	Louis Gary Lamit, "Introduction to Pro/ENGINEER" SDC Publications, 2004.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C

B.E.	**16AG 6002**	**DRAWING OF FARM STRUCTURES**	0	0	4	2

Course Objective	To conceive and design various farm structures related to agricultural engineering.

S.NO	**LIST OF EXPERIMENTS**
1	Planning and Layout of farmstead
2	Design of stall bam
3	Design of loose housing and milk parlors
4	Design of poultry house
5	Design of a sheep / goat house
6	Design of ventilation system for dairy and poultry house
7	Design of silos – over ground and underground and hay storages
8	Design of farm fencing system
9	Design of machinery and equipment shed and workshops
10	Design of septic tank and sanitary structures
11	Design of rural/farm roads and culverts.

Course Outcome	At the end of the course, the student will be able to design and draw all farm structures connected to agricultural engineering including animal housing, grain storage, small civil structures.

REFERENCES:

R1	Barre, H.J. and Sammet, L.L. "Farm Structures". John Wiley and Sons Inc. 1950."
R2	Neubaur, L. W. and Walker, H.B. "Farm Buildings Design". Prentice Hall Inc., 1961.
R3	Khanna, S.K. and Justo, C.E.G. "Highway Engineering". Nemchand and Bros., Roorkee,India.
R4	Dutta, B.N. "Estimating and Costing in Civil Engineering Theory and Practice". S. Dutta and Co.
R5	Bazirani, V.N. and Ratwani, M.M. "Steel Structures". Khanna Publishers, Delhi, 1981
R6	Justo, C.E.G. and Khanna, S.K. "Highway Engineering". Nemchand and Bros., Roorkee, India (Revised).

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG6003	FOOD AND DAIRY ENGINEERING LABORATOR	0	0	4	2

Course Objective	To get hands on experience on various aspects of food science and food process Engineering.

S.NO	LIST OF EXPERIMENTS
1	Determination of cooking properties of parboiled and raw rice.
2	Estimation of microbial load in food materials.
3	Determination of rehydration ratio of dehydrated foods.
4	Experiment on osmotic dehydration of foods
5	Experiment of food extruder
6	Experiment on properties of food through microwave oven heating.
7	Determination of properties of milk
8	Experiments on cream separator to determine the separation efficiency
9	Experiments on construction and operation of butter churn and butter working accessories
10	Experiments on detection of Food Adulteration
11	Experiments on estimation of protein in food.
12	Experiment on expansion and Oil absorption characteristic of fried snacks
13	The lab includes visit to food processing and dairy industry

Course Outcome	On completion of the lab course, the students will be able to get experience on various aspects of food processing, preservation.

S.NO	LIST OF EQUIPMENTS REQUIRED	REQUIRED QUANTITY
1	Extruder	1
2	Pasteurizer	1
3	Hot air oven	1
4	Hand refractometer.	1
5	Dessicator	1
6	Dean and Stark‟s apparatus	1

7	Cabinet dryer	1
8	Soxhlet flask.	1
9	Distillation column	1
10	Kjeldahl flask	1
11	Distillation apparatus	1
12	Microwave oven	1
13	Cream separator	1
14	Butter churner	1

*Other basic requirements like weighing balance, physical balance, blotting papers, tracing sheets, burette, vernier calipers, pipette, conical flask, test tubes, beakers, spatula and other glasswares, food samples, chemicals should be available.

REFERENCES:

R1	Singh, R.Paul. and Heldman, R.Dennis.2004. Introduction to Food Engineering. 3rd Edition. Academic Press, London.
R2	Kessler, H.G.1981. Food engineering and dairy technology. Verlag A.Kessler, Freising.
R3	Walstra, P. T.J. Geurts, A. Nooman, A. Jellema and M.A. J.S Van Boekel. 2005. DairyTechnology. Marcel Dekker Inc. New york.
R4	Clunie Harvey, W.M and Harry Hill. 2009 Milk Products. IV Edition Biotech Books, NewDelhi.
R5	Robinson, R.K.1986. Modern dairy technology Vol.I Advances in Milk processing. Elsevier Applied Science Publishes, London.
R6	Karel Marcus, Fennama, R.Owen and Lund, B.Dayal. 1975. Principles of food science,Part II - Physical principles of food preservation, Marcel Dakker, Inc.
R7	Hall,C.W and T.J.Hedrick. 1971. Drying of milk and milk products. AVI Publishing Co.,West Port, Connecticut.
R8	Charm, S.E.1971. The fundamentals of Food engineering, AVI pub.Co.,Inc

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

SEMESTER VII

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16AG7201	Groundwater and Well Engineering	3	0	0	3	25	75	100	PC
2	16AG7202	Remote Sensing and Geographical Information System	3	0	0	3	25	75	100	PC
3	16AG7203	Solar and Wind Energy Engineering	3	0	0	3	25	75	100	PC
4	16AG7204	Agricultural Extension	3	0	0	3	25	75	100	PC
5	16AG73XX	Professional Elective-III	3	0	0	3	25	75	100	PE
6	16AG73XX	Professional Elective – IV	3	0	0	3	25	75	100	PE
7	16XX74XX	Open Elective – II	3	0	0	3	25	75	100	OE
PRACTICAL										
8	16AG7001	GIS Laboratory for Agricultural Engineers	0	0	2	1	50	50	100	PC
9	16AG7002	Renewable Energy Laboratory	0	0	4	2	50	50	100	PC
10	16AG7003	ICT in Agricultural Engineering	0	0	4	2	50	50	100	PC
11	16AG7701	Industrial Training / Technical Seminar	0	0	0	2	0	100	100	EEC
		Total	**18**	**4**	**10**	**28**			**1000**	

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7201**	**Groundwater and Well Engineering**	**2**	**0**	**2**	**3**

Course Objective	• To introduce the students to the concepts of groundwater occurrence, its storage and movement alongside exploration and utilization • To expose the students to the theories behind well design, construction and maintenance • To motivate the students to learn appropriate groundwater quality management techniques.

Unit	Description	Instructional Hours
I	**GROUNDWATER DYNAMICS** Ground water development and potential in India – Groundwater theory - Types of Aquifers: Unconfined (Water Table) Aquifer – Phreatic Surface - Confined (Artesian) Aquifer – Piezometric Surface - Perched Aquifer – Aquiclude, Aquitard and Aquifuge - Leaky Aquifers - Aquifer properties : Permeability, Specific Yield, Specific Retention, Porosity – Aquifer Constants : Transmissibility and Storage coefficient – Seepage and Flow net Analysis.	12
II	**WELL HYDRAULICS** Pumping Tests – Drawdown – Cone of Depression – Hydraulic Gradient - Darcy's Law - Groundwater Flow Equations –Dupuit- Forcheimer Assumptions – Steady state radial flow – Thiem's Equation – Unsteady state radial flow – Theis method – Chow's Method - Cooper-Jacob method – Recuperation Tests – Theis Recovery Method - Image well theory – Partial penetration of wells	12
III	**GROUNDWATER EXPLORATION AND RECHARGE** Water Divining - Geophysical techniques – Electrical resistivity survey – Schlumberger and Wenner Electrode arrangements - Artificial Recharge Techniques – Subterranean Rainwater Harvesting - Infiltration Basins – Percolation Pits – Recharge Shafts – Sea water Intrusion	6
IV	**CONSTRUCTION AND MAINTENANCE OF WELLS** Types of wells - Open (Dug)Wells and Bore (Tube) Wells - Design characteristics for wells - Well diameter, depth and Well screen design – Materials for well screens – Well casing – Design of collector wells and Infiltration gallery – Well drilling - Boring, Jetting – Rotary drilling, Hammer drilling - Construction – Installation of pipes and screens - Well development, Completion and disinfection – Well maintenance – Well performance test – Well effectiveness – Well losses – Pumping equipment – Rehabilitation of open wells and bore wells.	9
V	**GROUNDWATER QUALITY** Solute Transport and Contamination sources - Geochemical Survey – Water sampling - Groundwater quality criteria – Agricultural, Industrial and Domestic requirements – EC, pH, CEC, SAR, TDS,TSS - Water Quality Indexing - Ground water pollution and legislation – Water Quality enhancements – FAO and WHO guidelines.	6

Total Instructional Hours	45

Course Outcome	• Students' knowledge base gets enriched with the technical aspects of groundwater, its availability, assessment and utilization • Better exposure to the theory behind well design, construction and water quality management is ensured.

