Course Structure and Syllabus
of
B.Tech Programme
In

ELECTRICAL ENGINEERING

(Admission Batch: 2018-19 Onwards)

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG
(An Autonomous Institute of Government of Odisha)
Dhenkanal, Odisha- 759146
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INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

Course Structure for 3rd Year B.Tech ELECTRICAL ENGINEERING

(Admission Batch: 2018-19 Onwards)

Fifth Semester				Sixth Semester			
Theory				**Theory**			
Course Code	**Course Name**	**L-T-P (Periods/ Week)**	**Credits**	**Course Code**	**Course Name**	**L-T-P (Periods/ Week)**	**Credits**
	Programme Core Subject			HSHM3306M/ HSHM3306	Enhancing Soft Skills and Personality	2-0-0	2
PCEE4306	Power Electronics	3-0-0	3		***Programme Core Subject***		
PCEE4307	Microprocessor & Microcontroller	3-0-0	3	PCEE4309	Electrical Drives	3-0-0	3
PCEE4308	Electrical Power Transmission and Distribution	3-0-0	3	PCEE4310	Power System Operation & Control	3-0-0	3
(Any One) PEEE5301/ PEEE5302/ PEEE5303	***Programme Elective I*** Electromagnetic Field Theory / Special Electrical Machines / Digital Signal Processing	3-0-0	3	**(Any One)** PEEE5304/ PEEE5305	***Programme Elective II*** Power Quality/ FACTS	3-0-0	3
(Any One)	**Open Elective II** Refer List of Open Electives	3-0-0	3	**(Any One)**	**Open Elective III** Refer List of Open Electives	3-0-0	3
MCGN9305/ MCHM9306	***Mandatory Course V*** Environmental Science/ Universal Human Values	2-0-0	0	MCHM9306/ MCGN9305	***Mandatory Course VI*** Universal Human Values/ Environmental Science	2-0-0	0
Total (Theory)		**17**	**15**	**Total (Theory)**		**16**	**14**
Honours/ Minor		3-1-0	4	**Honours/ Minor**		3-1-0	4
HNEE0303	Electrical Machine Design			HNEE0304	Control System Engineering-II		
MNEE0303	Electrical Power Transmission and Distribution			MNEE0304	Sensors and Transducers		
Practical/ Sessional				**Practical/ Sessional**			
PCEE7306	Power Electronics Laboratory	0-0-3	2	PCEE7309	Electrical Drives Laboratory	0-0-3	2
PCEE7307	Microprocessor & Microcontroller Laboratory	0-0-3	2	PCEE7310	Power System Laboratory-II	0-0-3	2
PCEE7308	Power System Laboratory-I	0-0-3	2	HSHM3305	Business Communication & Interview Skills	0-0-3	1
				PJEE8301	Skill Project	0-0-3	2
Total (Practical/ Sessional)		**9**	**6**	**Total (Practical/ Sessional)**		**12**	**7**
TOTAL		**26**	**21**	**TOTAL**		**28**	**21**
TOTAL SEMESTER CREDITS: 21				TOTAL SEMESTER CREDITS: 21			
TOTAL CUMULATIVE CREDITS: 104				TOTAL CUMULATIVE CREDITS: 125			

OPEN ELECTIVE SUBJECTS

OPEN ELECTIVE-II (OE-II) 5th Semester						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours**	**Credits**	**Departments to Teach the Subject**	**Students to whom Option is Open**
1	OECH6311	Petroleum Refinery Engineering	3-0-0	3	Chemical Engg.	All branches
2	OECH6330	Green Technology	3-0-0	3	Chemical Engg, Civil Engg.	All branches
3	OECE6312	Mechanics of Solids	3-0-0	3	Civil Engg.	All branches
4	OECS6203	OOPs Using C++	3-0-0	3	CSE	CH, CS, EC, MM, PD
5	OECS6331	Cloud Computing	3-0-0	3	CSE	All branches
6	OEEE6313	Digital Signal Processing	3-0-0	3	Electrical Engg.	All branches
7	OEEC6314	Industrial Automation with PLC and SCADA	3-0-0	3	ETC Engg.	All branches
8	OEME6316	Introduction to Composite Materials	3-0-0	3	Mech. Engg.	All branches
9	OEMT6315	Nanomaterials	3-0-0	3	MME	All branches
10	OEPD6317	Powder Metallurgy	3-0-0	3	Prod. Engg.	All branches
11	OEMA6207	Numerical Methods	3-0-0	3	Mathematics	CE, EE, ME
OPEN ELECTIVE-III (OE-III) 6th Semester						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours**	**Credits**	**Departments to Teach the Subject**	**Students to whom Option is Open**
1	OECH6318	Food Biotechnology	3-0-0	3	Chemical Engg.	All branches
2	OECH6319	Fluidization Engineering	3-0-0	3	Chemical Engg.	All branches
3	OECE6320	Structural Dynamics and Earthquake Engineering	3-0-0	3	Civil Engg.	All branches
4	OECS6321	Data Science	3-0-0	3	CSE	All branches
5	OEEE6322	Sensors and Transducers	3-0-0	3	Electrical Engg.	All branches
6	OEEC6324	Mechatronics	3-0-0	3	ETC Engg.	All branches
7	OEHM6325	Marketing Management	3-0-0	3	Humanities	All branches
8	OEMA6326	Optimization in Engineering	3-0-0	3	Mathematics	All branches
9	OEME6327	Industrial Engineering and Operation Research	3-0-0	3	Mechanical Engg.	All branches
10	OEMT6328	Biomaterials	3-0-0	3	MME	All branches
11	OEPD6329	Operation Research	3-0-0	3	Prod. Engg.	All branches

CE:	Civil Engineering	CS, CSE:	Computer Science and Engineering
EE:	Electrical Engineering	EC, ETC:	Electronics and Telecommunication Engineering
ME:	Mechanical Engineering	MT, MME:	Metallurgical and Materials Engineering
CH:	Chemical Engineering	PD, Prod.:	Production Engineering
HM:	Humanities	MA:	Mathematics

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

B.TECH SYLLABUS for ELECTRICAL ENGINEERING

(Admission Batch: 2018-19 Onwards)

5th Semester

PCEE4306	Power Electronics	3-0-0	3 Credits

Course Objectives: The students will be able to:

1. Develop characteristics of different power electronic switching devices.
2. Reproduce working principle of power electronic converters for different types of loads.
3. Analyze the performance of power electronic converters.

MODULE 1 **[12 Hours]**

Switching and V-I characteristic of devices: power diode, SCR, IGBT, and MOSFET, Series and parallel grouping of SCR, Two Transistor model of SCR. Triggering Methods: SCR: (Cosine Firing Scheme), BJT gate drive, IGBT gate drive, Isolation of gate and base drive.

Protection of Devices: SCR: Over voltage, Over Current, dv/dt, di/dt, Gate Protection. Transistor: protection of power BJT, IGBT and power MOSFET, dv/dt& di/dt limitation. [Chapter: 2.2-2.7, 4.1-4.5,4.7,4.10,4.14,4.15,4.18]

MODULE 2 **[12 Hours]**

AC to DC converter: Un-controlled Diode rectifier: Single phase half wave and full wave rectifiers with R-L and R -L-E load, 3 phase bridge rectifier with R-L and R-L-E load(Waveform and Performance Parameters).

Phase Controlled Converter: Principle of phase controlled converter operation, single phase full converter with R-L and R-L-E load, Effect of source inductance on the operation of converter, 3 phase full converter with R-L and R-L-E load, single phase semi converter with R-L and R-L-E load, 3 phase semi-converter with R-L and R-L-E load. (Waveforms and Performance Parameters).single phase dual-converter (descriptive only) [Chapter: 3.1,3.2,3.5,3.7,3.8,3.9.1,3.9.5,3.9.6] [6.1-6.8].

MODULE 3 **[12 Hours]**

DC to DC converter: Classification: First quadrant, second quadrant, first and second quadrant, third and fourth quadrant, fourth quadrant converter. Switching mode regulators: Buck regulators, Boost regulators, Buck-Boost regulators, Cuk-regulators.[Chapter: 7.1-7.4]

DC to AC converter: Inverters: Single phase Bridge Inverters, 3-Phase Inverters-180^0mode conduction, 120^0 mode conduction. Voltage control of 1-Phase/3-Phase Inverters by Sinusoidal PWM, Current Source Inverter. PWM Techniques: Single pulse, multiple pulse and sinusoidal pulse width modulation with Fourier analysis.[Chapter: 8.1-8.5, 8.6.3,8.7.1,8.8.1,8.8.2] .

MODULE 4 **[6 Hours]**

AC –AC converter: AC voltage controller: Single phase bi-directional controllers with R and R-L load, single

phase Cyclo-converters. [Chapter: 9.1-9.3,10.1]

Text Books:

1. Power Electronics by Dr. P.S. Bhimbra, Khanna Publication 5th Edition

Reference Books:

1. Power Electronics: Circuits, Devices and Applications by M H Rashid, 3 rd
2. Power Electronics Converters, Applications & Design: by N. Mohan, 2nd Edition, John Wiley & Sons
3. Elements Of Power Electronics: Philip T. Krein, Oxford University Press
4. Power Converter Circuits: by W Shepherd and L Zhang, CRC, Taylor and Francis, Special Indian Edition .

PCEE4307	Microprocessor & Microcontroller	3-0-0	3 Credits

Course Objectives:

1. To acquire knowledge on Microcontrollers, Processors and interfacing devices.
2. To impart knowledge on the following Topics
3. Architecture of Microprocessor 8085, 8086 & Microcontroller 8051
4. Addressing modes & instruction set of 8085, 8086 & 8051.
5. Need & use of Interrupt structure 8085, 8086 & 8051.
6. Simple applications development with programming 8085, 8086 & 8051.

MODULE-1 **[12 Hours]**

INTEL 8085 Microprocessor

Evolution of Microprocessors, Microcontrollers and Computers. Introduction to Microprocessor and Microcomputer, INTEL 8085 Microprocessor Architecture and pin details, Register Organization, Timing and control module, Interrupt structure of 8085.

Instruction Set and Assembly Language Programming of 8085:- Instruction set of 8085,Adressing Modes, Data Transfer techniques ,Assembly language programming using 8085 Instruction Set, Use of Stack & Subroutines, Look up table,8085 Instruction Timing & Execution.

MODULE-2 **[12 Hours]**

INTEL 8086 Microprocessor

Introduction to INTEL 8086 Microprocessor, Basic difference between 8085 and 8086 Processor, Basic features of Advance Microprocessors, INTEL 8086 Architecture, Register organization, signal descriptions, Physical Memory Organization, 8086 interrupts.

INTEL 8086 Instructions Sets & Simple Assembly language programs, Addressing Modes, Instruction Formats. Simple application: Delay calculation, square wave generation.

MODULE-3 **[12 Hours]**

Interfacing Devices

Memory & I/O addressing: Interfacing EPROM & RAM Memories, 2716, 2764, 6116 & 6264.
Study of Architecture, Configuration & Interfacing with ICs: Programmable Peripheral Interface: 8255. Programmable DMA Controller: 8257, Programmable Interrupt Controller: 8259**.**
Application: Keyboard display controller (8279) and timer/counter (8253) and A/D and D/A converter, Square wave generation.

MODULE-4 **[6Hours]**

INTEL 8051 Microcontroller

Architecture, Pins diagram, Register Organization, Timing & Control Module, ports, interrupt structure, Timer and Counter. Instruction Set of 8051,8051 simple programming,
Application: keyboard and display interface. Delay calculation, square wave generation.

Text book:

1. Ramesh S. Gaonkar, "Microprocessor - Architecture, Programming and Applications with the 8085", Penram International publishing private limited, fifth edition.
2. D.V Hall and S.S.S.P Rao" Microprocessor& its Interfacing"- 3rd Edition, TMH Publication
3. Ghosh& Sridhar, " 0000 to 8085 Introduction to Microprocessor for Scientists & Engineers", PHI
4. M.A Mazidi& J.G Majidi, "Microcontroller and Embedded Systems", 2nd Edition, Prentice Hall publication.
5. N. Senthil Kumar, M. Saravnan&S.Jeevananthan, "Microprocessors and Microcontrollers",2nd Edition, Oxford University press.

Course outcomes:

1. Ability to acquire knowledge in Addressing modes & instruction set of 8085, 8086 & 8051.
2. Ability to need &use of Interrupt structure8085, 8086&8051.
3. Ability to understand the importance of Interfacing
4. Ability to explain the architecture of Microprocessor and Microcontroller.
5. Ability to write the assembly language program. Ability to develop the Microprocessor

PCEE4308	Electrical Power Transmission & Distribution	3-0-0	3 Credits

Module-I **[12 Hours]**

Line Constant Calculations: Introduction to per unit system and calculation for transmission system. Resistance of transmission lines, Inductors and Inductance Magnetic field Intensity due to long current carrying conductors, Inductance of two wire transmission line, Flux linkages with one conductor in a group of conductors, Transposition of power lines, Composite Conductors, Inductance of Composite Conductors, Concept of GMD, Bundled conductors, Skin and Proximity effect.