TEXT BOOKS:	
T1	Karanth, K.R. Groundwater Assessment, Development and Management. Tata Mc-GrawHill, 2008.
T2	Raghunath, H.M. Groundwater Hydrology, Wiley Eastern Ltd., 2000.
REFERENCE BOOKS:	
R1	Rastogi,A.K. Numerical Groundwater Hydrology, Penram International Publishing. Pvt. Ltd., Bombay, 2008.
R2	David Keith Todd. Groundwater Hydrology, John Wiley & Sons, Inc. 2007
R3	Fletcher.G.Driscoll, "Groundwater and Wells", Johnson Revision, New York

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7202**	**REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM**	**3**	**0**	**0**	**3**

Course Objective	• To introduce the basic principles and concepts of Remote Sensing and GIS as applicable to the multi-facets of Agricultural Engineering • To introduce the spatial data models, analysis and presentation techniques.

Unit	Description	Instructional Hours
I	**CONCEPTS OF REMOTE SENSING AND SATELLITES** Definition- Historical background - Components of remote sensing – Energy source, electromagnetic spectrum, radiation principle, platforms and sensors - Active and passive remote sensing interference - Atmospheric effects on remote sensing – Energy interaction with earth surface feature - Data acquisition - Reflectance, spectral signatures for water, soil and vegetation.- Satellites - Types - Sun synchronous - Geo synchronous remote sensing satellites - LANDSAT,SPOT & IRS - Resolution - Spectral, spatial, radiometric and Temporal resolution - Recent satellites with applications.	9
II	**DATA PRODUCTS AND IMAGE ANALYSIS** Data products –based on level of processing- o/p – scale – area/coverage – data availability – data ordering- data price - Image interpretation – Visual interpretation	9

	elements – interpretation key. Digital image processing – Image enhancement – image classification – Supervised and unsupervised – Vegetation Indices.	
III	**CONCEPTS OF GIS** Definition – Map and their influences – Characteristics of Maps – Elements – Map scale, Projection, Coordinate systems – Sources of spatial data – History and development of GIS – Definition – Components – Hardware and Software.	9
IV	**DATA INPUT AND ANALYSIS** Data – Spatial, Non-Spatial – Database models – Hierarchical network, Relational and Object Oriented Data Models – Raster and Vector – Methods of Data input – Data Editing – Files and formats – Data structure – Data compression. Introduction to analysis – Measurements – Queries– Reclassification – Simple spatial analysis – Buffering – Neighboring functions – Map overlay –Vector and raster – Spatial interpolation – Modelling in GIS – Digital Elevation Modelling – Expert systems.	9
V	**APPLICATION OF RS AND GIS** Crop Acreage estimation - Estimation of Crop Water Requirement – Crop condition - Soil mapping– classification of soil with digital numbers – soil erosion mapping- reservoir sedimentation using image processing - Inventory of water resources – water quality assessment - Application of Remote Sensing and GIS in Precision Agriculture - Monitor Crop Health - Management Decision Support Systems.	9
	Total Instructional Hours	45

Course Outcome	• The students will understand the remote sensing principles, remote sensing systems satellite data processing and available data products. • The students will understand decision making process using DBMS and utilization of these advanced techniques in addressing the real world problems.

TEXT BOOKS:	
T1	Anji Reddy. M, Remote Sensing and Geographical Information Systems, BS Publications, Hyderbad, 2001
T2	Lillesand, T. M., and Kiefer, R.W., Remote Sensing and Image Interpretation, John Wiley and Sons, New York, 2000.
REFERENCE BOOKS:	
R1	Bettinger, P., and Michael, G.W., “Geographical Information System: Applications in Forestry and Natural Resources Management,” Tata McGraw–Hill Higher Education, New Delhi, 2003
R2	Ian Heywood., “An Introduction to GIS”, Pearson Education, New Delhi, 2001.
R3	Jeffery Star and John Estes, “Geographical Information System – An Introduction,” Prentice Hall India Pvt. Ltd., New Delhi, 1998.
R4	Patel A.N & Surendra Singh, “Remote sensing principles & applications”, Scientific Publishers, Jodhpur 1992

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG7203	SOLAR AND WIND ENERGY ENGINEERING	3	0	0	3

Course Objective	• To impart knowledge on solar energy systems, wind energy systems and its applications.

Unit	Description	Instructional Hours
I	**SOLAR ENERGY RADIATION AND SOLAR THERMAL COLLECTORS** Solar radiation availability - radiation measurement – transmittance - absorptance – Basic earth sun angles - estimation of average solar radiation, radiation on tilted surface - Flat plate collectors - heat transfer correlations - collector efficiency - heat balance – absorber plate – types – selective surfaces. Solar water heaters - types- their performance. Solar driers – types – heat transfer - performance of solar dryers – agro industrial applications.	9
II	**SOLAR CONCENTRATING COLLECTORS** Concentrating collectors – types – reflectors - solar thermal power stations – principle and applications - Solar energy storage systems – thermal - sensible and latent heat, chemical, electrical, electro-magnetic energy storage – selection of materials for energy storage – Solar distillation – application - Solar stills - types - Solar pond - performance – characteristics - applications – Solar refrigeration.	9
III	**SOLAR PV TECHNOLOGY** Solar photovoltaic technology –introduction – solar cell basics – Types of solar cells and modules– encapsulation – Design of solar PV system – load estimation - batteries – invertors – operation - system controls. Standalone and grid connected systems - PV powered water pumping – Hybrid system - Solar technologies in green buildings.	9
IV	**WIND ENERGY** Nature of the wind – power in the wind – factors influencing wind – wind energy potential and installation in India- wind speed monitoring - wind resource assessment -wind power laws - velocity and power duration curves - Betz limit - site selection.	9
V	**WIND MILL TYPES AND APPLICATIONS** Wind energy conversion devices - classification, characteristics, applications – Design of horizontal axis wind mill rotor diameter - Wind energy storage - wind farms - wheeling and banking - testing and certification procedures. Water pumping - Hybrid systems – Wind mill safety and environmental aspects.	9
	Total Instructional Hours	45

Course Outcome	• The student will be able to understand • The concepts of solar and wind energy resources. • The applications of solar and wind energy systems.

TEXT BOOKS:	
T1	Rai., G.D. "Solar Energy Utilization" Khanna publishers, New Delhi, 2002.
T2	More, H.S and R.C. Maheshwari, " Wind Energy Utilization in India" CIAE Publication – Bhopal, 1982.
T3	Solanki, C.S. "Renewable Energy Technologies: A Practical guide for beginners**".** PHI learning Pvt. Ltd, New Delhi. 2008.
REFERENCE BOOKS:	
R1	Solanki, C.S. "Solar Photovoltaic Technology and Systems", PHI learning Pvt. Ltd., New Delhi, 2013.
R2	Rai. G.D. "Non Conventional Sources of Energy", Khanna Publishers, New Delhi, 2002.
R3	Rao. S and B.B. Parulekar. "Energy Technology – Non conventional, Renewable and Conventional". Khanna Publishers, Delhi, 2000.
R4	Rajput. R.K. "Non- Conventional Energy Sources and Utilization", S. Chand & Company Pvt. Ltd, New Delhi, 2013.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7204**	**AGRICULTURAL EXTENSION**	**3**	**0**	**0**	**3**

Course Objective	• To explain the extension functionaries on the latest developments in the field of agricultural extension • To equip the extension functionaries in latest tools and techniques for participatory decision making • To develop an insight into various extension models to enrich the agri - value chain

Unit	Description	Instructional Hours
I	**Principles of Extension** Extension-definition-principles-Philosophy-Objectives- Extension teaching methods- definition-meaning and functions-selection of teaching methods and factors influencing the selection.	9
II	**Methods of contact** Individual contact-farm and home visit -official call, telephone call -personal letter and result demonstration-observation and trail plots-Group contact -method demonstration-meetings -lecture, symposium, panel-brain storming and buzz session. Exhibition-campaign and public speaking purposes- procedure advantage and limitations. Field trips and tours -purpose procedure, advantage and limitations	9

III	**Methods of communication** Mass contact -written communication, circular letter, leaflet, folder, pamphlet and newspaper-purpose procedure advantages and limitations. Organizing youth club - farmer club mahila mandal purpose and procedure.	9
IV	**Visual communication** Audio -visual aids-definition, importance, selection ,use and factors influencing selection , merits and demerits-Electronic media -radio, television and video procedure – purpose techniques – advantage and limitations- Transfer of technology -meaning , importance and major components – communication - definition, meaning, scope and importance-functions and types- communication process -elements and models – Aristotle litterer ,westley -Maclean, Berlo and Leagan.	9
V	**Methods of Feedback** Feedback-types, factors affecting audience response -Adoption -definition, difference between adoption and diffusion, stages and information sources- Adopter categories and factors influencing adoption- Attributes of innovation and their relationship with adoption.	9
Total Instructional Hours		45

Course Outcome	By the End of the course student will be able to critically analyze different Agricultural Extension approaches. • Understand Agricultural Knowledge Information System • Understand Advances in Extension Cyber extension, ICT enabled extension services Market Led Extension, Public Private Partnership, Mainstreaming gender in extension organizational Innovations.

TEXT BOOKS	
T1	Annamalai, R., M. Manoharan, S.Somasundarm and K.N.Krishnakumar, 1987;Extension methods and their principles. Palaniappa printers, Tirunelveli.
T2	Berlo,1970; Process of communication. Holt Rinehart Winston Inc. Newyork.
T3	Dahama,O.P. and O.P.Bhatnagar,1985; Education and communication for development, Oxford and IBH publishing Co.,New Delhi.
REFERENCE BOOKS	
R1	Directorate of extension, 1968; Extension education in community development, Ministry of food and agriculture, Government of India, New Delhi
R2	Ray G.L.1971;Extension communication and management, Naya Prakash, Kolkata
R3	Rogers E. 1985; Diffusion of innovation, Collier McMillan publishers, London.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7301**	**INDUSTRIAL WASTE WATER MANAGEMENTS**	**3**	**0**	**0**	**3**

Course Objective	This course will enable students to • To understand the basic characteristics of wastewater. • Understanding the kinetics of biological system. • Understand the design and working principle of various treatment methods.

Unit	Description	Instructional Hours
I	**IMPORTANT OF WASTEWATER TREATMENT** Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis. Wastewater Treatment Flow Diagrams and Hydraulic Profile.	6
II	**PROCESS OF WASTEWATER TREATMENT** Wastewater treatment – aerobic, anaerobic, suspended and attached growth systems. Kinetics of biological treatment systems –batch and continuous systems	9
III	**DESIGN OF WASTE WATER TREATMENT REACTORS** Theoretical principles and design considerations - screens, equalization basin, grit chamber, primary and secondary settling tanks. suspended growth system - attached growth system – trickling filter, bio-towers and rotating biological contactors.	12
IV	**SLUDGE PROCESSING** Sludge Processing – separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Nitrification and De-nitrification Processes, Phosphorous removal - Wastewater disinfection.	9
V	**DEGRADATION OF POLLUTANTS** Microbial Treatment - Degradation of high concentrated toxic pollutants- Rural wastewater systems – Septic tanks, two-pit latrines, Ecotoilet, soak pits.	9
	Total Instructional Hours	45

Course Outcome	Course outcome At end of this course, students will be qualified : • To know the basic characteristics of wastewater and the kinetics of Biological system. • Understand the design and working principle of various treatment Methods.

TEXT BOOKS	
T1	"Wastewater Engineering - Treatment and Reuse", Metcalf and Eddy Inc., (2003), 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
T2	"Wastewater Treatment Concepts and Design Approach", Karia G.L., and Christian R.A., (2001), Prentice Hall of India Pvt. Ltd., New Delhi.
REFERENCE BOOKS	
R1	Fair G.M., Geyer J.G and Okun, "Water-wastewater Engineering".
R2	"Wastewater Engineering - Treatment and Reuse", Metcalf and Eddy Inc., (2003), 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

CHAIRMAN/BOARD OF STUDIES	PRINCIPAL/DEAN ACADEMIC

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7302**	**ERGONOMICS AND SAFETY IN AGRICULTURAL ENGINEERING**	**3**	**0**	**0**	**3**

Course Objective	• To impart the fundamental knowledge and basic concepts of Ergonomics, safety and its application in the area of agricultural engineering.

Unit	Description	Instructional Hours
I	**ERGONOMICS AND ITS APPLICATION** Ergonomics –Introduction –important –Human metabolism- energy liberation in human body- energy content of nutrient – energy release –energy for storage and energy work- application of ergonomics in farm machinery design.	9
II	**SKELETAL STRUCTURE OF HUMAN** Base of human motor activities –the skeletal structure- skeletal muscle system- muscle metabolism- physiological stress- efficiency of work – age and individual deference in physical function.	8
III	**ENERGY EXPENDITURE** Physiological and operational criteria of physical activity- energy expenditure of activities –keeping energy expenditure within in bounds.	8
IV	**MOVEMENT OF BODY MEMBERS**	8

	Movement of body members and strength and endurance of movements – speed and accuracy of movements –time and distance of movements.	
V	**ANTHROPOMETRY** Anthropometry –types of anthropometrical data- terminology – anthropometric measurement techniques- percentile- application of anthropometric data- anatomical reference position-standard reference terminology-anthropometric consideration in tool/ equipment design-displays and controls location of controls in tractor.	12
	Total Instructional Hours	45

Course Outcome	• The student will gain knowledge to improve the performance of the farm systems by improving the human - machine interaction with safety measures.

TEXT BOOKS:	
T1	Mark S.Senders,Ernest J.Mccormick (1975)human factors in Engineering Design.
T2	McGraw Hill Book co., New York 2. Wesley E.Woodson (1981),Human factors design hand book,
REFERENCE BOOKS:	
R1	Robert W.Bailey (1992).Human performance Engineering .PTR Prentice Hall, Englewood cliffs, New Jersey.07632.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7303**	**ON FARM WATER MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objective	• To understand the fundamentals of minor irrigation, its types, operation and maintenance and people's participation • Command Area Development, On farm structures, policy, operation and maintenance.

Unit	Description	Instructional Hours
I	**DESIGN OF IRRIGATION CHANNELS** Design of Erodible and Non-Erodible, Alluvial channels- Kennedy' s and Lacey' s Theories - Materials for Lining watercourses and field channel - Water control and Diversion structure - Design - Land grading - Land Leveling methods	**9**

II	**COMMAND AREA** Command area - Concept – CADA Programmes in Tamil Nadu - Duty of water - expression - relationship between duty and delta - Warabandhi - water distribution and Rotational Irrigation System – case studies.	**9**
III	**CONJUNCTIVE USE OF SURFACE AND GROUNDWATER** Availability of water - Rainfall, canal supply and groundwater – Irrigation demand - water requirement and utilization - Prediction of over and under utilization of water – Dependable rainfall – Rainfall analysis by Markov chain method – Probability matrix	**9**
IV	**WATER BALANCE** Groundwater balance model – Weekly water balance - Performance indicators – Adequacy, Dependability, Equity and efficiency – conjunctive use plan by optimization – Agricultural productivity indicators – Water use efficiency	**9**
V	**SPECIAL TOPICS** National water policy - Institutional aspects - Socio-economic perspective- Reclamation of salt affected soils- Seepage loss in command area- Irrigation conflicts- Water productivity – Water pricing	**9**
Total Instructional Hours		**45**

Course Outcome	• The students will have a clear understanding of various practices of water management on farm

TEXT BOOKS:	
T1	Michael, A.M. Irrigation Theory and practice, Vikas publishing house, New Delhi, 2006.
REFERENCE BOOKS:	
R1	Keller, .J. and Bliesner D.Ron, 2001 Sprinkler and Trickle irrigation, An ari book, Published by Van No strand Rein hold New York
R2	Israelson, 2002, Irrigation principles and practices, John Wiley & sons, New York.
R3	Modi, P.N., 2002. Irrigation and water resources and water power engineering, Standard Book House, New Delhi.
R4	Michael, A.M. and Ojha, T.P. 2002. Principles of Agricultural Engineering Vol II Jain Brothers, New Delhi.
R5	Suresh, R. 2008. Land and water management principles, Standard Publishers & Distributors, New Delhi

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7304**	**WATERSHED HYDROLOGY AND MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objective	• To introduce the student to the concept of hydrological aspects of water availability and requirements and should be able to quantify, control and regulate the water resources.

Unit	Description	Instructional Hours
I	**PRECIPITATION AND ABSTRACTIONS** Hydrological cycle- Meteorological measurements – Requirements, types and forms of precipitation - Rain gauges-Spatial analysis of rainfall data using Thiessen and Isohyetal methods-Interception - Evaporation. Horton's equation, pan evaporation measurements and evaporation suppression - Infiltration-Horton's equation - double ring infiltrometer, infiltration indices.	9
II	**RUNOFF** Watershed, catchment and basin - Catchment characteristics - factors affecting runoff - Run off estimation using empirical - Strange's table and SCS methods – Stage discharge relationships- flow measurements- Hydrograph – Unit Hydrograph – IUH	9
III	**FLOOD AND DROUGHT** Natural Disasters-Flood Estimation- Frequency analysis- Flood control- Definitions of droughts-Meteorological, hydrological and agricultural droughts- IMD method- NDVI analysis- Drought Prone Area Programme (DPAP)	9
IV	**RESERVOIRS** Classification of reservoirs, General principles of design, site selection, spillways, elevation – area - capacity - storage estimation, sedimentation - life of reservoirs – rule curve	9
V	**GROUNDWATER AND MANAGEMENT** Origin- Classification and types - properties of aquifers- governing equations – steady and unsteady flow - artificial recharge - RWH in rural and urban areas	9
	Total Instructional Hours	45

Course Outcome	• The students completing the course will have : • An understanding of the key drivers on water resources, hydrological processes and their integrated behaviour in catchments • Ability to construct and apply a range of hydrological models to surface water and groundwater problems including Hydrograph, Flood/Drought management, artificial recharge • Ability to conduct Spatial analysis of rainfall data and design water storage reservoirs • Understand the concept and methods of ground water management