Capacitance of Transmission Lines: Electric Field of a Line of charge, Straight Conductor, The Potential Difference between Two Points due to a line Charge, Two infinite lines of charge, Capacitance of a Two Wire Line, Capacitance of a Three Phase Line with Unsymmetrical Spacing, Inductance of three phase unsymmetrical spaced transmission, Effect of Earth on the Capacitance of conductors.

Module-II [12 Hours]

Performance of Lines: Representation of Lines, Short Transmission Lines, The Medium Transmission Lines, The Long Transmission Line: The Long Transmission Line, ABCD constants, Ferranti Effect, The Equivalent Circuit of a Long Line. Power flow through Transmission Line. Reactive Compensation of Transmission Line. Series and shunt compensation.

Corona: Critical Disruptive Voltage, Corona Loss, Disadvantage of Corona, Radio Interference, Inductive Interference between Power and Communication Lines.

Module-III [12 Hours]

Overhead Line Insulators: Insulator Materials, Types of Insulators, Voltage Distribution over Insulator String, Methods of Equalizing the potential. Mechanical Design of Overhead Transmission Lines: Sag Tension calculation, supports at different levels, effect of ice and wind. Vibration and Vibration Dampers.

Distribution: Comparison of various Distribution Systems, AC three-phase four-wire Distribution System, Types of Primary Distribution Systems, Types of Secondary Distribution Systems, Voltage Drop in DC Distributors, Voltage Drop in AC Distributors, Kelvin's Law, Limitations of Kelvin's Law.

Module-IV [6 Hours]

Insulated Cables: Types and construction of cable, Insulation Resistance of Cable, Grading of Cables, Capacitance of Single Core and three core Cables. Substation: Types of substations, arrangement of bus-bars and control equipment. Power system earthing: Earth Resistance, Tolerable Step and Touch Voltage, Actual Touch and Step Voltages, Design of Earthing of Grid.

Text books:

1. Power System Analysis- By John J. Grainger & W. D. Stevenson, Jr, Tata McGraw-Hill, 2003 Edition, 15th Reprint, 2010.

Reference books:

1. Power System Analysis & Design- By B. R. Gupta, S. Chand Publications, 3rd Edition, Reprint, 2003
2. Electrical Power Systems-C. L. Wadhwa, New Age International Publishers, Sixth Edition.
3. Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed., 2008 Wiley India.

Course Outcomes: At the end of the course, the students will be able to

1. Understand the concepts of power systems
2. Understand the various power system components.
3. Evaluate fault currents for different types of fault.
4. Understand the voltage distribution across various transmission lines.
5. Understand different types of earthling in a power system.
6. Understand the economic power handling capacity of a conductor

PEEE5301	Electromagnetic Field Theory	3-0-0	3 Credits

Module – I **[12 Hours]**

Co-ordinate systems & Transformation: Cartesian co-ordinates, circular cylindrical co-ordinates, spherical co-ordinates. Vector Calculus: Differential length, Area & volume, Line surface and volume Integrals.
Del operator, Gradient of a scalar, Divergence of a vector & divergence theorem, curl of a vector &Stoke's theorem, Laplacian of a scalar (Text Book 1: Chapter- 1, Chapter-2)

Module-lI **[12 Hours]**

Electrostatic Fields: Coulomb's Law, Electric Field Intensity, Electric Fields due to point, line, surface and volume charge, Electric Flux Density, Gauss's Law – Maxwell's Equation, Applications of Gauss's Law, Electric Potential, Relationship between E and V –Maxwell's Equation An Electric Dipole & Flux Lines
Energy Density in Electrostatic Fields., Electrostatic Boundary – Value Problems: Possion's & Laplace's Equations, Uniqueness theorem, General procedures for solving possion's or Laplace's Equation. (Textbook-1: Chapter- 3, 4, 5.1 to 5.5)

Module- III **[12 Hours]**

Magnatostatic Fields: Magnetic Field Intensity, Biot-Savart's Law, Ampere's circuit law-Maxwell Equation, applications of Ampere's law, Magnetic Flux Density-Maxwell's equations. Maxwell's equation for static fields, Magnetic Scalar and Vector potentials.
Electromagnetic Fields and Wave Propagation: Faraday's Law, Transformer & Motional Electromagnetic Forces, Displacement Current, Maxwell's Equation in Final forms (Textbook-1: Chapter- 6.1 to 6.8)

Module – IV **[6 Hours]**

Time Varying Potentials, Time-Harmonic Field. Electromagnetic Wave Propagation: Wave Propagation in lossy Dielectrics, Plane Waves in loss less Dielectrics, Power & pointing vector. (Textbook-1: Chapter-8.1 to 8.7, Ch.9.1 to 9.3 & 9.6)

Text Book:

1. Matthew N. O. Sadiku, Principles of Electromagnetics, 4th Ed., Oxford Intl. Student Edition.

Reference Book:

1. W. H. Hayt (Jr), J. A. Buck, "Engineering Electromagnetics", TMH
2. K. E. Lonngren, S.V. Savor, "Fundamentals of Electromagnetics with Matlab", PHI
3. E.C.Jordan, K.G. Balmain, "Electromagnetic Waves & Radiating System", PHI.
4. C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, 3rd, TMH.

Course Outcomes: At the end of the course, the students will be able

1. To understand the basic laws of electromagnetism.
2. To obtain the electric and magnetic fields for simple configurations under static conditions.
3. To analyze time varying electric and magnetic fields.

4. To understand Maxwell's equations in different forms and different media.
5. To understand the propagation of electromagnetic waves.

PEEE5302	Special Electrical Machines	3-0-0	3 Credits

Course Objectives:

Main focus of this course is to:

1. Understand the concepts and principle operation of Stepper Motors.
2. Understand the concepts and principle operation of Switched Reluctance Motors.
3. Understand the concepts and principle operation of Permanent Magnet DC Motors.
4. Understand the concepts and principle operation of Permanent Magnet Synchronous Motors.
5. Understand the concepts and principle operation of Synchronous Reluctance Motors.
6. Understand the concepts and principle operation of Linear Electric Machines.

Module- I **[12 HOURS]**

STEPPER MOTOR(6 hours)

Variable Reluctance (VR) Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor (HSM), Windings in Stepper Motor, Torque Equation, Characteristics of Stepper Motor, Open Loop Control of Stepper Motor, Closed Loop Control of Stepper Motor, Comparison of Stepper Motor, Application of Stepper Motor.

Ch.1.1 to 1.9, Ch. 1.11, Ch. 1.12

SWITCHED RELUCTANCE MOTOR (SRM) (6 hours)

Construction, Principle of Working, Basics of SRM Analysis, Constraints on Pole Arc and Tooth Arc, Torque equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensor, Current Regulators.

Ch.2.1 to 2.9

Module- II **[12 HOURS]**

Permanent Magnet DC (PMDC) Motors: Construction, Principle of Working, Torque Equation and Equivalent Circuit, Performance Characteristics, Moving Coil (MC) Motors, Printed Circuit (PC) Motors, Shell Type PMDC Motors, Disc Motors

Ch. 3.1 (3.1.1 to 3.1.8)

Brushless Permanent Dc (BLDC) Motors: Classification of BLDC Motors, Construction, Electronic Commutation, Principle of Operation, Type of BLDC Motor, Control of BLDC Motor, Microprocessor Based Control of BLDC Motor, DSP Based Control of BLDC Motor, Sensor less Control of BLDC Motor, Comparison of Conventional DC Motor and BLDC Motor, Application of BLDC Motor

Ch. 3.2 (3.2.1 to 3.2.4, 3.2.6 to 3.2.12)

Module- III **[8 HOURS]**

PERMANENT MAGNET SYNCHRONOUS MOTOR (PMSM) (4 hours)

Construction, Principle of Operation, EMF Equation of PMSM, Torque Equation, Phasor Diagram,

Circle Diagram of PMSM, Comparison of Conventional and PM Synchronous Motor, Application of PMSM

Ch. 4.1 to 4.7, 4.9

SYNCHRONOUS RELUCTANCE MOTOR (SyRM)(4hours)

Construction of SyRM, Working of SyRM, Phasor Diagram and Torque Equation of SyRM, Control of SyRM, Advantages of SyRM, Applications of SyRM

Ch. 5.1 to 5.6

MODULE- IV [10 HOURS]

LINEAR ELECTRIC MACHINES

Linear Induction Motor (LIM): Construction of LIM, Thrust equation of LIM, Performance Equation Based on Current Sheet Concept, Goodness Factor, Equivalent Circuit of LIM, Characteristic of LIM, Certain Design Aspects of LIM, Control of LIM.

Linear Synchronous Motor (LSM): Type and Construction of LSM, Thrust equation of LSM, Control of LSM, Application of LSM.

DC Linear Motor (DCLM): Type and Construction of DCLM, Persistent Current Tubular Electromagnetic Launcher, Induction Tubular EML, DC Pulsed Flat Series EML, DC Tubular Series EML.

Ch. 8.1(8.1.1 to 8.1.8), Ch. 8.2(8.2.1 to 8.1.4), Ch. 8.3(8.3.1 to 8.3.6)

Text Book:

1. Special Electric Machines – E.G.JANARDANAN – PHI Learning Pvt. Ltd,.

Reference Book(s):

1. Special Electric Machines –K. VENKATARATNAM- Universities Press Pvt. Ltd.
2. Electromechanical System and Devices- Sergey E. Lyshevski-CRC Press
3. Linear Motion Electromagnetic Devices- I. Boldea, S.A. Nasar-Taylor and Francis

Course Outcomes:

At the end of this course, students will be able to:

1. Understand the concepts of Magnetic circuits.
2. Understand the concepts and principle operation of Stepper Motors.
3. Understand the concepts and principle operation of Switched Reluctance Motors.
4. Understand the concepts and principle operation of Permanent Magnet DC Motors.
5. Understand the concepts and principle operation of Permanent Magnet Synchronous Motors.
6. Understand the concepts and principle operation of Synchronous Reluctance Motors.
7. Understand the concepts and principle operation of Linear Electric Machines.

PEEE5303	Digital Signal Processing	3-0-0	3 Credits

Course Objectives:

To impart knowledge about the following topics:

1. Signals and systems & their mathematical representation.
2. Discrete time systems.

3. Transformation techniques & their computation.
4. Filters and their design for digital implementation.

MODULE I (12Hours)

Introduction:

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, aliasing effect.

The Z-Transform and Its Application:

Z-transform and its properties, inverse z-transforms; difference equation–Solution by z-transform, application to discrete systems-Stability analysis, frequency response–Convolution.

MODULE II (12 Hours)

The Discrete Fourier Transform: Its Properties and Applications:

Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

Implementation of Discrete-Time Systems:

Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures;

Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

MODULE III (12Hours)

Discrete Fourier Transform &Computation:

Discrete Fourier Transform-properties, magnitude and phase representation-Computation of DFT usingFFT algorithm–DIT &DIF using radix 2 FFT–Butter fly structure.

Design of Digital Filters:

FIR & IIR filter realization–Parallel & cascade forms. FIR design: Windowing Techniques–Need and choice of windows–Linear phase characteristics. Analog filter design–Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation Warping, pre warping.

MODULE IV (6Hours)

Adaptive Filters:

Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive Direct-Form FIR Filters-The LMS Algorithm: Minimum Mean Square Error Criterion, The LMS Algorithm.

Text Books:

1. Digital Signal Processing Principles, Algorithms and Applications, J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.
2. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
3. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanapriya, TMH.

Reference Books:

1. Digital Signal Processing, Manson H. Hayes, Schaum's Outlines, TMH.
2. Digital Signal Processing: A Modern Introduction, Ashok K Ambardar, Cengage Learning.
3. Modern Digital Signal Processing, Roberto Cristi, Cengage Learning.
4. Digital Signal Processing: Fundamentals and Applications, Li Tan, Jean Jiang, Academic Press, Elsevier.
5. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
6. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
7. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
8. D. J. De Fatta, J. G. Lucas and W. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

Program Outcomes:

1. Ability to understand the importance of Fourier transform, digital filters.
2. Ability to acquire knowledge on Signals and systems & their mathematical representation.
3. Ability to understand and analyze the discrete time systems.
4. Ability to analyze the transformation techniques & their computation.
5. Ability to understand the types of filters and their design for digital implementation.

MANDATORY COURSE

MCGN9305	Environmental Science	2-0-0	Credit-0

Unit 1: Multidisciplinary nature of environmental studies

Definition, scope and importance), Need for public awareness.

Renewable and non-renewable resources

Natural resources and associated problems, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

Unit 2: Ecosystems

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystems:-

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem

d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3: Biodiversity and its conservation

- Introduction – Definition: genetic, species and ecosystem diversity.
- Bio geographical classification of India
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation
- Hot-sports 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.

Unit 4: Environmental Pollution Cause, effects and control measures of :-
Air pollution, water pollution, soil pollution, noise pollution, nuclear hazards and solid waste Management: Causes, effects and control measures of urban and industrial wastes, Disaster management: floods, earthquake, cyclone and landslides.

Unit 5: Social Issues and the Environment
Sustainable development, water conservation, rain water harvesting, resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion.

Text Books

1. Environmental Science And Engineering by Rajesh Gopinath N. Balasubramanya, Cengage India.
2. Fundamental Concepts in Environmental Studies by Dr. D.D. Mishra S. Chand Publication.
3. Basic environmental Sciences for undergraduates by Dr. Sohini Singh, Dr. Tanu Allen and Dr. Richa K. Tyagi, Vayu education of India.