TEXT BOOKS:	
T1	Subramanya .K. "Engineering Hydrology"- Tata McGraw Hill, 2010

T2	Jayarami Reddy .P. "Hydrology", Tata McGraw Hill, 2008.
T3	Linsley, R.K. and Franzini, J.B. "Water Resources Engineering", McGraw Hill International Book Company, 1995
REFERENCE BOOKS:	
R1	David Keith Todd. "Groundwater Hydrology", John Wiley & Sons, Inc. 2007
R2	Ven Te Chow, Maidment, D.R. and Mays, L.W. "Applied Hydrology", McGraw Hill International Book Company, 1998.
R3	Raghunath .H.M., "Hydrology", Wiley Eastern Ltd., 1998.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7305**	**Application of Drone Technology in Agriculture**	**3**	**0**	**0**	**3**

Course Objective	To assimilation of theoretical and practical knowledge required to design, build, program and use of the drones under safety conditions and maximize its application in agriculture.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO DRONE TECHNOLOGY** History of drone -Types of current generation of drones based on their method of propulsion Classifications of the UAS -installation and utilization - on-board controls and communications - Telemetry-tracking - launch and recovery systems - ground control stations.	9
II	**DRONE ANATOMY AND ASSEMBLY** Multi rotor introduction - Drone Anatomy: Motor – Propeller - ESC – Flight controller – Transmitter – Receiver Sensors – Assembly – Autonomous system - Emergency identification and handling.	9
III	**DRONE PROGRAMMING AND OPERATION** Drones configurations -The methods of programming drone-Install program on computer Running Programs –Multi rotor stabilization -Flight modes - Wi-Fi connection .Concept of operation for drone -Drone controls - drone operations management tool.	9
IV	**APPLICATIONS OF DRONES IN AGRICULTURE** Agriculture -Seed Planting-Crop Spraying and Spot Spraying-Crop Mapping and Surveying-Irrigation Monitoring and Management-Real-Time	9

	Livestock Monitoring and health issues.	
V	**OPERATIONAL CONSIDERATIONS AND FUTURE SCOPE** DGCA regulations –CAR - NPNT – fly zones - Digital sky platform - Federal Aircraft Regulations - Future Prospects and Challenges- Case Studies – Mini and Micro UAVs.	9
	Total Instructional Hours	45

Course Outcome	• After successful completion of the course, our students will be able to: • understand drone concepts and terminology • understand the technology to transmit and receive data • identify examples of related real-world applications of drones • Understand and identify business opportunities with the use of drone technology

TEXT BOOKS:	
T1	Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
T2	Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
REFERENCE BOOKS:	
R1	Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001
R2	Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
R3	Gerard Sylvester ,"E-Agriculture in action: Drones for Agriculture" Published by Food and Agriculture Organization of the United Nations And International Telecommunication Union Bangkok, 2018.
R4	Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**
B.E.	16AG7306	Dairy Process Technology	3	0	0	3

Course Objective	To introduce the students to dairy industry, properties, Technologies involved and processing of milk, manufacturing of dairy products.

Unit	**Description**	**Instructional Hours**

I	**CHEMISTRY OF MILK** Milk definition, composition and variation; Structure of milk - fat globules, casein micelles, globular proteins, lipoprotein particles and their properties and grading of milk; Milk proteins - Introduction, definition and nomenclature of milk proteins, milk proteins classification and its importance, Protein denaturation and hydrolysis; Enzymes in milk, Carbohydrates and Lipids in milk, Salt composition in milk.	9
II	**SEPARATION EQUIPMENT** Mechanical Separation: Fundamentals involved in separation - Gas-Solid Seperations, Liquid-Solid Separations; Principle Involved in filtration, Types, Rates of filtration, Pressure drop Calculations; Gravity setting, Sedimentation, Principles of centrifugal separation, Different types of centrifuges, application in dairy industry; Clarifies, Tri-Processors, Cream Separator, Self-De sludging centrifuge, Bacto –Fuge; Care And Maintenance Of Separators and Clarifiers.	9
III	**HOMOGENIZERS, PASTEURIZERS AND STERILIZERS** Homogenization: classification, single stage and two stage homogenizer pumps, Power requirement for homogenization, Care and maintenance of homogenizers, Aseptic Homogenizers; Pasteurization: Batch, Flash And Continuous (HTST) Pasteurization, Care and maintenance of pasteurizer; Sterilizer - Different types Of Sterilizer, In Bottle Sterilizers, Autoclaves Continuous sterilization plant, UHT Sterilization, Care And Maintenance Of Sterilizers.	9
IV	**MECHANIZATION IN MANUFACTURE OF INDIGENOUS DAIRY PRODUCTS** Butter Making Machines - Introduction, Batch Butter Churns - Rotating Churns, Batch Method Using Rotating Churns, Continuous Churns, Continuous Butter Making; Ghee Making Machines – Introduction, Ghee making equipments; Ice-Cream Making Equipment - Introduction, types, controls and automation; Cheese Making Equipments.	9
V	**PACKAGING MACHINES FOR MILK & MILK PRODUCTS** Packaging machines for Milk – Introduction, Sequence of operation, Controls; UHT Milk Packing Machine; Package Terminologies; Tetra Brik Filling Machines; Packaging Machines For Milk Products - Cheese Packing Machine Types, Aseptic packaging and equipment, Vacuum Packaging.	9
	Total Instructional Hours	45

Course Outcome	• The students will gain knowledge about Dairy technology and Understand the process of manufacturing of dairy products.

TEXT BOOKS:	
T1	Chandra Gopala Rao. Essentials of Food Process Engineering. B.S. Publications, Hyderabad, 2006.
T2	Walstra. P., Jan T. M. Wouters., Tom J. Geurts "Dairy Science and Technology", CRC press, 2005.
REFERENCE BOOKS	
R1	Subbulakshmi.G., and Shobha A. Udipi, Food Processing and Preservation, New Age International Publications, New Delhi, 2007.
R2	Toledo, R.T., "Fundamentals of Food Process Engineering", CBS Publishers and Distribution, New Delhi, 1997.
R3	Dairy Science and Technology Handbook, Volumes 1-3, John Wiley & Sons,1993.

CHAIRMAN/BOARD OF STUDIES	PRINCIPAL/DEAN ACADEMIC

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG7307	STORAGE AND PACKAGING TECHNOLOGY	3	0	0	3

Course Objective	• To understand the underlying principles of spoilage and storage • To provide knowledge on different storage methods and packaging techniques.

Unit	Description	Instructional Hours
I	**SPOILAGE AND STORAGE** Direct damages, Indirect damages of perishable and durable commodities – control measures - factors affecting storage – types of storage – Losses in storage and estimation of losses.	9
II	**FUNCTIONS OF PACKAGING MATERIALS** Improved storage methods for grain-modern storage structures-infestation-temperature and moisture changes in storage structures-CAP storage-CA storage of grains and perishables construction operation and maintenance of CA storage facilities.	9
III	**STORAGE METHODS** Introduction – packaging strategies for various environment – functions of package – packaging materials – cushioning materials – bio degradable packaging materials	9

	– shrink and stretch packaging materials.	
IV	**FOOD PACKAGING MATERIALS AND TESTING** Introduction – paper and paper boards - flexible - plastics - glass containers – cans – aluminium foils - package material testing-tensile, bursting and tear strength.	9
V	**SPECIAL PACKAGING TECHNIQUES** Vacuum and gas packaging - aseptic packaging - retort pouching – edible film packaging – tetra packaging – antimicrobial packaging – shrink and stretch packaging.	9
	Total Instructional Hours	45

Course Outcome	The students will have a clear understanding of various methods of storage and different packaging techniques for food.

TEXT BOOKS:	
T1	Sahay, K.M. and K.K.Singh. 1996. Unit operations of agricultural processing. Vikas Publishing House Pvt. Ltd., New Delhi.
T2	Food Packaging Technology, Hand book, 2004. NIIR Board, New Delhi.
T3	Pandey, P.H.2002. Post harvest engineering of horticultural crops through objectives. Saroj Prakasam. Allahabad.
REFERENCE BOOKS:	
R1	Himangshu Barman. 2008, Post Harvest Food grain storage. Agrobios (India), Jodhpur.
R2	Chakaraverty, A. 2000. 3rd edition. Post harvest technology of cereals, pulses and oil seeds. Oxford & IBH publishing & Co.Pvt.Ltd. New Delhi.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7308**	**PROCESS ENGINEERING OF FRUITS AND VEGETABLES**				

Course Objective	• To understand the basics of Post Harvest Technology of fruits and vegetables through their structure and composition • To study the different methods of processing and preservation of fruits and vegetables including drying and dehydration • To learn the latest methods of storage of fruits and vegetables.

Unit	Description	Instructional

		Hours
I	**STRUCTURE, COMPOSITION, RIPENING AND SPOILAGE** Importance of post harvest technology of horticultural crops – post harvest losses – factors causing losses - structure, cellular components, composition and nutritive value of horticultural crops – fruit ripening – mechanism and equipment - spoilage of perishable commodities – mechanism and factors causing spoilage.	9
II	**CLEANING, GRADING AND ON-FARM PROCESSING** Harvesting and washing of fruits and vegetables – cleaning and grading – fruits and vegetables - peeling - equipments – construction and working – pre-cooling – importance, methods, pretreatments and advantages.	9
III	**PRESERVATION OF FRUITS AND VEGETABLES** Thermal and non-thermal techniques of preservation of fruits and vegetables and their products - methods - minimal processing of horticultural commodities – fruits and vegetables, advantages - quick freezing preservation - commercial canning of fruits, vegetables and other perishable commodities – processing and concentration of juice - membrane separation process and application - hurdle technology of preservation and techniques.	9
IV	**DRYING AND DEHYDRATION** Dehydration of fruits and vegetables – types of dryers, construction and working - methods – fluidized bed dryer, freeze drying, osmotic dehydration and foam mat drying – principles, construction, operation and applications - quality parameters and advantages.	9
V	**STORAGE** Storage of fruits and vegetables – storage under ambient conditions, low temperature storage, evaporative cooling – cold storage of horticultural commodities – estimation of cooling load - controlled atmosphere storage – concept and methods –modified atmosphere packaging – gas composition, quality of storage – waxing of fruits – types of wax, equipment and advantages.	9
	Total Instructional Hours	45

Course Outcome	• At the end of this course, the student will be thorough in various methods of processing, preservation and storage of fruits and vegetables using latest technologies.

TEXT BOOKS:	
T1	Fellows. P. 2000. Food Processing Technology – Principles and Practice, second edition, CRC Press, Woodland Publishing Limited, Cambridge, England.
T2	Sudheer K. P. and V. Indra.2007. Post harvest Technology of Horticultural Crops. New India Publishing Company, New Delhi.
T3	L.R.Verma and V.K.Joshi. 2000. Post Harvest Technology of Fruits and Vegetables – handling, Processing, Fermentation and waste management. Indus Publishing company, New Delhi.
REFERENCE BOOKS:	
R1	Heid,J.L. and M.A.Joslyn. 1983. Food processing operations. Vol. II. AVI Publishing Co. Inc. Westport, Connecticut.

R2	Potter, N.N.1976. Food science. AVI Publishing Co. Inc.Westport, Connecticut, 2nd edition.
R3	Sivetz Michael and N.W.Desrosier. 1979. Coffee Technology. AVI Publishing Co. Inc, Westport, Connecticut.
R4	Humberto vega and Gustavo v Barbosa. 1996. Dehydration of foods. Springer Science, Business Media, Chapman&Hall Publishers, U.K.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7401**	**Emerging Technologies in Food Process Engineering**	**3**	**0**	**0**	**3**

Course Objective	• To study the emerging technologies in food process Engineering.

Unit	Description	Instructional Hours
I	**STATUS OF FOOD PROCESSING INDUSTRY AND FUTURE PROSPECTS** Introduction to food processing in India Introduction Factors Influencing The Consumers To Seek Processed Foods Steps Taken By Government For Upliftment Of Food Processing Industry Status Of Food Industry In India And Abroad Magnitude And Interdependence Of Dairy And Food Industry Recent Developments And Future Growth In The Food Industry	9
II	**THERMAL PROCESSING** Thermal processing: Death rate kinetics, thermal process calculations, methods of sterilization and equipments involved, latest trends in thermal processing, novel dehydration techniques.	9
III	**HIGH PRESSURE PROCESSING AND PULSED ELECTRIC FIELD PROCESSING** High pressure processing of foods, High pressure processing of salads and ready meals, Microbial aspects of HPP, Advantages and Disadvantages. Application in food industry. PEF for foods, PEF of liquid foods and beverages, Effect of high intensity electric field pulses on solid foods, Enzymatic inactivation by PEF, Food safety aspects of PEF, Advantages and Disadvantages. Application in food industry.	9
IV	**NON-THERMAL PROCESSING** Non-thermal processing: Osmotic dehydration, Athermal membrane processes for the concentration of liquid foods, High intensity pulsed light technology, Radio	9

	frequency heating, Ultrasound, Food irradiation, Microwave heating, ohmic heating, combined microwave vacuum drying, new hybrid drying technologies, NMR Technology.	
V	**Innovations in Food refrigeration and minimal processing** Vacuum cooling of foods, Ultrasonic assistance of food freezing, High pressure freezing, Controlling the freezing process with antifreeze proteins. Minimal fresh processing of vegetables, fruits and juices, Minimal processing of ready meals, Modified atmosphere packaging for minimally processed foods.	9

Total Instructional Hours	45

Course Outcome	The student will gain the knowledge on various emerging technologies in Food processing sector.

TEXT BOOKS:	
T1	Unit Operations in Food Processing - R. L. Earle
T2	Chakraverty, A. Post harvest technology for Cereals, Pulses and Oilseeds. Oxford & IBH Publication Pvt Ltd, New Delhi, Third Edition, 2000.
REFERENCE BOOKS:	
R1	**Da-Wen Sun., 2005.,Emerging Technologies for Food Processing., Copyright © 2005 Elsevier Ltd. https://doi.org/10.1016/B978-012676757-5/50000-1**
R2	Pande, P.H. Principles of Agriculture Processing. Kalyani Publishers, Ludhiana, 1994.
R3	Henderson, S.M. and R.L. Perry. Agricultural Process Engineering. John Wiley and Sons, New York. 1955. 3. Mohsenin, N.N. Physical Properties of Plant and Animal Materials Gordon and Breach Publishers, Ludhiana, 1970.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AGI7001**	**GIS LABORATORY FOR AGRICULTURAL ENGINEERS**				

Course Objective	• To introduce the principles and basic concepts of Remote Sensing and GIS through intensive hands on training.

S.NO	LIST OF EXPERIMENTS
1	Measurement of relief displacement using parallax bar
2	Stereoscopic vision test
3	Aerial photo interpretation - visual

4	Satellite images interpretation – visual
5	Introduction to QGIS
6	Geo-referencing of images
7	Image enhancement practice
8	Supervised classification practice
9	Unsupervised classification practice
10	Database Management Systems
11	Spatial data input and editing - Digitising
12	Raster analysis problems – Database query
13	GIS applications in DEM and its analysis
14	GIS application in watershed analysis
15	GIS application in rainfall-runoff modelling
16	GIS application in soil erosion modelling

Course Outcome	On completion of the lab course, the students will have adequate knowledge in application of RS and GIS in various fields of agricultural engineering.

S.NO	LIST OF EQUIPMENTS REQUIRED	REQUIRED QUANTITY
1	Computers	30
2	Licensed software like GIS	1

REFERENCES

R1	Lillesand, T.M. and Kiefer, R.W. 2005. “Remote Sensing and Image Interpretation “, II edition. John Wiley & sons.
R2	Heywood, I., Cornelius. S., Carver. S 2002. An Introduction to Geographical Information Systems. Addison Wesley Longman, New York.
R3	Floyd F.Sabins. 2005. “Remote Sensing: Principles and Interpretation”, III edition. Freeman and Company New York.
R4	Jensen, J.R., 2004. “Introductory Digital Image Processing: A Remote Sensing Perspective”. Prentice – Hall. New Jersey.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AGI7002**	**RENEWABLE ENERGY LABORATORY**	**0**	**0**	**4**	**2**

Course Objective	• To help the students gain the practical knowledge on various renewable energy sources, gadgets and contrivances.

S.NO	LIST OF EXPERIMENTS
1	Characterization of biomass – proximate analysis
2	Determination of caloric value of fuels – solids and gases
3	Design of KVIC / Deenbandhu model biogas plant
4	Study of UASB biomethanation plant
5	Purification of biogas – CO2 and H2S removal
6	Performance evaluation of agro based gasifier
7	Study on pyrolysis unit – Biochar, Charcoal and Tar making process
8	Testing of biogas/producer gas engines
9	Study on briquetting and Stoichiometric calculations
10	Automatic weather station – Analysis of wind data and prediction
11	Testing of solar water heater
12	Testing of natural convection solar dryer
13	Study on Solar power and I-V Characteristics
14	Testing of solar photovoltaic water pumping system (The lab includes visit to biomass power plant and wind farms).

Course Outcome	On completion of the lab course, the students will be familiarized to renewable energy sources and their application.