MANDATORY COURSE

MCHM9306	Universal Human Values	2-0-0	Credit-0

Objective:

1. To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education.
2. To sensitize the student towards issues in society and nature.
3. To Strengthen self-reflection to know what the students 'really want to be' in their life and profession.
4. To understand harmony at all the levels of human living, applying the understanding of harmony in existence in their profession and lead an ethical life.

Module I **10 Hours**

1. Need, basic guidelines, content and process for Value Education, Self-Exploration– content and process;

2. Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities for Human Aspirations.

3. Method to fulfill the human aspirations: understanding and living in harmony at various levels.

Module II **10 Hours**

1. Human being as a co-existence of the sentient 'I' and the material 'Body', Self ('I') and 'Body' - *Sukh* and *Suvidha*

2. Body as an instrument of 'I' (I being the doer, seer and enjoyer), the characteristics and activities of 'I' and harmony in 'I',

3. Harmony of I with the Body: *Sanyam* and *Swasthya*; Needs of Body and Psyche: *Sanyam* and *Swasthya*

Module III **12 Hours**

1. Harmony in the Family, values in human-human relationship; Trust (*Vishwas*) and Respect (*Samman*) as the foundational values of relationship, meaning of *Vishwas* and *Samman*

2. Harmony in the society: *Samadhan, Samridhi, Abhay, Sah*-astitva, universal harmonious order in society- family to world family, harmony in the Nature : recyclability and self-regulation in nature

3. Natural acceptance of human values, Ethical Human Conduct, and Humanistic Education,

Module IV **08 Hours**

1. Competence in Professional Ethics: professional competence for augmenting universal human order, people-friendly and eco-friendly production systems, technologies and management

2. Strategy for transition from the present state to Universal Human Order

3. Being socially and ecologically responsible engineers with mutually enriching institutions and organizations.

Text Book:

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

References Books:

1. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books

Course Outcome:

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

1. Distinguish between values and skills; understand the need, basic guidelines, content and process of

value education.
2. Distinguish between the Self and the Body; understand the meaning of Harmony in the Self the Co-existence of Self and Body.
3. Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings.
4. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment.

HONOURS

HNEE0303	Electrical Machine Design	3-1-0	4Credits

Course Objectives:
To impart knowledge about the following topics:
1. Design of Transformers.
2. Design of DC machines.
3. Design of Three Phase Induction motors.
4. Design of Synchronous machines.

MODULE I (12Hours)

Design of Transformers: Classification of transformer, transformer core, yoke, transformer winding, cooling of transformers, method of cooling of transformers, transformer tank, cooling ducts, transformer insulation, conservator and breather, output of transformer, output equation, ratio of iron loss to copper loss, relation between core area and weight of iron and copper, optimum design, variation of output and lossless in transformers with linear dimensions, design of core, selection of core area and type of core, choice of flux density, design of windings, Design of insulation, surge phenomenon, surge protection widow space factor, window dimension, width of window for optimum output, design of yoke, overall dimensions, simplified steps for transformer design, operating characteristics, resistance of winding, leakage reactance of winding, regulation.

Ch- 5.2, 5.7, 5.10, 5.17, 5.18, 5.19, 5.20, 5.21, 5.24, 5.29, 5.30-5.45, 5.46, 5.47, 5.48

MODULE II (12 Hours)

D C Machines; Output equations, choice of average gap density, choice of ampere conductor per meter, selection of number of poles, core length, Armature diameter, pole proportions, number of ventilating ducts, estimation of air gap length, **Armature reaction;** flux distribution at load, effect of armature reaction, brush shift and its effect, reduction of effects of armature reaction **Armature design;** choice of armature winding, numbers of armature conductors, numbers of armature slots, cross section of armature conductors, insulation of armature winding, slot dimension, armature voltage drop, depth of armature core, **Design of field system;** pole design, design of field winding, design of yoke, magnetic circuit, magnetization curve, design of field winding, commutation phenomenon, forms of current in coil undergoing commutation, **Design of commutator and brushes;** number of segments, commutator diameter, length of commutator, dimension of

brushes, losses at commutator surface, loss and efficiency.
Ch-9.10, 9.11-9.20, 9.22-9.30, 9.31-9.39

MODULE III (12Hours)

Three Phase Induction Motors; output equation, choice of average flux density in air gap, choice of armature conductors, efficiency and power factor, main dimensions, stator winding, Shape of stator slots, number of stator slots, area of stator slots, length of mean turn, stator teeth, stator core, **Rotor design;** length of air gap, number of rotor slots, effects of harmonics, reduction of harmonic torques, design of rotor bars and slots, design of end rings, full load slip, design of wound rotor, rotor teeth, rotor core, operating characteristics; no load current, short circuit current, leakage reactance.
Ch-10.9, 10.10, 10.11-10.22, 10.22.2, 10.23-10.25, 10, 27, 10.31

MODULE IV (6Hours)

Design of synchronous Machines; output equation, design of salient pole machines-main dimensions, short circuit ratio, length of air gap, shape of pole face, armature design, armature winding, coils and their insulation, slot dimension, length of mean turn, stator pole, elimination of harmonics, armature parameters, estimation of air gap length, design of rotor, magnetic circuits, Open circuit characteristics, determination of full load field mmf, design of field winding, design of turbo-Alternator- main dimension, length of air gap, stator design, rotor design. Ch-11.8 - 11.25 and 11. 30 – 11.33

Text books:

1. A course in Electrical Machine Design by A.K. Sawhney and Dr. A. Chakrabarti –Publisher: Dhanpat Rai& Company Pvt. Ltd., Year of Edition- 2015.

References books:

1. Clayton A E & Hancock N N: The Performance and Design of Direct Current Machines; CBS Publishers and Distributors Electrical Engineering.
2. Say M G: The Performance and Design of Alternating Current Machines; CBS Publishers and Distributors.
3. Sen S K: Principles of Electrical Machine Design with Computer Programs; Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. A. Shanmugasundaram, G. Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd.

Program Outcomes:

1. Ability to understand the importance of design of Transformers.
2. Ability to acquire knowledge on design of DC machines.
3. Ability to understand the design of Three Phase Induction motors.
4. Ability to understand the design of Synchronous machines.

MINOR

MNEE0303	Electrical Power Transmission and Distribution	3-1-0	4 Credits

Module-I **[12 Hours]**

Line Constant Calculations: Introduction to per unit system and calculation for transmission system. Resistance of transmission lines, Inductors and Inductance Magnetic field Intensity due to long current carrying conductors, Inductance of two wire transmission line, Flux linkages with one conductor in a group of conductors, Transposition of power lines, Composite Conductors, Inductance of Composite Conductors, Concept of GMD, Bundled conductors, Skin and Proximity effect.

Capacitance of Transmission Lines: Electric Field of a Line of charge, Straight Conductor, The Potential Difference between Two Points due to a line Charge, Two infinite lines of charge, Capacitance of a Two Wire Line, Capacitance of a Three Phase Line with Unsymmetrical Spacing, Inductance of three phase unsymmetrical spaced transmission, Effect of Earth on the Capacitance of conductors.

Module-II **[12 Hours]**

Performance of Lines: Representation of Lines, Short Transmission Lines, The Medium Transmission Lines, The Long Transmission Line: The Long Transmission Line, ABCD constants, Ferranti Effect, The Equivalent Circuit of a Long Line. Power flow through Transmission Line. Reactive Compensation of Transmission Line. Series and shunt compensation.

Corona: Critical Disruptive Voltage, Corona Loss, Disadvantage of Corona, Radio Interference, Inductive Interference between Power and Communication Lines.

Module-III **[12 Hours]**

Overhead Line Insulators: Insulator Materials, Types of Insulators, Voltage Distribution over Insulator String, Methods of Equalizing the potential. Mechanical Design of Overhead Transmission Lines: Sag Tension calculation, supports at different levels, effect of ice and wind. Vibration and Vibration Dampers.

Distribution: Comparison of various Distribution Systems, AC three-phase four-wire Distribution System, Types of Primary Distribution Systems, Types of Secondary Distribution Systems, Voltage Drop in DC Distributors, Voltage Drop in AC Distributors, Kelvin's Law, Limitations of Kelvin's Law.

Module-IV **[6 Hours]**

Insulated Cables: Types and construction of cable, Insulation Resistance of Cable, Grading of Cables, Capacitance of Single Core and three core Cables. Substation: Types of substations, arrangement of bus-bars and control equipment. Power system earthing: Earth Resistance, Tolerable Step and Touch Voltage, Actual Touch and Step Voltages, Design of Earthing of Grid.

Text books:

1. Power System Analysis- By John J. Grainger & W. D. Stevenson, Jr, Tata McGraw-Hill, 2003 Edition, 15th Reprint, 2010.

Reference books:

1. Power System Analysis & Design- By B. R. Gupta, S. Chand Publications, 3rd Edition, Reprint, 2003
2. Electrical Power Systems-C. L. Wadhwa, New Age International Publishers, Sixth Edition.
3. Weedy B.M. and Cory B.J., "Electric Power Systems", 4th Ed., 2008 Wiley India.

Course Outcomes: At the end of the course, the students will be able to

1. Understand the concepts of power systems
2. Understand the various power system components.
3. Evaluate fault currents for different types of fault.
4. Understand the voltage distribution across various transmission lines.
5. Understand different types of earthling in a power system.
6. Understand the economic power handling capacity of a conductor

PRACTICAL / SESSIONAL

PCEE7306	Power Electronics Laboratory	0-0-3	2 Credits

List of Experiments: (Any Eight)

1. Study of the V-I characteristics of SCR, TRIAC and MOSFET.
2. Study of the cosine controlled triggering circuit
3. To measure the latching and holding current of a SCR
4. Study of the single-phase half wave-controlled rectifier and semi converter circuit with R and R-L Load
5. Study of single-phase full wave-controlled rectifier circuits (mid-point and Bridge type) with R and R-L Load
6. Study of three phase full wave-controlled rectifier circuits (Full and Semi converter) with R and R-L Load
7. Study of the Buck converter and boost converter.
8. Study of the single phase PWM voltage source inverter.
9. Study the performance of three phase VSI with PWM control.
10. Study of the forward converter and fly-back converter.

PCEE7307	Microprocessor & Microcontroller Laboratory	0-0-3	2 Credits

Microprocessor 8085 and/or 8086 programming:

- Addition, Subtraction of two 8 bit numbers
- Addition, Subtraction of two 8 bit numbers
- Multiplication, Division of two 8 bit numbers
- Finding the Smallest and Largest number from the array
- Arranging numbers in ascending and descending order.
- Binary to Gray Code and Hexadecimal to decimal conversion.

Interfacing with microprocessor:

- Generate square waves of different frequencies

- Interfacing steeper motor and operating in different modes

Microcontroller 8051 programming:

- Addition, subtraction of 16 bit numbers.
- Multiplication, Division of 16 bit numbers

Interfacing with Microcontroller:

- Interfacing traffic light controller
- Interfacing keyboard Display unit
- Interfacing PIC
- Interfacing stepper motor controller

PCEE7308	Power System Laboratory-I	0-0-3	2 Credits

1. Study of Ferranti Effect.
2. Determination of generalized constants A, B, C, D of a long transmission line.
3. Determination of string efficiency.
4. Earth resistance measurement by earth tester.
5. Series and shunt capacitance computation in transmission line.
6. Dielectric strength test of insulating oil (transformer oil).
7. Dielectric constant, tan delta, resistivity test of transformer oil.
8. Study of various lightning arresters.
9. Distribution system power factor improvement using switched capacitor.
10. Study of corona discharge.
11. Determination of breakdown strength of solid insulating material.
12. Study of different types of insulator.

OPEN ELECTIVE-II (OE-II) 5th Semester

OECH6311	Petroleum Refinery Engineering	3L-0T-0P	3 Credits

Course objectives: The objectives of this course are

1. Indicate what crude oils consists of and how crude oils are characterized based on their physical properties.
2. Demonstrate how a petroleum refinery works and sketch a flow diagram that integrates all refining processes and the resulting refinery products.
3. Examine how each refinery process works and how physical and chemical principles are applied to achieve the objectives of each refinery process.

Module-1 **(4 weeks/12 Hours)**

Overview of Petroleum Refinery its Products and Properties

Unit I (6 Hours/ 2 weeks): Origin and formation of petroleum, reserves and deposits of the world, Indian petroleum industries, Composition and Compounds of Petroleum, Crude pre-treatment: Desalting and Dehydration, Petroleum Refinery Units.

Unit II (6 Hours/ 2 weeks): Properties of Crude oil, Test Methods for Gasoline and Diesel, Refinery Products: Gasoline and its Specification, Distillate Fuels, Residual Fuel Oils, LPG, ASTM and TBP Distillation, Octane and Cetane number.

Module-2 **(4 weeks/12 Hours)**

Refinery Processes Units

Unit III (6 Hours/ 2 weeks):Coking and Thermal Processes, Catalytic Cracking

Unit IV (6 Hours/ 2 weeks): Catalytic Hydrocracking, Hydro processing and Resid Processing.