S.NO	LIST OF EQUIPMENTS REQUIRED	REQUIRED QUANTITY
1	Hot air oven	1
2	Muffle furnace	1
3	Junkers gas calorimeter	1
4	Bomb calorimeter	1
5	Model of Biogas and Deenabandhu biogas plant	1
6	Biogas scrubbing unit	1
7	Gasifier - Lab Scale	1
8	Pyrolysis unit	1
9	Biogas/ Producer gas dual fuel Engine	1

10	Briquetting Machine - Lab Scale	1
11	Automatic weather station.	1
12	Solar water heater	1
13	Solar dryer-1 no.	1
14	Solar PV training kit-	1
15	Solar PV water pumping system	1

The equipment's includes the basic requirements like petri plates, silica crucible with lid, weighing balance, tongs, gloves, solarimeter, hand held anemometer, temperature and humidity sensor.

REFERENCES	
R1	Khandelwal, K.C. and Mahdi, S.S. "Biogas Technology". Tata Mc Graw Hill Pub. Co. Ltd., New Delhi, 1986.
R2	Nijaguna, B. T. "Biogas Technology" New Age International Pvt. Ltd., New Delhi, 2006.
R3	Rao. S and B.B. Parulekar. Energy Technology – Non conventional, Renewable and Conventional. Khanna Publishers, New Delhi, 2000.
R4	Solanki, C.S. "Solar Photovotaics – Fundamentals, Technologies and Applications", PHI Learning Pvt. Ltd., New Delhi, 2011.

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Programme	**Course Code**	**Name of the Course**	**L**	**T**	**P**	**C**
B.E.	**16AGI7003**	**ICT IN AGRICULTURAL ENGINEERING**	**0**	**0**	**4**	**2**

Course Objective	• To gain practical knowledge on various technologies in information and communication for agricultural engineering applications.

S.NO	**LIST OF EXPERIMENTS**
1	Configuring timers for automatic switching "on and off" of irrigation systems
2	Experience with solenoid valves for pressurized irrigation
3	Using sensors for Agro meteorological measurements
4	Employing Printed Circuit Board (PCB) or Breadboard for controlling or triggering an agricultural system
5	Use of mobile apps for controlling or triggering an agricultural system
6	Construction of crop growth functions (best fit) for crop yields simulations

7	Image processing as tool for biotic and abiotic stress identification
8	Experience with existing open source crop simulation models
9	Exposing cloud resources for agricultural applications
10	Developing automated agro advisory systems
Course Outcome	By the end of the course, the students will be able to • Gain practical knowledge on various technologies in information and communication for agriculture. • Write various languages (*like.*, Java, C, Javascript, swift and PHP) to activate model .

S.NO	LIST OF EQUIPMENTS REQUIRED	REQUIRED QUANTITY
1	Timing devices and small pumps for simulations – required nos.	1
2	Solenoid valves and layout of drip or sprinkler system – required nos.	1
3	Time Domain Reflectometer (TDR)	1
4	Digital thermometer	1
5	Breadboards, relays etc.	1
6	MATLAB software	1
7	Open source Crop simulation models – any one for demonstration	1
8	Other facilities for cloud resources, agro advisory systems etc.	1

REFERENCES

R1	Gelb, E. and Voet, H., 2009. ICT Adoption Trends in Agriculture: A summary of the EFITA ICT Adoption Questionnaires (1999-2009). Abrufbar unter: http://departments. agri. huji. ac. il/economics/voet-gelb. pdf. Letzter Zugriff, 20, p.2010.
R2	Tolulope Kehinde, K.A., Agwu, D. and Edwin, M., 2015. Application of ICT to Agriculture as a Panacea to Unemployment in Nigeria
R3	Taragola, N. and Gelb, E., 2005. Information and Communication Technology (ICT) adoption in horticulture: A comparison to the EFITA baseline. ICT in agriculture: Perspectives of technological innovation.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG7701**	**INDUSTRIAL TRAINING/TECHNICAL SEMINAR**	**0**	**0**	**0**	**2**

Course Objective	• To train the students in field work by attaching to any industry / organization so as to have a firsthand knowledge of practical problems in Agricultural Engineering • To gain working experience and skills in carrying out engineering tasks related to

	various fields of agriculture.

PLACE OF TRAINING
The students individually undertake training in reputed engineering companies / Govt organisations / NGOs / Educational Institutions who work in the area of Agricultural Engineering for the specified duration. At the end of the training, a report on the work done will be prepared and presented. The students will be evaluated through a viva-voce examination by a team of internal staff.

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SEMESTER VIII

Sl.No	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL	Category
THEORY										
1	16AG83XX	Professional Elective – V	3	0	0	3	25	75	100	PE
2	16AG83XX	Professional Elective-VI	3	0	0	3	25	75	100	OE
PRACTICAL										
3	16AG8901	Project Work	0	0	20	10	100	100	200	EEC
		Total	**6**	**0**	**20**	**16**			**400**	

Program	Course Code	Name of the Course	L	T	P	C
B.E.	16AG8301	AGRI BUSINESS MANAGEMENT AND ENTERPREUSHIP	3	0	0	3

Course Objective	• To introduce the importance of Agri-business management, its characteristics and principles • To impart knowledge on the functional areas of Agri-business like Marketing management, Product pricing methods and Market potential assessment.

Unit	Description	Instructional Hours
I	**AGRIBUSINESS MANAGEMENT** Concept - components of agribusiness - forms of agribusiness firms. Management - concept - functions of management - managerial roles and skill (Mintzbergs) required at various levels of management.	9
II	**MANAGEMENT FUNCTIONS** Planning - steps and types of plans. Organizing - basics for Departmentation - Staffing - human resource planning process - Directing - techniques of direction. Coordination and control - types.	9
III	**FUNCTIONAL AREA - I** Operations management - planning and scheduling - supply chain management in agribusiness - Human resource management - job analysis, recruitment and selection process	9
IV	**FUNCTIONAL AREA - II** Marketing Management - market segmentation, consumer buying behaviour and marketing mix - Financial management - concept and financial planning for agribusinesses	9
V	**ENTREPRENEURSHIP** Entrepreneur - entrepreneurship - types, characteristics and process - Innovation, business incubation and financing entrepreneurs.	9
	Total Instructional Hours	45

Course Outcome	• The students shall be exposed to various trends in agricultural business management.

TEXT BOOKS:	
T1	Himanshu, “Agri Business Management – Problems and prospects”, Ritu Publications, Jaipur, 2005.
T2	Smita Diwase, “Indian Agriculture and Agribusiness Management”, Krishi resource Management Network, Pune 2004.
REFERENCE BOOKS:	

R1	Chandra Prasanna, “Projects: Preparation, Appraisal, Budgeting and Implementation”, Tata McGraw Hill Publications, New Delhi, 2001.
R2	Kotler, P., “Marketing Management. Analysis, Planning and Control”, Prentice Hall Inc., New York, 2001.
R3	Rao, V.S.P., and Narayana, P.S., “Principles and Practices of Management”, Konark Publishing Private Limited, New Delhi, 2001.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16AG8302	AGRICULTURAL ECONOMICS AND FARM MANAGEMENT	3	0	0	3

Course Objective	• To impart the fundamental knowledge and basic concepts of Economics and Farm Management • To understand the types of resources and Investment analysis in agriculture sector Farm financial analysis, Investment and Budgeting for farms.

Unit	Description	Instructional Hours
I	**FARM MANAGEMENT** Agricultural Economics – definition and scope – Farm Management – definition – scope- Classification of farms – Basic concepts in farm management - Relationship between farm management and other basic sciences - Farm layout – Farm records and accounts – Farm appraisal techniques – Valuation .	9
II	**LAWS OF ECONOMICS** Basic laws of economics – demand and supply concepts – law of increasing, diminishing and constant returns – Equi-marginal returns - Product relationship – Production function – definition and types – Production function curves – Optimum level of input use – Economies of scale external and internal economies and diseconomies - Cost concepts – types - Opportunity cost – comparison of costs – Factor relationship – concepts.	9
III	**COST CURVES** Principle of substitution – isoquant, isocline, expansion path, ridge line and least cost combination of inputs-Product-product relationship – Production possibility curve, isorevenue line and optimum combination of outputs – Cost curves –Optimum input and output levels – Factor –factor relationship – Least cost combination of inputs – Estimation of cost of cultivation and cost of production of crops - annual and perennial crops – Preparation of interview schedule and farm visit for data collection.	9
IV	**MANAGEMENT OF RESOURCES** Concept of risk and uncertainty – causes for uncertainty – Managerial decisions	9

	to reduce risks in production process – Management of resources – types of resources- land, labour, capital and measurement of their efficiencies – Mobilization of farm resources- Cost of machinery and maintenance – Break even analysis – Investment analysis – Discounting techniques.	
V	**FARM MANAGEMENT AND FINANCIAL ANALYSIS** Farm management- need and analysis – Farm financial analysis – Balance sheet – Income statement – Cash flow analysis – Farm investment analysis – Time comparison principles – Farm planning – Elements of farm planning – Whole farm planning and partial planning – Farm level management system – Farm budgeting – whole farm budgeting and partial budgeting – Estimation of credit - examples of farm planning and budgeting.	9
Total Instructional Hours		45

Course Outcome	• Students are able to plan the financial aspects related to farm management in a cost effective manner.