Module-3 **(4 weeks/12 Hours)**

Refinery Processes Units

Unit V (6 Hours/ 2 weeks): Hydro treating, Catalytic Reforming and Isomerization

Unit VI (6 Hours/ 2 weeks): Alkylation and Polymerization, Visbreaking.

Module-4 **(2 weeks/6 Hours)**

Treatment of Products

Unit VII (6 Hours/ 2 weeks): Treatment of products, additives, blending of gasoline. Treatment of gasoline, kerosene, lubes and lubricating oils, waxes.

Text book :

1. 'Petroleum Refining: Technology and Economics', 5th ed. by J H Gary, G E Handwerk, and M J

Kaiser, CRC Press.

Reference Books :

1. 'Modern Petroleum Refining Processes', 6th ed. by B K B Rao, Oxford & IBH.
2. 'Petroleum Refinery Engineering', W L Nelson, McGraw-Hill.
3. 'Handbook of Petroleum Processing', 2nd ed. by S A Treese, P R Pujado and D S J Jones, Springer.

Course Outcomes (CO):

At the end of the course, students

1. Have introductory information about petroleum and refinery.
2. Learn the history of refinery development and composition of petroleum.
3. Learn refinery products, test methods and petroleum properties.
4. Should have knowledge about the different process units involved in refinery to get the valuable products like Gasoline, Diesel etc. that can be directly use by the consumers.

OECH6330	GREEN TECHNOLOGY	3L-0T-0P	3 Credits

Objectives:

1. To present different concepts of green technologies.
2. To acquire principles of Energy efficient technologies.
3. To learn the importance of green fuels and its impact on environment.

Module-1 **(4 weeks/12 Hours)**

Unit I: Principles of green technology and engineering.

Unit II: Principles of atom and mass economy, E-factor.

Module-2 **(4 weeks/12 Hours)**

Unit III: Design of greener and safer chemicals, Solvent-free methods: Microwave, Ultraviolet, and Solar.

Unit IV: Green catalysts: ionic liquids, zeolites, photo catalyst, PEG, nano catalyst, and biocatalyst.

Module-3 **(4 weeks/12 Hours)**

Unit V: Green solvents: Supercritical fluids, fluorous phase, and non-aqueous solvents.

Unit VI: Scale-up effect, reactors, separators, Process intensification.

Module-4 **(2 weeks/6 Hours)**

Unit VII: Bio-conversion of renewable. Comparison of green fuels with conventional fossil fuels with reference to environmental, economical and social impacts.

Reference Books:

1. Handbook of Green Chemistry, Vol. 1 to 9 by P T Anastas, Wiley VCH.
2. Green Chemistry and Engineering: A Practical Design Approach by C J González and D J C Constable, Wiley.

3. Green Chemistry and Engineering: A Pathway to Sustainability by A E Marteel Parrish and M A Abraham, Wiley.
4. Green Chemistry for Environmental Sustainability by S K Sharma and A. Mudhoo, CRC Press.
5. Green Engineering: Environmentally Conscious Design of Chemical Processes by D T Allen and D R Shonnard, PHI.

Course outcomes:

1. Enlist different concepts of green technologies in a project.
2. Understand the principles of Energy efficient technologies.
3. Recognize the benefits of green fuels with respect to sustainable development.

OECE6312	Mechanics of Solids	3-0-0	Credit-3

Module – I

Stress, St. Venant's principle, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain Diagrams, Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads, stresses due to freely falling weight.

Analysis of Axially Loaded Members: Composite bars in tension and compression - temperature stresses in composite rods, Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.

Analysis of Biaxial Stress. Plane stress, Principal stress, Principal plane, Mohr's Circle for Biaxial Stress.

Strain Deformation: Two dimensional state of strain, Mohr's circle for strain, Principal strains and principal axes of strain, strain measurements, Calculation of principal stresses from principal strains.

Module – II

Stresses in thin cylinders, thin spherical shells under internal pressure -wire winding of thin cylinders. Thick cylinders subjected to internal and external pressures, compound cylinders. Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, strength of solid and hollow circular shafts. Stresses due to combined bending and torsion, Strength of shafts in combined bending and twisting.

Module – III

Theory of Columns: Eccentric loading of a short strut, Long columns, Euler's column formula, Lateral buckling, Critical Load, Slenderness ratio. Close - coiled helical springs.

Theories of failure: Maximum principal stress theory, maximum shear stress theory, maximum strain theory, total strain energy theory, maximum distortion theory, octahedral shear stress theory graphical representation and comparison of theories of failure.

Module IV

Unsymmetrical bending: Properties of beam cross selection, slope of neutral axis, stresses and deflection in unsymmetrical bending, shear centre.

Curved Beam: Bending of beam with large initial curvature, Stress distribution in beam with rectangular, circular and trapezoidal cross section, stresses in crane hooks, ring and chain links.

Text Books/Reference Books:

1. Elements of Strength of Materials by S.P. Timoshenko and D.H. Young, Affiliated East-West Press
2. Strength of Materials by G. H. Ryder, Macmillan Press
3. Strength of Materials by James M. Gere and Barry J. Goodno, Cengage Learning
4. Mechanics of Materials by Beer and Johnston, Tata McGraw Hill
5. Mechanics of Materials by R.C. Hibbeler, Pearson Education
6. Mechanics of Materials by William F. Riley, Leroy D. Sturges and Don H. Morris, Wiley Student Edition
7. Mechanics of Materials by James M. Gere, Thomson Learning
8. Engineering Mechanics of Solids by Egor P. Popov, Prentice Hall of India
9. Strength of Materials by S.S. Rattan, Tata McGraw Hill
10. Strength of Materials by R. Subramaniam, Oxford University Press
11. Advanced mechanics of solids by L.S. Srinath, McGraw Hill.
12. Advanced mechanics of materials, Kumar & Ghai, Khanna Publishers.

OECS6203	OOPs Using C++	3-0-0	Credit-3

Course Objective:

This course is aimed at mastering object oriented programming technique in software development and demonstrates these techniques in solution to different types of problems.

Module –I **(10 Hours)**

Introduction to OOP, OOP Concepts, Overview of C++, C++ fundamentals, Classes, Objects, Inline functions, function Overloading, Scope Resolution Operator, Constructors ,Destructors, Static Members, Passing objects to functions, Function returning objects.

Module – II **(10 Hours)**

Arrays, Pointers, this pointer, References, Dynamic memory Allocation, functions Overloading, Default arguments, Overloading Constructors, copy constructors, Pointers to Functions, Ambiguity in function overloading.

Module –III **(10 Hours)**

Operator Overloading, Overloading of some special operators, Inheritance, Types of Inheritance, Protected members, Polymorphism, Virtual base Class, Virtual functions, Pure virtual functions, Abstract classes.

Module – IV **(8 Hours)**

Class template, Generic classes, Function template, generic functions, Exception Handling, Exception handling options, Streams, Formatted I/O, C++ File I/O, Array based I/O, Standard Template Library (STL).

Text Books

1. H. Schildt - C++ The Complete Reference, 4th Edition, Tata McGraw-Hill, New Delhi.

Reference Books

1. A. N Kanthane, Object Oriented Programming with ANSI & Turbo C++, Pearson Education, New Delhi.
2. Object Oriented Programming with C++, E. Balagurusamy, Mcgraw Hill Education
3. Object Oriented Programming in C Robert Lafore – SAMS Publishing.

Course Outcomes: Students will be able to -

1. Familiar with issues with software design.
2. Be familiar to key concepts of object oriented programming.
3. Have knowledge about C++ concepts related to good modular design.
4. Implement patterns involving realization of abstract interfaces and polymorphism.
5. Learn how to utilize Exceptions and standard template library.

OECS6331	CLOUD COMPUTING	3-0-0	Credit-3

Course Objective: This course gives students an insight into the basics of cloud computing along with virtualization, cloud computing is one of the fastest growing domain from a while now. It will provide the students basic understanding about cloud and virtualization along with it how one can migrate over it.

Module-I **10 Hrs**

Evolution of Computing Paradigms - Overview of Existing Hosting Platforms, Grid Computing, Utility Computing, Autonomic Computing, Dynamic Datacenter Alliance, Hosting/ Outsourcing, Introduction to Cloud Computing, Workload Patterns for the Cloud, "Big Data", IT as a Service, Technology Behind Cloud Computing,

Module-II **10 Hrs**

A Classification of Cloud Implementations- Amazon Web Services - IaaS, The Elastic Compute Cloud (EC2), The Simple Storage Service (S3), The Simple Queuing Services (SQS), VMware v Cloud - IaaS, v Cloud Express, Google AppEngine - PaaS, The Java Runtime Environment.

Module-III **10 Hrs**

The Python Runtime Environment- The Datastore, Development Workflow, Windows Azure Platform - PaaS, Windows Azure, SQL Azure, Windows Azure AppFabric, Salesforce.com - SaaS / PaaS, Force.com, Force Database - the persistency layer, Data Security, Microsoft Office Live - SaaS, LiveMesh.com, Google Apps -

SaaS, A Comparison of Cloud Computing Platforms, Common Building Blocks.

Module-IV **8 Hrs**

Cloud Security – Infrastructure security – Data security – Identity and access management Privacy- Audit and Compliance.

Text Book:

1. Kai Hwang, Geoffrey C. Fox and Jack J. Dongarra, "Distributed and Cloud Computing
2. from Parallel Processing to the Internet of Things", Morgan Kaufmann, Elsevier, 2012

Reference Books

1. Barrie Sosinsky, "Cloud Computing Bible" John Wiley & Sons, 2010
2. Tim Mather, Subra Kumaraswamy, and Shahed Latif, "Cloud Security and Privacy An Enterprise Perspective on Risks and Compliance", O'Reilly 2009

OEEE6313	Digital Signal Processing	3-0-0	3 Credits

Course Objectives:

To impart knowledge about the following topics:

1. Signals and systems & their mathematical representation.
2. Discrete time systems.
3. Transformation techniques & their computation.
4. Filters and their design for digital implementation.

MODULE I **(12 Hours)**

Introduction:

Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, aliasing effect.

The Z-Transform and Its Application:

Z-transform and its properties, inverse z-transforms; difference equation–Solution by z-transform, application to discrete systems-Stability analysis, frequency response–Convolution.

MODULE II **(12 Hours)**

The Discrete Fourier Transform: Its Properties and Applications:

Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

Implementation of Discrete-Time Systems:

Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures;
Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

MODULE III (12Hours)

Discrete Fourier Transform &Computation:

Discrete Fourier Transform-properties, magnitude and phase representation-Computation of DFT using FFT algorithm–DIT &DIF using radix 2 FFT–Butter fly structure.

Design of Digital Filters:

FIR & IIR filter realization–Parallel & cascade forms. FIR design: Windowing Techniques–Need and choice of windows–Linear phase characteristics. Analog filter design–Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation Warping, pre warping.

MODULE IV (6Hours)

Adaptive Filters:

Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive Direct-Form FIR Filters-The LMS Algorithm: Minimum Mean Square Error Criterion, The LMS Algorithm.

Text Books:

1. Digital Signal Processing Principles, Algorithms and Applications, J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.
2. S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
3. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanapriya, TMH.

Reference Books:

1. Digital Signal Processing, Manson H. Hayes, Schaum's Outlines, TMH.
2. Digital Signal Processing: A Modern Introduction, Ashok K Ambardar, Cengage Learning.
3. Modern Digital Signal Processing, Roberto Cristi, Cengage Learning.
4. Digital Signal Processing: Fundamentals and Applications, Li Tan, Jean Jiang, Academic Press, Elsevier.
5. A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 1989.
6. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
7. J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
8. D. J. De Fatta, J. G. Lucas and W. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

Program Outcomes:

1. Ability to understand the importance of Fourier transform, digital filters.
2. Ability to acquire knowledge on Signals and systems & their mathematical representation.
3. Ability to understand and analyze the discrete time systems.
4. Ability to analyze the transformation techniques & their computation.
5. Ability to understand the types of filters and their design for digital implementation.

OEEC6314	Industrial Automation with PLC & SCADA	3-0-0	Credits 3

COURSE OBJECTIVES

1. Gain the Knowledge of various skills necessary for Industrial applications of Programmable logic controller (PLC)
2. Understand the basic programming concepts and various logical Instructions used in Programmable logic controller (PLC)
3. Solve the problems related to I/O module, Data Acquisition System and Communication Networks using Standard Devices.

MODULE-I (12 Hours)

Unit 1

What is A PLC, Technical Definition of PLC, What are its advantages, characteristics functions of A PLC, Chronological Evolution of PLC, Types of PLC, Unitary PLC, Modular PLC, Small PLC, Medium PLC, Large PLC.

Unit 2

Block Diagram of PLC: Input/output (I/O) section, Processor Section, Power supply, Memory central Processing Unit: Processor Software / Executive Software, Multi asking, Languages, Ladder Language.

MODULE-II (12 Hours)

Unit 3

Bit Logic Instructions: introduction: Input and Output contact program symbols, Numbering system of inputs and outputs, Program format.