TEXT BOOKS:	
T1	Johl, S.S., and Kapur, T.R.,Fundamentals of Farm Business Management", Kalyani publishers, Ludhiana, 2007.
T2	Subba Reddy, S., Raghu Ram, P., Neelakanta Sastry T.V and Bhavani
T3	Devi, I., "Agricultural Economics"Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2006.
REFERENCE BOOKS:	
R1	Raju, V.T., "Essentials of Farm Management", Oxford and IBH Publishing Co. Pvt. Ltd.,New Delhi, 2002.
R2	Subba Reddy, S., and Raghu Ram, P. „ "Agricultural Finance and
R3	Management", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2002.
R4	Sankhayan, P.L. „"Introduction to Farm Management", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2001
R5	Muniraj, R., "Farm Finance for Development", Oxford and IBH Publishing Co. Pvt. Ltd.,New Delhi, 2000.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG8303**	**INTELLECTUAL PROPERTY RIGHTS**	**3**	**0**	**0**	**3**

Course Objective	• To impart knowledge to students on various methods of agricultural waste

	management for eco-friendly energy and manure production.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.	9
II	**REGISTRATION OF IPRs** Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad	9
III	**AGREEMENTS AND LEGISLATIONS** International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act. .	9
IV	**DIGITAL PRODUCTS AND LAW** Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies. .	9
V	**ENFORCEMENT OF IPRs** Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies Ethanol production from lingo cellulosic wastes - Processing of Biomass to Ethanol – pretreatment – fermentation - distillation.	9
	Total Instructional Hours	45

Course Outcome	Ability to manage Intellectual Property portfolio to enhance the value of the firm.

TEXT BOOKS:	
T1	V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India Pvt Ltd, 2012 2. S. V. Satakar, "Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002
REFERENCE BOOKS:	
R1	Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
R2	Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011
R3	Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013

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Programme	Course Code	Name of the Course	L	T	P	C

B.E.	16AG8304	AGRICULTURAL WASTE MANAGEMENT	3	0	0	3

Course Objective	• To impart knowledge to students on various methods of agricultural waste management for eco-friendly energy and manure production.

Unit	Description	Instructional Hours
I	**INTRODUCTION** Availability of different types of agriculture wastes - its overall characteristics – classification of agro wastes based on their characteristics- its recycling and utilization potential- current constraints in collection and handling of agricultural wastes – its environmental impact.	9
II	**COMPOSTING** Definition- Solid waste suitable for composting – Methods of composting - vermicomposting - Mineralization process in composting - Biochemistry of composting – Factors involved – Infrastructure required – maturity parameters – value addition – application methods	9
III	**BIOMASS BRIQUETTING** Definition – potential agro residues and their characteristics for briquetting – fundamental aspects and technologies involved in briquetting – economic analysis of briquetting – setting up of briquetting plant- appliances for biomass briquettes.	9
IV	**BIOCHAR PRODUCTION** Definition - characteristics of agro wastes suitable for Biochar production – Methods of Biochar production – fast and slow pyrolysis – characteristics of Biochar – role of Biochar in soil nutrition and carbon sequestration.	9
V	**BIOGAS AND BIO ETHANOL PRODUCTION** Screening of suitable lingo cellulosic substrate for biogas production -determination of bio-energy potential of agro-waste by estimating total solids - volatile solids - Calorific value- per cent total carbohydrates, moisture, lignin and cellulosic contents – preparation of feed stocks for anaerobic bio- digestion – types of digesters – factors affecting - nutrient value and utilization of biogas slurry. Ethanol production from lingo cellulosic wastes - Processing of Biomass to Ethanol – pretreatment-fermentation-distillation.	9
	Total Instructional Hours	45

Course Outcome	At the end of the course student will be able to understand • Various eco-friendly methods for agricultural waste management. • Nutritive value and energy production potential of agro wastes

TEXT BOOKS

T1	Raymond C Loehr, “Agricultural Waste Management- problems, processes and approaches”. First edition, Academic press, 1974.
T2	Diaz,l.F.,M. de Bertoldi and W. Bidlingmaier. 2007. Compost science and technology, Elsevier pub., PP.1-380
T3	Uta Krogmann, Ina Körne and Luis F. Diaz.2010. Solid waste technology and management (Vol 1 and2). Blackwel Pub Ltd., Wiley Online library.
T4	Yong Sik Ok, Sophie M. Uchimiya, Scott X. Chang, Nanthi Bolan.,” Biochar-production characterization and applications”. 2015. CRC press
REFERENCE BOOKS	
R1	P.D. Grover & S.K. Mishra, “Biomass Briquetting: Technology and Practices”. Published by FAO Regional Wood Energy Development Programme in Asia, Bangkok, Thailand, 1996
R2	Magdalena Muradin and Zenon Foltynowicz, “Potential for Producing Biogas from Agricultural Waste in Rural Plants in Poland”. Sustainability, 2014, 6, 5065-5074.
R3	Biochar production from agricultural wastes via low-temperature microwave carbonization
R4	Qian Kang, Lise Appels, Tianwei Tan and Raf Dewil, “Bioethanol from Lignocellulosic Biomass: Current Findings Determine Research Priorities” The Scientific World Journal, 2014, Article ID 298153, 13 pages

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG8305**	**SPECIAL FARM EQUIPMENT**	**3**	**0**	**0**	**3**

Course Objective	• To study the special machineries used for agricultural applications

Unit	Description	Instructional Hours
I	**Mowers and Weeding Equipment** Weeding and intercultural equipment. Junior hoe - guntaka - blade harrow - rotary weeders for upland and low land - selection, constructional features and adjustments - Spading machine – coir pith applicators - Mower mechanism – lawn mowers.	9
II	**Sprayers and Dusters** Sprayers – Sprayer operation – boom sprayer – precaution – coverage – factors affecting drift. Rotating disc sprayers – Controlled Droplet Application (CDA) – Electrostatic sprayers – Areal spraying – Air assist sprayers – orchard sprayers – Dusters – types – mist blower cum duster – other plant protection devices, care and maintenance.	9
III	**Threshers and Harvesters**	9

	Construction and adjustments – registration and alignment. Windrowers, reapers, reaper binders and forage harvesters. Diggers for potato, groundnut and other tubers. Sugarcane harvesters -cotton pickers – corn harvesters – fruit crop harvesters – vegetable harvesters.	
IV	**Threshers and Other Machineries** Thresher – construction and working of multi crop thresher. Forest machinery - shrub cutters - tree cutting machines – post hole diggers – Chaff cutter- flail mowers - lawn mowers – tree pruners	9
V	**Specialized Farm Equipment** Pneumatic planters – air seeders – improved ploughs – reversible ploughs – suction traps – seed and fertilizer broadcasting devices, manure spreaders, sweep weeders – direct paddy seeders, direct paddy cum daincha seeder, coconut tree climbing devices, tractor operated hoist, tractor operated rhizome planter – Transplanters and Balers.	9
	Total Instructional Hours	45

Course Outcome	• After completion of the course, the students will have a thorough knowledge on special farm equipment required for various agricultural operations.

TEXT BOOKS	
T1	Jagdishwar Sahay. 2010. Elements of Agricultural Engineering. Standard Publishers Distributors, Delhi 6.
T2	Michael and Ojha. 2005. Principles of Agricultural Engineering. Jain brothers, New Delhi.
REFERENCE BOOKS:	
R1	Kepner, R.A., et al. 1997. Principles of farm machinery. CBS Publishers and Distributers, Delhi.
R2	Harris Pearson Smith et al. 1996. Farm machinery and equipments. Tata McGraw-Hill pub., New Delhi
R3	Srivastava, A.C. 1990. Elements of Farm Machinery. Oxford and IBH Pub. Co., New Delhi

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG8306**	**MECHANICS OF TILLAGE AND TRACTION**	**3**	**0**	**0**	**3**

Course Objective	• To impart the fundamental knowledge of mechanics and dynamics in various tillage implements • To study the tyres, traction and its applications

Unit	Description	Instructional Hours
I	**Introduction to mechanics of tillage tools** History of tillage –Soil machine crop system –Mechanics of tillage tools- Analysis of soil machine dynamics in tillage. Physical properties of soils- Mechanical properties of soils – Assessment of the dynamic properties of soil.	9
II	**Design of tillage tools and principles of soil cutting** Design of tillage tools - design factors-Shape-Macroshape-Mould board plow surface – principles of soil cutting – Design equation.	9
III	Application of dimensional analysis in soil dynamics Dimensional Analysis – Development of prediction equations- Methods of dimensional analysis – Application of dimensional analysis and simulation to soil mechanics.	9
IV	**Traction and Mechanics** Traction- Traction Mechanics-off road traction- traction model- traction improvement and traction prediction- Cone index and tire basics- tires for agricultural tractors- tire terminology and selection of tires – ballasting	9
V	**Soil compaction and plant growth** soil compaction- mechanical and hydraulic properties of compacted soil-soil physical properties and plant growth-measure for optimizing crop growth by avoiding excessive soil compaction- GIS for soil variability study .	9
	Total Instructional Hours	45

Course Outcome	• After completion of the course, the students will be able to understand the concepts of mechanics, dynamics and traction of implements and their applications.