Unit 4

Introduction to logic: Equivalent Ladder diagram of AND gate, Equivalent ladder diagram of or Gate, equivalents Ladder Diagram of NOT gate, equivalent ladder diagram of XOR gate, equivalent ladder diagram of NAND gate, equivalent ladder diagram of NOR gate, equivalent ladder diagram to demonstrate De Morgan theorem. Ladder design. Examples: Training Stopping, Multiplexer, DE multiplexers

MODULE-III (12 Hours)

Unit 5

PLC Timers and Counters: On Delay and OFF delay timers, Timer-on Delay, Timer off delay, Retentive and non-retentive timers. Format of a timer instruction. PLC Counter: Operation of PLC Counter, Counter Parameters, Counters Instructions Overview Count up (CTU) Count down (CTD).

Unit 6

PLC input output (I/O) modules and power supply: Introduction: Classification of I/O, I/O system overview, practical I/O system and its mapping addressing local and expansion I/O, input-output systems, direct I/O, parallel I/O systems serial I/O systems.

MODULE-IV (8 Hours)

Unit 7

SCADA Systems

Introduction, definition and history of Supervisory Control and Data Acquisition, typical SCADA System Architecture, Communication Requirements, Desirable properties of SCADA system, Features, advantages,

disadvantages and applications of SCADA. SCADA Architecture (First generation-Monolithic, Second Generation-Distributed, Third generation-Networked Architecture), SCADA systems in operation and control of interconnected power system, Power System Automation, Petroleum Refining Process, Water Purification System.

Text Books:

1. Madhu Chhanda Mitra,S.S Gupta, "PLC and Industrial automation",Pernram International pub. (Indian) Pvt. Ltd., 2011.

Reference Books:

1. Ronald L Krutz, "Securing SCADA System", Wiley Publication, 2012.
2. Gary Dunning, "Introduction to Programmable Logic Controllers", Thomson, 2nd edition, 2006.

Course Outcomes:

1. Understand the basic programming concepts and various logical Instructions used in Programmable logic controller (PLC).
2. Compute the extent and nature of electronic circuitry in Programmable logic controller (PLC) and SCADA including monitoring and control circuits for Communication and Interfacing.

OEME6316	Introduction to Composite Materials	3-0-0	Credit-3

Course objective:

1. Introduce students to the concepts of modern composite materials.
2. Equip them with knowledge on how to fabricate and carry out standard mechanical test on composites.
3. To make student understand the basic stress and strain relations in composite materials.

Module I (10hours)

Introduction: Classification and characteristics of composite materials, mechanical behaviour of composites, constituents, Reinforcements, Matrices, Fillers, Additives, Applications and advantages of composites. Processing – Pultrusion; Filament winding; Prepreg technology; Injection & compression moulding; Bag moulding; Resin transfer moulding.

Module II (12hours)

Macromechanics of a Lamina: Stress strain relations of anisotropic materials - Engineering constants for orthotropic materials, Stress strain relations for specially orthotropic lamina. Transformation relationships for a lamina of arbitrary fibre orientation.

Module III (12hours)

Micromechanics of a Lamina: Rule of mixture; Volume & mass fractions; Density & void content. Evaluation of the nine mechanical and four hygrothermal constants: four elastic moduli(Strength of Materials Approach), five strength parameters, two coefficients of thermal expansion and two coefficients of moisture expansion of a unidirectional lamina from the individual properties of the fiber and the matrix.

Module IV **(10hours)**

Analysis: Classical lamination theory; Stress analysis of composite laminates; Failure predictions – Maximum stress theory; Maximum strain theory; Tsai-Hill theory; Modes of failure of composites; First ply failure; Partial ply failure; Total ply failure.

Text Books:

1. Mechanics of Composite Materials, R.M. Jones, Mc. Graw Hill Book Co.
2. Mechanics of Composite Materials, A. K. Kaw, CRC Press.
3. Mechanics of composite materials & structures, M Mukhopadhay, Universities Press.

COURSE OUTCOME

1. (Knowledge based) identify and explain the types of composite materials and their characteristic features;
2. Understand the differences in the strengthening mechanism of composite and its corresponding effect on performance and application;
3. Understand and explain the methods employed in composite fabrication;
4. Appreciate the theoretical basis of the experimental techniques utilized for failure mode of composites.
5. (Skills) develop expertise on the applicable engineering design of composite;
6. Learn simple micromechanics and failure modes of composites.

OEMT6315	Nanomaterials	3-0-0	Credits 3

Objectives of the Course:

To recognize the differences between nanomaterials and conventional materials and to become familiar with a wide range of nanomaterials, their synthesis, characterization, properties and applications.

Module 1: **(12 Hours)**

Introduction: Types of nanomaterials, emergence of nanotechnology, bottom-up and top-down approaches, challenges in nanotechnology. Nanoparticles: synthesis of metallic nanoparticles, semiconductor nanoparticles, oxide nanoparticles (sol-gel processing); vapour phase reactions, solid phase segregation. Nanowires: Synthesis of nanowires by evaporation – condensation growth, VLS or SLS growth, high energy ball milling, cryo rolling, and equal channel angular extrusion, template based synthesis, electrospinning, types of lithography. Thin Films: fundamentals of film growth, PVD, CVD and ALD.

Module-II **(12 Hours)**

Specific nano materials and their applications: Carbon nanostructures (Nanotubes, nanohorns, graphene, buckyballs etc.), Semiconducting nanomaterials – Quantum confinement, Quantum wells, quantum wires and quantum dots. Magnetic nanomaterials – super paramagnetism Ferroelectric, nano ceramics Super plasticity Nanocomposites and their types.

Module III: **(12 Hours)**

Thermodynamics of nanomaterials, Mechanical property aspects of nanomaterials, inverse Hall-Petch

relationship, nano indentation, electrical properties of nanomaterials, optical properties of nanomaterials, magnetic properties of nanomaterials, Characterization techniques from the perspective of nanomaterials: BET, XRD, SEM, TEM, AFM, EDS, WDS, LEED, XPS etc.

Module IV: **(06 Hours)**

Application of nanomaterials such as medicine, energy, environment, information and communication technology.

Suggested text books:

1. Rishal Singh, S.M. Gupta, Introduction to nanotechnology, Oxford university press, (2016).
2. Dieter Vollath._ Nanomaterials: An Introduction to Synthesis, Properties and Applications, Second Edition. Published 2013 by Wiley-VCH Verlag GmbH & Co. KGaA.

Suggested reference books:

1. Charles Poole and Frank Owens, Introduction to Nanomaterials, Wiley 2007
2. Cao G., Nanostructures and Nanomaterials: Synthesis, Properties and Applications, Imperial College Press
3. Gagotsi Y., Nanomaterails Handbook, (Ed.), Taylor and Francis.
4. Edlstein and Cammarate, Nano Materials Synthesis, Properties and Applications.
5. Bandyopadyay A.K., Nano Materials, New age Publications.
6. Pradeep T., Nano - The Essentials, TMH.
7. Koch,C. Nanostructured Materials: Processing, Properties and applications, William Andrew Publishing.

Course Outcomes

After completing this course, the student should be able to:

1. Indicate the differences between nanomaterials and conventional materials
2. Indicate how specific synthesis techniques can result in nanomaterials
3. Give examples of specific nanomaterials and explain the scientific reasons for the properties displayed by them
4. Describe how specific characterization techniques can be used to analyze nanomaterials

OEPD6317	POWDER METALLURGY	3L-0T-0P	3 Credits

Course Objective

The course is a specialized course of the metallic materials area. The scope is to provide the necessary knowledge on the metallic part production by metal powders. It covers subjects such as metal powder characterization, metal powder production methods, and powder metallurgy processing steps.

Module I **[12]**

Introduction Historical and modern developments in Powder Metallurgy. Advantages, limitations and

applications of Powder Metallurgy. Basic Steps for Powder Metallurgy. Characteristics of metal powder Chemical composition, Particle size, shape and size distribution, Characteristics of powder mass such as apparent density, tap density, flow rate, friction index. Properties of green compacts and sintered compacts

Module II **[10]**

Powder Characterization Powder conditioning, fundamentals of powder compaction, density distribution in green compacts, compressibility, green Strength, pyro phorocity and toxicity.

Module III **[10]**

Powder Compaction Methods Basic aspects, types of compaction presses, compaction tooling and role of lubricants, Single and double die compaction, isostatic pressing, Hot pressing. Powder Forming Powder rolling, powder forging, powder extrusion and explosive forming technique

Module IV **[10]**

Sintering Definition, stages, effect of variables, sintering atmospheres and furnaces, Mechanism, liquid-phase sintering, Secondary operations. Sintered Products Study of sintered bearings, cutting tools, metallic filters, friction and antifriction parts and electrical contact materials. Defects in Powder metallurgy processed materials and their processing to minimize defects: Friction stir processing etc.

Text Books:

1. Introduction to Powder Metallurgy, A. K. Sinha, Dhanpatrai Publication.
2. Powder Metallurgy: Science, Technology, and Materials, Anish Upadhyaya, Gopal Shankar Upadhyaya, CRC Press
3. Powder Metallurgy, ASM Handbook, Vol-VII.

Reference Books:

1. Powder Metallurgy: Science, Technology and Applications, P. C. Angelo, R. Subramanian
2. Powder Metallurgy, W.D. Jones
3. Principles of Powder Metallurgy, T. Shukerman
4. Handbook of Powder Metallurgy :- H.H. Hausner

Course Outcomes:

Upon successful completion of the course, student will able to:

1. Acquire the knowledge of Powder Metallurgy History, Applications and its importance.
2. Measure the various powder characteristics like apparent density; tap density, flow rate, friction index.
3. Acquainted the knowledge of metal powder production methods.
4. Aware about the powder characterization techniques.
5. Understand the basic methods of Powder compaction for green compact.

OEMA6207	Numerical Methods	3-0-0	Credit-3

Module –I **(12 Hours)**

Number system, Floating point arithmetic, Errors, truncation error, Bisection method, Scant method, Regula-Falsi Method, Newton-Raphson method, Muller method, Rate of Convergence,

Lagranges's interpolation, Newton divided difference interpolation, Newton's forward and backward interpolation, Piecewise and Spline interpolation.

Module -II : **(12 Hours)**

Numerical integration: Romberg integration, Gaussian Quadrature (2-point, 3-point), Newton- Cotes rules.

Numerical solution to ordinary differential equations: Taylor's series methods, Euler method, modified Euler method Runge - Kutta methods, predictor- corrector method, multistep methods.

Module -III: **(8 Hours)**

Matrix eigen value problem, power method, Rayleigh Quotient, shifted power method, inverse power method, QR method.

Module IV: **(8 Hours)**

Parabolic Partial Differential Equation: Explicit Method, Implicit method, Crank-Nicolson method. Hyperbolic Partial Differential Equation: Explicit Method, Implicit method. Elliptic Partial Differential Equation: Finite-difference method.

Text Books

1. Jain M.k, Iyengar S.R.K & Jain R.K, Numerical methods for Scientific and Engineering Computation, 6th Edition,New Age International(P) Ltd.
2. Atkinson Kendall E, An introduction to Numerical Analysis, 2ndEdition, John Wiley & Sons

Reference Books

1. Fusset L.V, Applied numerical Analysis Using MATLAB,2nd Edition, PEARSON
2. Chapra Steven C & Canale Raymond P., Numerical methods for Engineers, 7th Edition, McGraw Hill Education.

INDIRA GANDHI INSTITUTE OF TECHNOLOGY, SARANG

B.TECH SYLLABUS for ELECTRICAL ENGINEERING

(Admission Batch: 2018-19 Onwards)

6th Semester

HSHM3306	Enhancing Soft Skills and Personality	2-0-0	Credit-2

Course Objective

The course aims to cause an enhanced awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality. Hard or technical skills help securing a basic position in one's life and career. But only soft skills can ensure a person retain it, climb further, reach a pinnacle, achieve excellence, and derive fulfillment and supreme joy. Soft skills comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility, friendliness and effective communication skills. The focus of this course is on interpersonal and management skills.

Module I **10 Hours**

- Highlights of Developing Soft Skills and Personality Course-1-24
- Highlights of Developing Soft Skills and Personality Course-25-48
- Definitions and Types of Mindset
- Learning Mindsets
- Secrets of Developing Growth Mindsets
- Importance of Time and Understanding Perceptions of Time
- Using Time Efficiently
- Understanding Procrastination
- Overcoming Procrastination
- Don't Say "Yes" to Make Others Happy!

Module II: **10 Hours**

- Types of People
- How to Say "No"
- Controlling Anger
- Gaining Power from Positive Thinking-1
- Gaining Power from Positive Thinking-2
- What Makes Others Dislike You?
- What Makes Others Like You?-1
- What Makes Others Like You?-2
- Being Attractive-1
- Being Attractive-2

Module III **10 Hours**

- Common Errors-1
- Common Errors-2
- Common Errors-3

- Common Errors-4
- Common Errors-5
- Humour in Communication
- Humour in the Workplace
- Function of Humour in the Workplace
- Money and Personality
- Managing Money

Module IV **10 Hours**

- Health and Personality
- Managing Health-1: Importance of Exercise
- Managing Health-2: Diet and Sleep
- Love and Personality
- Managing Love
- Ethics and Etiquette
- Business Etiquette
- Managing Mind and Memory
- Improving Memory
- Care for Environment
- Highlights of the Course

Books for Reference:

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3. Klaus, Peggy, Jane Rohman & Molly Hamaker. The Hard Truth about Soft Skills. London: Harper Collins E-books, 2007.
4. Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5. Stein, Steven J. & Howard E. Book. The EQ Edge: Emotional Intelligence and Your Success. Canada: Wiley & Sons, 2006.

PCEE4309	Electrical Drives	3-0-0	3 Credits

Course Objectives:

To impart knowledge about the following topics:

1. Steady state operation and transient dynamic of motor load system..
2. Characteristic and control of DC and AC drive
3. Application of electric drive.

MODULE I (12 Hours)

Introduction:

Requirements, AC and DC drives, Advantages of Electrical Drives, Choice of electrical Drives, Nature and Classification of Load Torques.

Fundamentals of Torque Equations, Speed Torque Conventions and Multi-quadrant Operation, Equivalent Values of Drive Parameters, Components of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization, Control of Electrical Drives, Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating.

MODULE II (12 Hours)

DC Drives:

DC Motors and their Performances, Starting, Braking, Transient Analysis, Speed Control, Methods of Armature Voltage Control, Controlled Rectifier Fed DC Drives, Chopper Controlled DC Drives.

Induction Motor Drives:

Speed Control, Pole Changing, Pole Amplitude Modulation, Stator Voltage Control, Variable Frequency Control from Voltage Source, Voltage Source Inverter Control, Variable Frequency Control from Current Source, Current Source Inverter Control, Current Regulated Voltage Source Inverter Control.

MODULE III (12 Hours)

Synchronous Motor Drives:

Synchronous Motor Variable Speed Drives, Variable Frequency Control of Multiple Synchronous Motors.

Electric Traction Drive:

System of electric traction Mechanics of Train Movement: Speed-time, distance-time and simplified speed-time curves, Attractive effort for acceleration and propulsion, effective weight, train resistance, adhesive weight, specific energy output and consumption.

MODULE IV (6 Hours)

Application of Drives:

Drives for specific application like Textile Mills, Steel Rolling Mills, Cranes and Hoist Drives, Cement Mills, Sugar Mills, Machine Tools, Paper Mills, Coal Mines, Centrifugal Pumps. Application Areas and Functions of Microprocessors in Drive Technology.

TEXT BOOKS

1. Fundamentals of Electrical Drives-By G.K. Dubey.
2. Electric Drives-Concepts and Applications- By Vedam Subramanyam, Second Edition, Tata McGraw Hill Publication, 2010-11.

REFERENCE BOOKS

1. B.K. Bose, "Modern Power Electronics and AC Drives", PHI Publisher.
2. M.H. Rashid, "Power Electronics", PHI Publisher.

Course Outcomes:

1. Ability to understand the steady state operation and dynamic of electric drive.

2. Ability to understand drives components and processing.
3. Ability to understand the characteristic of electric drive.
4. Ability to understand the control and application of electric drive.

PCEE4310	Power System Operation & Control	3-0-0	3 Credits

MODULE I **[12 Hours]**

Control of voltage and frequency:

Turbines and Speed-Governors, Frequency dependence of loads, Droop Control and Power Sharing. Automatic Generation Control. Generation and absorption of reactive power by various components of a Power System. Excitation System Control in Synchronous Generators, Automatic Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs. Tap Changing Transformers. Power flow control using phase shifters.

MODULE II **[12 Hours]**

Power Flow Analysis:

Review of the structure of a Power System and its components. Real and reactive power balance equations at a node. Load and generator specifications. Formation of bus admittance matrix. Application of numerical methods for solution of non-linear algebraic equations: Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational issues in Large-scale Power Systems.

MODULE III **[12 Hours]**

Power System Stability:

Steady state and Transient Stability, Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three--phase fault. Analysis using numerical integration of swing equations (Runge-Kutta 4th order method), as well as the Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.

MODULE IV **[6 Hours]**

Economic Operation of Power System:

Distribution of Load between units within a plant, Transmission losses as function of plant generation, Calculation of loss coefficients, Distribution of loads between plants with special reference to steam and hydel plants, Automatic load dispatching, Unit Commitment.

Text/Reference Books:

1. J. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “An Introduction Electric Energy Systems Theory”, McGraw Hill Education, 1995.

3. C. L. Wadhwa, "Electric Power System", New Age Publishers.
4. Abhijit Chakrabarti and Sunita Haldar, "Power System Analysis Operation and Control", Third Edition, PHI Publications.
5. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
6. P.Kudur, "Power System Stability and Control", TMH, Publisher.

Course Outcomes:

At the end of this course, students will demonstrate the ability to :

1. Use numerical methods to analyse a power system in steady state.
2. Understand stability in a power system.
3. Understand methods to control the voltage, frequency and power flow.
4. Understand the monitoring and control of a power system.
5. Understand the basics of economic operation of power system.

PEEE5304	Power Quality	3-0-0	3 Credits

Module-I **[12 Hours]**

Terms & Definitions: General Classes of Power Quality Problems, Transients, Long Duration Voltage Variations, Short-Duration Voltage Variations, Voltage Imbalance, Waveform Distortion, Voltage Fluctuations, Power Frequency Variations, Power Quality Terms.

Voltage Sags & Interruptions: Sources of Sags and Interruptions, Estimating Voltage Sag Performance, Fundamental Principles of Protection, Solutions at the End-User Level, Evaluating the Economics of Different Ride-Through Alternatives, Motor Starting Sags, Utility System Fault-Clearing Issues.

(Chapter-2: 2.2 to 2.10 and Chapter-3: 3.1 to 3.7)

Module-II **[12 Hours]**

Transient Over Voltages: Sources of Transient Over Voltages, Principle of Over Voltage Protection, Devices for Over Voltage Protection, Utility Capacitor-Switching Transients, Utility System Lightning Protection, Managing Ferro-resonance, Switching Transient Problems with Loads, Computer Tools for Transient Analysis.

Fundamentals of Harmonics: Harmonic Distortion, Voltage Versus Current Distortion, Harmonics Versus Transients, Power System Quantities under Non-sinusoidal Conditions, Harmonic Indices, Harmonic Sources from Commercial Loads, Locating Harmonic Sources, System Response Characteristics, Effects of Harmonic Distortion, Inter-harmonics.

(Chapter-4: 4.1 to 4.8 and Chapter-5: 5.1 to 5.11)

Module-III **[10 Hours]**

Long Duration Voltage Variations: Principles of Regulating the Voltage, Devices for Voltage Regulation, Utility Voltage Regulator Application, Capacitors for Voltage Regulation, End- User Capacitor Application, Regulating Utility Voltage with Distributed resources, Flicker.

Power Quality Monitoring: Monitoring Considerations, Historical Perspective of Power Quality Measuring

Instruments, Power Quality Measurement Equipment, Assessment of Power Quality Measurement Data, Application of Intelligent Systems, Power Quality Monitoring Standards.
(Chapter-7: 7.1 to 7.7 and Chapter-11: 11.1 to 11.6)

Text book:

1. "Electrical Power Systems Quality" By Roger C. Dugan, Mark F. Mcgranaghan, Surya Santoso & H.Wayne Beaty, 2nd Edition, TMH Education Private Ltd., New Delhi.

Reference Book:

1. Power System Quality Assessment, J. Arrilaga, N.R. Watson, S. Chen, John Wiley & Sons.
2. Understanding Power Quality Problems: Voltage Sags & Interruptions, M.H.J. Boller IEEE,1999

PEEE5305	FACTS	3-0-0	Credits

Module-I **[12 Hours]**

FACTS concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What limits the Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Basic Description and Definitions of FACTS Controllers.
Static Shunt Compensation: Objectives of Shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators, SVC and STATCOM.
(Chapter-1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 and 1.7)
(Chapter-5: 5.1, 5.2 and 5.3)

Module-II **[12 Hours]**

Static Series Compensators: Objective of Series Compensation (GCSC, TSSC, TCSC), Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (SSSC) Static Voltage and Phase Angle Regulators: Objectives of Voltage and Phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs).
(Chapter-6: 6.1, 6.2 and 6.3)
(Chapter-7: 7.1 and 7.2)

MODULE-III **[10 Hours]**

Combined Compensators: Introduction, Unified Power Flow Controller (UPFC), The Interline Power Flow Controller (IPFC), Generalized and Multifunctional FACTS Controllers.
(Chapter-8: 8.1, 8.2, 8.3 and 8.4)

Text book:

1. "Understanding FACTS: Concepts & Technology of Flexible AC Transmission Systems" By N.G. Hingorani & L. Gyugyi, IEEE Press, Standard Publishers Distributors, Delhi.

Reference Book:

1. Facts Controllers in Power Transmission & Distribution by K.R. Padiyan, New Age International.
2. Modelling & Simulation in Power Networks, Enrique Acha, Clandio Esquival & H.A.Perez, CACamcho, John Wiley & Sons.

MANDATORY COURSE

MCGN9305	Environmental Science	2-0-0	Credit-0

Unit 1: Multidisciplinary nature of environmental studies

Definition, scope and importance), Need for public awareness.

Renewable and non-renewable resources

Natural resources and associated problems, role of an individual in conservation of natural resources, equitable use of resources for sustainable lifestyles.

Unit 2: Ecosystems

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, food webs and ecological pyramids, Introduction, types, characteristic features, structure and function of the following ecosystems:-

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit 3: Biodiversity and its conservation

- Introduction – Definition: genetic, species and ecosystem diversity.
- Bio geographical classification of India
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation
- Hot-sports 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.

Unit 4: Environmental Pollution Cause, effects and control measures of :-

Air pollution, water pollution, soil pollution, noise pollution, nuclear hazards and solid waste Management: Causes, effects and control measures of urban and industrial wastes, Disaster management: floods, earthquake, cyclone and landslides.

Unit 5: Social Issues and the Environment

Sustainable development, water conservation, rain water harvesting, resettlement and rehabilitation of people;

its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion.

Text Books

1. Environmental Science And Engineering by Rajesh Gopinath N. Balasubramanya, Cengage India.
2. Fundamental Concepts in Environmental Studies by Dr. D.D. Mishra S. Chand Publication.
3. Basic environmental Sciences for undergraduates by Dr. Sohini Singh, Dr. Tanu Allen and Dr. Richa K. Tyagi, Vayu education of India.

MANDATORY COURSE

MCHM9306	Universal Human Values	2-0-0	Credit-0

Objective:

1. To help students distinguish between values and skills, and understand the need, basic guidelines, content and process of value education.
2. To sensitize the student towards issues in society and nature.
3. To Strengthen self-reflection to know what the students 'really want to be' in their life and profession.
4. To understand harmony at all the levels of human living, applying the understanding of harmony in existence in their profession and lead an ethical life.

Module I **10 Hours**

1. Need, basic guidelines, content and process for Value Education, Self-Exploration– content and process;

2. Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship and Physical Facilities for Human Aspirations.

3. Method to fulfill the human aspirations: understanding and living in harmony at various levels.

Module II **10 Hours**

1. Human being as a co-existence of the sentient 'I' and the material 'Body', Self ('I') and 'Body' - *Sukh* and *Suvidha*

2. Body as an instrument of 'I' (I being the doer, seer and enjoyer), the characteristics and activities of 'I' and harmony in 'I',

3. Harmony of I with the Body: *Sanyam* and *Swasthya*; Needs of Body and Psyche: *Sanyam* and *Swasthya*

Module III **12 Hours**

1. Harmony in the Family, values in human-human relationship; Trust (*Vishwas*) and Respect (*Samman*) as the foundational values of relationship, meaning of *Vishwas* and *Samman*

2. Harmony in the society: *Samadhan, Samridhi, Abhay*, *Sah*-astitva, universal harmonious order in society- family to world family, harmony in the Nature : recyclability and self-regulation in nature

3. Natural acceptance of human values, Ethical Human Conduct, and Humanistic Education,

Module IV **08 Hours**

1. Competence in Professional Ethics: professional competence for augmenting universal human order, people-friendly and eco-friendly production systems, technologies and management

2. Strategy for transition from the present state to Universal Human Order

3. Being socially and ecologically responsible engineers with mutually enriching institutions and organizations.

Text Book:

1. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

References Books:

1. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
2. A N Tripathy, 2003, Human Values, New Age International Publishers.
3. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books

Course Outcome:

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

1. Distinguish between values and skills; understand the need, basic guidelines, content and process of value education.
2. Distinguish between the Self and the Body; understand the meaning of Harmony in the Self the Co-existence of Self and Body.
3. Understand the value of harmonious relationship based on trust, respect and other naturally acceptable feelings.
4. Distinguish between ethical and unethical practices, and start working out the strategy to actualize a harmonious environment.

HONOURS

HNEE0304	Control System Engineering-II	3L-1T-0P	4 Credits

Course Objectives:

To impart knowledge about the following topics:

1. Study discrete time control system and its stability analysis.
2. Modeling of linear time invariant system in state-space.
3. Designing of state feedback controllers.
4. Study of non-linear control systems and its stability analysis.

MODULE I (12Hours)

Discrete - Time Control Systems:

Introduction: Discrete Time Control Systems and Continuous Time Control Systems, Sampling Process. Digital Control Systems: Sample and Hold, Analogue to digital conversion, Digital to antilog conversion.