TEXT BOOKS:	
T1	Klenin, N.L.; Popov, I.F. and V.A. Sakum, (1985). Agricultural machines. Amerind Pub. Co. NewYork
T2	J. B. Liljedahl, P. K. Turnquist, D. W. Smith, & M. Hoki , 1996. Tractors and their power units. Fourth ed. American Society of Agricultural Engineers, ASAE
REFERENCE BOOKS:	
R1	Kepner, R. A., Roy Bainer and E. L. Barger. 1978. Principles of farm machinery. Third edition; AVI Publishing Company Inc: Westport, Connecticut.
R2	S. C. Jain, Farm Machinery- An Approach

R3	Ralph Alcock.1986. Tractor Implements System. AVI Publ.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**19AG8307**	**MICRO IRRIGATION SYSTEMS**	**3**	**0**	**0**	**3**

Course Objective	• To expose the students to basic conceptual differences in the design of Pressure Irrigation systems viz., Drip, Sprinkler, Surge and Capillary modes • To help the students gain a thorough design and layout understanding based on the Hydraulics of pipe-flow coupled with friction loss calculations • To impart technical confidence in the minds of students in making choice based and corrections imbibed layout designs with cost economics.

Unit	Description	Instructional Hours
I	**CONCEPTS AND HYDRAULICS OF MICROIRRIGATION** Pressure Irrigation Concepts – Underground/Overground irrigation conveyance - Drip Irrigation – Sprinkler Irrigation –Perfospray Irrigation - Blind Pipe Hydraulics – Head Loss due Friction – Multi-outlet (Irrigation)/Multi-inlet (Drainage) Pipe flow Hydraulics – General Formula - Darcy-Weisbach theoretical and empirical formulae – Hazen-Williams Formula – Reduction Factor – Christiansen's Formula - Hydraulic Gradient - Slope gradient effects on friction losses - Surge Irrigation – Subsurface Capillary Diffusion – Pitcher Irrigation – Micro-sprinklers – Pop-up Sprinklers – Lawn and Landscape Irrigation layouts.	9
II	**DESIGN AND LAYOUT OF DRIP IRRIGATION** Basic Data and Information – Soil Compatibility – Crop Suitability – Row to Row and Plant to Plant Spacing – Per Hectare Square Layouts – Crop Population – Evapo-transpiration variations with Crop and Climate – Wetting Circles around Plants – Daily Water Requirements – Pump Discharge requirements – Emitter types – Daily Irrigation Duration – Permissible Friction Loss variations – Dripper Pressure Vs Discharge – Multi-outlet Lateral and Sub-main Pressures – Mainline Pressures (Blind pipes) – Horse-Power and Material Requirements –- Pipe size determinations Uniformity Coefficient– Catch-Can and Hydraulic Gradient techniques- Cost Economics – Operation and maintenance	12
III	**DESIGN AND LAYOUT OF SPRINKLER IRRIGATION** Basic Data and Information – Soil types and Infiltration rates –Bulk crop coverage – Water Requirement – Frequency of Irrigation - Materials required – Solid Systems – Portable systems – system components – sprinkler spacing along laterals - Lateral Spacing along sub-mains – Operational Pressure requirements – Horse Power of Pump – theoretical water distribution patterns – sprinkler spray circle	9

	overlapping - Perfospray sprinkling – High Pressure Spray Guns – determination of pipe sizes – calibration of sprinkler discharges with operating Pressures – catch-cans for Uniformity Coefficient evaluation – Operation and Maintenance aspects – cost economics.	
IV	**DESIGN AND LAYOUT OF SURGE IRRIGATION** Surge Flow Furrow Irrigation – Hydraulics – ON-OFF flow cycling – Surge Cycle Ratio - infiltration variations – water front advance predictions – optimization of furrow inflow rates with length and spacing – Water Distribution Efficiency – soil and crop compatibility – semi-automation with lever systems – total automation with sensor system – limitations – cost economics.	9
V	**DESIGN AND LAYOUT OF SUB-SURFACE IRRIGATION** Sub-surface piping and wick networks – capillary diffusion mode – location of pipes and outlets – rootzone wetting patterns – Pitcher Pot Irrigation – Afforestation, Kitchen Gardening and Terrace cultivation prospects – surface mulching – automation with soil moisture deficit sensing – cost economics.	9
	Total Instructional Hours	45

Course Outcome	• The students gain confidence with the exposure to different water saving micro-irrigation systems alongside the field-oriented designs and layouts • The students will be able to interact with farmers for cost effective microirrigation layouts benefitting them for sustained productivity alongside optimal water usage even under scarcity situations.

TEXT BOOKS:	
T1	Dilip Kumar Majumdar., "Irrigation Water Management", Prentice-Hall of India, New Delhi, 2008.
T2	Michael, A.M., "Irrigation Engineering", Vikas Publishers, New Delhi, 2008.
T3	Garg, S.K., "Irrigation Engineering," Laxmi Publications, New Delhi, 2008.
REFERENCE BOOKS:	
R1	Basak, N.N., "Irrigation Engineering", Tata McGraw-Hill Publishing Co, New Delhi, 2008.
R2	Murthy, V.V.N. Land and water management, Kalyani publishing, New Delhi, 1998.

CHAIRMAN/BOARD OF STUDIES	**PRINCIPAL/DEAN ACADEMIC**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG8308**	**AUTOMATION IN IRRIGATION**	**3**	**0**	**0**	**3**

Course Objective	• To expose the students to the concept of Irrigation Automation • To introduce the concepts of Automatic Systems and IoT applications • To train the students to explore and use new technologies in Irrigation.

Unit	Description	Instructional Hours
I	**INTRODUCTION TO AUTOMATION** Automatic Irrigation – Traditional methods of Irrigation – Need for Automation – Comparison between Traditional and Automated Irrigation – Advantages – Disadvantages – Economic Impacts of Automation on Agricultural Firms – Future of Automation.	9
II	**SYSTEMS OF IRRIGATION AUTOMATION** Irrigation Mode Automation Systems – Pneumatic System – Portable timer system – Timer/Sensor Hybrid/SCADA – Methods of automating Irrigation layout – Machine Learning in Tank Monitoring System.	9
III	**IoT IN IRRIGATION** IoT based Automated Irrigation System – IoT based Smart Irrigation – Sensor based Automation – types – operation – Solar based Automatic Irrigation System – components – operation - Automation by sensing soil moisture – Automation using ANN based controller – operation.	9
IV	**SURFACE AND MICRO-IRRIGATION AUTOMATION** Automation and control in Surface Irrigation Systems – Equipments – benefits – barriers – Automation Design in Bay, Basin and Furrow Irrigation – Automation in Micro Irrigation – Systems components of Automation – Design – Cost – Operation and maintenance.	9
V	**ASSESSMENT OF PARAMETERS IN IRRIGATION** Crop water estimate using Satellite data – Automation of Lysimeter for PET Measurements and Energy based Remote Sensing model – Remote Monitoring design of Automatic Irrigation system – Cost and Benefits of Automation.	9
	Total Instructional Hours	45

Course Outcome	• Student will understand the technologies available for automation • Students can design conventional methods as automated system to be more efficient.

TEXT BOOKS:	
T1	H.R.Haise, E.G.Kruse. et al., 1981. "Automation of Surface Irrigation: 15 years of USDA Research and Development at Fort Collins, Colorado"
T2	Brian Wahlin and Darell Zimbelman, Canal Automation for Irrigation Systems, American Society of Civil Engineers, 2014
REFERENCE BOOKS:	
R1	Darell D.Zimbelman, Planning, Operation, Rehabilitation and Automation of Irrigation water delivery system, American Society of Agricultural Engineers,1987.

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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	**16AG8901**	**PROJECT WORK**	**0**	**0**	**20**	**10**

Course Objective	• To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination • Students in a group of 3 or 4 shall work on a topic approved by the head of the department under the guidance of a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. • The progress of the project is evaluated based on three reviews by the review committee constituted by the Head of the Department. • The project work is evaluated based on oral presentation and the final project report jointly by a team of examiners including one external examiner.

Course Outcome	On completion of the project work, students will be in a position to take up any challenging practical problem and find solution by formulating proper methodology.

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