The Z-transform: Discrete-Time Signals, the Z-transform, Z-transform of Elementary functions, important properties and Theorem of the Z-transform. The inverse Transform, Z Transform method for solving Difference Equations. Z-Plane Analysis of Discrete

Time Control Systems: Impulse sampling & Data Hold, Reconstruction of Original signals from sampled signals: Sampling theorem.

Pulse Transfer function: Starred Laplace Transform of the signal involving both ordinary and starred Laplace Transforms; General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems. Mapping between the s-plane and the z-plane,

Stability analysis of closed loop systems in the z-plane: Stability analysis by use of the Bilinear Transformation and Routh- stability criterion, Jury's stability Test.

MODULE II (12 Hours)

State Variable Analysis and Design:

Introduction, Concepts of State, Sate Variables and State Model, StateModels for Linear Continuous-Time Systems, State Variables and Linear Discrete-Time Systems, State – space Representation using Canonical Variables, Derivation of Transfer Function for State model.

Diagonalization: Eigen values and Eigen vectors, Generalized Eigenvectors.

MODULE III (12Hours)

Nonlinear Systems:

Introduction, Common Physical Non-linearity, The Phase-plane Method: Basic Concepts, Singular Points, Stability of Nonlinear System, Construction of Phase-trajectories, The Describing Function Method: Basic Concepts, Derivation of Describing Functions, Stability analysis by Describing Function Method, Jump Resonance, Signal Stabilization.

Liapunov's Stability Analysis: Introduction, Liapunov's Stability Criterion, The Direct Method of Liapunov's and the Linear System, Methods of Constructing Liapunov Functions for Nonlinear Systems, Popov's Criterion.

MODULE IV (6Hours)

Solution of State Equations:
Properties of the State Transition Matrix, Computation of State Transition Matrix, Computation by Techniques Based on the Cayley-Hamilton Theorem, diagonalization, Solution of State Equations. Concepts of Controllability and observability, Effect of Pole zero Cancellation in Transfer Function,Pole Placement by State Feedback, observer based state feedback control.

Text books:

1. Discrete-Time Control System, K.Ogata, PHI, 2nd Edition, 2009.
2. Control Systems Engineering, I.J. Nagrath and M.Gopal, New Age International (P) Ltd. Publishers, 5th Edition, 2007/ 2009.
3. Modern Control Systems by K.Ogata, 5th Edition (2010), PHI.
4. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.

Reference Books:

1. Design of Feedback Control Systems by Stefani, Shahian, Savant, Hostetter, Fourth Edition(2009), Oxford
2. University Press.
3. Modern Control Systems by Richard C. Dorf. And Robert, H.Bishop, 11th Edition (2008),Pearson
4. Education Inc. Publication.
5. Control Systems Engineering by Norman S.Nise, 4th Edition (2008), Wiley India (P) Ltd.

Course Outcomes:
At the end of this course, students will demonstrate the ability to:

1. Investigate discrete time control system
2. Understand the modeling of linear-time-invariant systems using transfer function and state space representations.
3. Design simple feedback controllers.
4. Analyze non-linear systems and its stability.

MINOR

MNEE0304	Sensors and Transducers	3-1-0	4 Credits

Module -I **[12 Hours]**

Elements of a general measurement system; Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems. **(Bentley: Chapters 1-4)**

Techniques for dynamic compensation, Loading Effects and Two-port Networks
(Bentley: Sections 4.4 and 5.1-5.2)

Module-II **[12 Hours]**

Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric;

Inductive sensing elements: variable reluctance and LVDT displacement sensors; Electromagnetic sensing elements: velocity sensors. **(Bentley: Sections 8.1 to 8.6)**

RVDT, Hall Effect sensors **(Bentley: Sections 8.3 and 8.10)**

Piezoelectric sensing elements, Piezo-resistive sensing elements.
(Bentley: Sections 8.7 and 8.8)

Module-III [12 Hours]

Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity.

Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation
(Bentley: Sections 9.1 to 9.3; Ghosh: Sections 15.1 and 15.2)

Current transmitters, Oscillators and resonators **(Bentley: Sections 9.4 and 9.5)**

Module-IV [6 Hours]

Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation.

IC temperature sensor Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.
(Ghosh: Section 10.3 to 10.4)

Text Books:

1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi, 2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh (3/e), PHI Learning, New Delhi, 2009.

Reference Books:

1. Measurement Systems Application and Design- E.O. Doeblin (4/e), McGraw-Hill, International, NY.
2. Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY, 2003.
3. Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.

PRACTICAL / SESSIONAL

PCEE7309	Electrical Drives Laboratory	0-0-3	2 Credits

Any eight out of the following experiments:

1. Speed Control of Single Phase Induction Motor by using Single Phase AC to AC Converter.
2. Speed Control of Separately Excited DC Shunt Motor using Single Phase Fully Controlled AC to DC Converter.
3. Speed Control of Separately Excited DC Shunt Motor using Four-Quadrant Chopper.
4. Speed Control of Separately Excited DC Shunt Motor using Single Phase Dual Converter.
5. Speed Control of Three Phase Squirrel Cage Induction Motor using Three Phase AC to AC Controller.
6. Speed Control of Three Phase Squirrel Cage Induction Motor using Three Phase PWM Inverter.
7. Speed Control of Three Phase Slip Ring Induction Motor using Rheostatic Control Method.
8. Speed Control of DC Shunt Motor using Three Phase AC to DC Converter.
9. Determination of the Transfer Function of DC Shunt Motor.
10. Determination of the Moment of Inertia of DC Shunt Motor Drive System by Retardation Test.

PCEE7310	Power System Laboratory-II	0-0-3	2 Credits

(Any 10 experiments out of which at least 7 experiments from Group-A and 3 experiments from Group-B)

Group A:

HARDWARE BASED-

1. To determine negative and zero sequence synchronous reactance of an alternator.
2. To determine sub-transient direct axis and sub-transient quadrature axis synchronous reactance of a 3-ph salient pole alternator.
3. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.
4. To study the IDMT over-current relay and with different plug setting and time setting multipliers and plot its time – current characteristics.
5. To determine the operating characteristics of biased different relay with different % of biasing.
6. To study the MHO and reactance type distance relays.
7. To compute series inductance and shunt capacitance per phase per km of a three phase line with flat horizontal spacing for single stranded and bundle conductor configuration.
8. To determine location of fault in a cable using cable fault locator.
9. To study the Ferranti Effect and voltage distribution in HV long transmission line using transmission line model.
10. Study of layout of outdoor pole mounted & plinth mounted sub-stations.

Group B :

SIMULATION BASED (USING MATLAB OR ANY OTHER SOFTWARE)-

1. To obtain steady-state, transient and sub-transient short-circuit currents in an alternator.
2. To formulate the Y-Bus matrix and perform load flow analysis.
3. To compute voltage, current, power factor, regulation and efficiency at the receiving end of a three phase Transmission line when the voltage and power at the sending end are given. Use Π model.
4. To perform symmetrical fault analysis in a power system.
5. To perform unsymmetrical fault analysis in a power system.
6. Write a program in MATLAB to solve economic dispatch problem of a power system with only thermal units. Take production cost function as quadratic and neglect transmission loss.

Text books:

1. Hadi Sadat- Power System Analysis – TMH
2. T. K. Nagsarkar and M. S. Sukhija - Power System Analysis – Oxford University Press

PJEE8301	Skill Project	0-0-3	Credit-2

List of Experiments:

1. To prepare married joint of stranded aluminium or copper wire.
2. To prepare shackle insulator joint.
3. To prepare pin insulator joint.
4. To prepare Britannia joint.
5. To prepare an electrical switch board.
6. To make the connection and testing of Sodium vapour lamp.
7. To make the connection and testing of Mercury vapour lamp.
8. To prepare a pipe earthing for a residential building and to measure the earth resistance.

HSHM3305	Business Communication & Interview Skills	0-0-3	Credit-1

COURSE OBJECTIVES

1. To develop communicative competence in prospective engineers.
2. To train them to participate in Group Discussion, presentation & face interview
3. To understand team dynamic & effectiveness.
4. To learn leadership qualities and practice them.
5. To develop basic personality traits.

Detailed Syllabus

Emphasis will have to be given to practice sessions in the class room by the learners

Module –I (08 Hours)

1. Soft Skills: An introduction-Definition and Significance of Soft Skills; Importance and Measurement of Soft Skill Development, Role of effective communication in professional life.
2. Self-Discovery: Discovering the Self; Beliefs, Values, Attitude, Virtue,
3. Being Creative: Out of the box thinking, Lateral Thinking and its use.

Module-II (12 hours)

1. Public Speaking: Skills, Methods, Strategies and Essential tips for effective public speaking.
2. Teamwork and Leadership Skills: Concept of Teams; Building effective teams; being a team player, Concept of Leadership and developing Leadership skills
3. Group Discussion: Importance, Planning, Elements and Skills. GD as part of a selection process:

Evaluation and Analysis

Module-III (12 hours)

1. Interview Skills: Interviewee-in-depth perspectives, Types of Interview- In Campus / Onsite/ Telephonic, Before, During and After the Interview. Tips for Success.
2. Presentation Skills: Types, Content, Audience Analysis, Essential Tips-Before, During and After, Overcoming Nervousness/ reducing stage fright, visualization strategies, on camera techniques.
3. Preparing Curriculum Vitae, Resume, Bio-data, Job Application

Module-IV (08 hours)

1. Stress/ Time Management: Definition, Nature, types, Symptoms and Causes; Stress Analysis Models and Impact of Stress; Measurement and Management of Stress. Effective utilization of Time as a resource, Managing Time
2. Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Types of Leadership behavior; Assertiveness Skills.
3. Emotional Intelligence: Meaning, Features, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence.

Reference Books:

1. Managing Soft Skills for Personality Development-edited by B.N. Ghosh, McGraw Hill India, 2012.
2. English and Soft Skills-S.P. Dhanavel, Orient Blackswan India, 2012.
3. Personality Development and Soft Skills by Barun Mitra OUP
4. Communication Skills second edition Kumar Lata OUP
5. Crash Course in Personal Development- Brian Clegg Kogan Page Publication
6. Lateral Thinking by Edward De Bono Penguin Books

COURSE OUTCOMES

By the end of course, students shall be able to:

1. Understand the significance and essence of a wide range of soft skills. Learn how to apply soft skills in a wide range of routine social and professional settings.
2. Learn how to employ soft skills to improve interpersonal relationships. Learn how to use soft skills to enhance employability and ensure workplace and career success.
3. Participate in different types of Group Discussions/ Activities effectively, presenting a topic and face interviews with confidence.

OPEN ELECTIVE-III (OE-III) 6th Semester

OECH6318	Food Biotechnology	3L-0T-0P	3 Credits

Objective of the course: To study the aspects of production, composition and design of food products.

Module-I **(12 Hours/4 Weeks)**

Unit – 1 (6 Hours/2 Weeks) Food quality and Production technology: Analysis of food, major ingredients present in different product, Food additives: colour, flavour, vitamins, Single cell protein, mushroom.

Unit – 2 (6 Hours/2 Weeks) Fermentative production of food, Pickling and alcoholic beverages, genetically manipulated crops-based food, oriental foods, probiotics and prebiotics in food products.

Module-II **(12 Hours/4 Weeks)**

Unit – 3 (6 Hours/2 Weeks) Technology for improved process: Enzyme in bakery, fermented cereal products, Enzymes in fat/oil industries, Protease in cheese making, enzymes in beverage production.

Unit – 4 (6 Hours/2 Weeks) Utilization of food waste for production of value-added products, enzymes in sugar syrup, genetically modified food.

Module-III **(12 Hours/4 Weeks)**

Unit – 5 (6 Hours/2 Weeks) Food spoilage and control: Spoilage of food, Microbiology of water, meat, milk, vegetables, microbial safety of food products.

Unit – 6 (6 Hours/2 Weeks) Chemical safety of food products, heavy metal, fungal toxins, pesticide and herbicide contamination, Food preservatives and additives, Post-harvest technology for food preservation.

Module-IV **(6 Hours/2 Weeks)**

Unit – 7 (6 Hours/2 Weeks) Canning, dehydration, ultrafiltration, sterilization, irradiation.

Text Books

1. Modern Food Microbiology, 7th ed. by J M Jay, M J Loessner, and DA Golden, Springer.
2. Food Microbiology, 5th ed. by W C Frazier and D C Westhoff, McGraw-Hill.
3. Prescott & Dunn's Industrial Microbiology by G Reed, CBS.
4. Technology of Food Preservation, 4th ed. by N W Desrosier and J N Desrosier, Avi Publishing Co Inc.
5. Introduction to Food Engineering, 5th ed. by R P Singh and D R Heldman, Academic Press.

Course Outcomes:

At the end of the course, the student should be able to

1. Understand the process used to enhance the production, nutritional value, safety and taste of food.
2. Know about the modern biotechnological techniques applied to food science.
3. Know about improving crops so that they need fewer pesticides.
4. Design product & functionality, understand food innovation and marketing.
5. Gain knowledge about the rapid detection techniques of foodborne pathogens and chemical senses.

6. Know about the requirements for careers in the dynamic food sector as well as for research and development.

OECH6319	Fluidization Engineering	3L-0T-0P	3 Credits

Course objectives: The objectives of this course are to introduce

1. Basics of fluidization and various industrial application of fluidization;
2. Various fluidization regime, classification of particles;
3. Describe the staging of fluidized bed reactor.

Module-1 **(4 weeks/12 Hours)**

Basics of fluidization, types, behaviour, and parameters

Unit I (6 Hours/2 weeks): Introduction to fluidization, types of fluidization, gross behavior of fluidized beds, minimum fluidization velocity.

Unit II (6 Hours/2 weeks): Pressure drops in fluidized beds, bed voidage, transport disengaging height, viscosity and fluidity of beds, bubble behavior, bed expansion, distributor design.

Module-2 **(4 weeks/12 Hours)**

Mathematical treatment and calculations

Unit III (6 Hours/2 weeks): Simple mathematical treatment, Solid transport: flow and fluidized solids, solids transfer, terminal velocity, particle entrainment and elutriation.

Unit IV (6 Hours/2 weeks): Simple calculations relating to solid transport.

Module-3 **(4 weeks/12 Hours)**

Heat and mass transfer in fluidized beds

Unit V (6 Hours/2 weeks): Heat and mass transfer in fluidized beds: Heat transfer mechanism, principles of gas-solid and bed surface transfer, heat transfer to liquid fluidized systems.

Unit VI (6 Hours/2 weeks): Generalized correlation for fluidized bed mass transfer and its limitations.

Module-4 **(2 weeks/6 Hours)**

Semi-fluidization and fluidized bed reactors

Unit VII (6 Hours/2 weeks): Semi-fluidization: principles, estimation of various bed parameters, Industrial applications; Design of fluidized bed reactors: Concept of RTD, basic design principles for fluidized bed.

Text books :

1. 'Fluidization Engineering', 2nd ed. by D Kunii and O Levenspiel, Butterworth Heinemann.

Reference Books :

1. 'Fluidization' by M Leva, McGraw-Hill.
2. 'Fluidization' by J F Davidson and D Harrison, Academic Press.

Course Outcomes (CO):

At the end of the course, students would be able to understand about

1. Concept of fluidization
2. Applications of fluidization
3. Semi-fluidization
4. Fluidized bed reactors

OECE6320	Structural Dynamics and Earthquake Engineering	(3-0-0)	Credit-03

Module I

Elements of Earthquake origin & Propagation: Elements of Seismology, Earthquakes, Structure of the Earth, History of the Earth, Earthquake Mechanism, Propagation of Seismic Waves, Earthquake Phenomena, Earthquake Measurements, Definitions of magnitude, intensity, epicentre etc; Plate tectonics, seismographs, liquefaction, Types, effects and controlling factors

Module II

Theory of Vibration Effects: Dynamic Loads. D'Alembert's Principle and inertia forces, Stiffness and flexibility of elastic structures, Theory of Vibrations, Free vibrations of single and multiple degree freedom systems, computations of dynamic response to time dependent forces, mass and stiffness matrices, natural frequencies, Plate Tectonics Theory.

Module III

Earthquake Resistant Design: Principles of Earthquake Resistant Design, Response spectrum theory. Time – Acceleration method, Application of response spectrum theory to seismic design of structures.

Module IV

Earthquake Damages: Earthquake Damages to Various Civil Engineering Structures, Case Histories Earthquake, Earthquake response of structures, Soft storey collapse, Slender structures, unsymmetrical structures. Methods of disaster prevention: Earthquake resistant building Regulations, specification, guidelines for construction – Materials selection.

Reference Books

1. A K. Chopra (2003), Dynamics of Structures-Theory and Applications to Earthquake Engineering, Second Edition, Prentice-Hall India Pvt Ltd.
2. Pauley & Priestly (1995), Seismic design of reinforced concrete and masonry buildings, John Wiley & Sons.
3. Stratta. J.L. (2000), Manual of Seismic Design, Prentice-Hall India Pvt Ltd.
4. Kramer. S.L. (2000), Geotechnical Earthquake Engineering, Prentice-Hall India Pvt Ltd.
5. Agarwal & Shrinkhardo (2006), Earthquake Resistant design of structures, Prentice-Hall India.

OECS6321	Data Science	3-0-0	Credit-03

Prerequisite:
Brief knowledge in programming in C, C++ with great interest in quantitative/statistical analysis and a student having degree in BTech in any branch of Engineering, MCA, M.Tech, MS having occasionally programming knowledge may enrol for this subject. As this is just an introductory to data science techniques even a simple graduate student may take this course.

Module I: **10 Hrs.**
Benefits and uses of data science and big data, Data Science steps, Facets of data, Structured data, Unstructured data, Natural language , Machine-generated data, Graph-based or network data, Audio, image, and video, Streaming data, The data science process, Setting the research goal, Retrieving data, Data preparation, Data exploration, Data modelling or model building, Presentation and automation, The big data ecosystem and data science, Distributed file systems, Distributed programming framework, Data integration framework, Python Environment set-up, Jupyter overview, Python Numpy, Python Pandas, Python Matplotlib.

Module II: **8 Hrs.**
An introduction to R, Data structures in R, Data visualization with R, Data analysis with R, Data science using MS-excel, Important statistical concepts used in data science, Difference between population and sample, Types of variables, Measures of central tendency, Measures of variability, Coefficient of variance, Skewness and Kurtosis, Normal distribution, Test hypotheses, Central limit theorem, Confidence interval, F-test, T-test, Chi-square test, Type I and II errors, Student's T distribution.

Module III: **10 Hrs.**
Regression, ANOVA,R square, Correlation and causation, Exploratory data analysis, Data visualization, Missing value analysis, The correction matrix, Outlier detection analysis, Supervised machine learning, Python Scikit tool, Neural networks, Support vector machine, Logistic and linear regression, Decision tree classifier, Tableau, Working with Tableau, Deep diving with data and connection, Creating charts, Mapping data in Tableau, Dashboards and stories.

Module IV: **10 Hrs.**
Machine learning on cloud, ML on cloud platform, ML on AWS, ML on Microsoft Azure, Understanding NoSQL databases and why they're used today, Identifying the differences between NoSQL and relational databases, Defining the ACID principle and how it relates to the NoSQL BASE principle, Learning why the CAP theorem is important for multi-node database setup, Applying the data science process to a project with the NoSQL database Elastic search, The rise of graph data bases, graph mining, test mining and analysis, Natural Language Toolkit(NLTK),Data visualization to the end user, Dashboard development tools.

Text Books:
There is no text book for the course. A teacher may use lecture notes and videos, read research papers and Web Pages, which will be freely available on internet websites.

Reference Books:
1. Introducing Data Science BIG DATA, MACHINE LEARNING, AND MORE, USING PYTHON TOOLS by DAVY CIELEN ARNO, D. B. MEYSMAN and MOHAMED ALI, MANNING

SHELTER ISLAND
2. Introduction to Probability – By Joseph K. Blitzstein and Jessica Hwang
3. R for Data Science: Import, Tidy, Transform, Visualize, and Model Data 1st Edition, by Hadley Wickham
4. Python Data Science Handbook, Jake Vander Plas*, O'reilly*
5. Hands-On Machine Learning with Scikit-Learn, Keras, and Tensor Flow: Concepts, Tools, and Techniques to Build Intelligent Systems 2nd Edition, Aurélien Géron (Author),O'reilly

OEEE6322	Sensors and Transducers	3-0-0	3 Credits

Module -I **[12 Hours]**

Elements of a general measurement system; Static Characteristics: systematic characteristics, statistical characteristics, calibration; Dynamic characteristics of measurement systems: transfer functions of typical sensing elements, step and frequency response of first and second order elements, and dynamic error in measurement systems. **(Bentley: Chapters 1-4)**

Techniques for dynamic compensation, Loading Effects and Two-port Networks
(Bentley: Sections 4.4 and 5.1-5.2)

Module-II **[12 Hours]**

Sensing elements: Resistive sensing elements: potentiometers, Resistance Temperature Detector (RTD), thermistors, strain gages. Capacitive sensing elements: variable separation, area and dielectric;

Inductive sensing elements: variable reluctance and LVDT displacement sensors; Electromagnetic sensing elements: velocity sensors. **(Bentley: Sections 8.1 to 8.6)**

RVDT, Hall Effect sensors **(Bentley: Sections 8.3 and 8.10)**

Piezoelectric sensing elements, Piezo-resistive sensing elements.
(Bentley: Sections 8.7 and 8.8)

Module-III **[12 Hours]**

Signal Conditioning Elements: Deflection bridges: design of resistive and reactive bridges, push-pull configuration for improvement of linearity and sensitivity.

Amplifiers: Operational amplifiers-ideal and non-ideal performances, inverting, non-inverting and differential amplifiers, instrumentation amplifier, filters. A.C. carrier systems, phase sensitive demodulators and its applications in instrumentation
(Bentley: Sections 9.1 to 9.3; Ghosh: Sections 15.1 and 15.2)

Current transmitters, Oscillators and resonators **(Bentley: Sections 9.4 and 9.5)**

Module-IV **[6 Hours]**

Thermoelectric sensing elements: laws, thermocouple characteristics, installation problems, cold junction compensation.

IC temperature sensor Elastic sensing elements: Bourdon tube, bellows, and diaphragms for pressure sensing, force and torque measurement.

(Ghosh: Section 10.3 to 10.4)

Text Books:

1. Principles of Measurement Systems- J.P. Bentley (3/e), Pearson Education, New Delhi, 2007.
2. Introduction to Measurement and Instrumentation- A.K. Ghosh (3/e), PHI Learning, New Delhi, 2009.

Reference Books:

1. Measurement Systems Application and Design- E.O. Doeblin (4/e), McGraw-Hill, International, NY.
2. Instrumentation for Engineering Measurements- J.W. Dally, W.F. Riley and K.G. McConnel (2/e), John Wiley, NY, 2003.
3. Industrial Instrumentation- T.R. Padmanabhan, Springer, London, 2000.

OEEC6324	Mechatronics	3-0-0	Credits 3

COURSE OBJECTIVES

1. Understand key elements of Mechatronics system, its block diagram representation.
2. Understand principles of sensors, transducers, encoders and actuators and its characteristics.
3. Understand the concept of PLC system and its ladder programming, and significance of PLC systems in industrial applications.
4. Understand the system modelling and analysis in time domain and frequency domain.

MODULE-I **(12 Hours)**

Unit 1

Fundamental of Mechatronics: Definition and concepts of Mechatronics, Conventional system vs. mechatronic system, Evolution of Mechatronics.

Unit 2

Hardware components for Mechatronics. Need and Role of Mechatronics in Design, Manufacturing and Factory Automation.

MODULE-II **(12 Hours)**

Unit 3

Sensors:

An introduction to sensors. Principle of operation, Difference between transducer and sensors. Sensor types-

Transducer signal conditioning sensor, velocity and motion sensor, force sensor, fluid pressure sensor, liquid flow sensor, liquid level sensor, temperature sensor.

Unit 4

Transducers:

Introduction to transducers. Transducer types – photo emissive transducer, photo conductive transducer, photovoltaic transducer, thermistors, thermocouple, inductive transducer, capacitive transducer, piezoelectric transducer, hall effect transducers, ionization transducer, Use of sensor and transducer for specific purpose in mechatronics.

MODULE-III (12 Hours)

Unit 5

Actuators and encoders:

Electric motors: D.C. Motors, Stepper motor. Hydraulic actuators, Pneumatic actuators. Principle of operation of encoders, Types of encoders- incremental encoder, optical encoder, bimetallic strip encoder, strain gauge encoder, load cell encoder.

Unit 6

Programmable Logic Controller:

Basic Structure- Programming: Ladder diagram Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls, data handling, Analog input / output , PLC Selection &Application.

MODULE-IV (8 Hours)

Unit 7

MEMS and Microsystems:

Overview of MEMS and Microsystems. Micromachining techniques: silicon as a material for micromachining, photolithography, thin film deposition, doping, wet and dry etching, surface and bulk micromachining, wafer bonding, packaging.

Microsystems modelling and Design:

Mechanics of deformable bodies. Energy method. Estimation of stiffness and damping for different microstructures. Modelling of electromechanical system, it's analysis in time domain and frequency domain, pull-in voltage. Applications of MEMS.

Text Books:

1. Mahalik N.P, "Mechatronics: Principles, Concepts and applications", Tata McGraw Hill, 3rd edition (Indian), 2012.
2. Appu Kuttan, "Introduction to Mechatronics", Oxford University, 2007.

Reference Books:

1. RK Rajput, "A Textbook of Mechatronics", S. Chand Publishing, 1st Edition, 2007.
2. Ananthasuresh & Gopalkrishnan, "Micro and Smart Systems", Wiley India, 2012
3. A. Smaili& F Mrad, "Applied Mechatronics", Oxford University Press, 1st Edition 2007.
4. S. D. Senturia, "Microsystem Design", Springer, 1st edition 2nd reprint 2004

Course Outcomes:

1. To model, analyze, and control engineering systems.
2. Identify sensors, transducers, and actuators to monitor and control the behaviour of a process or product.
3. Develop PLC programs for a given task.
4. Evaluate the performance of mechatronics systems.

OEHM6325	MARKETING MANAGEMENT	3-0-0	Credit-3

Course Objectives

1. To understand the concepts of marketing management
2. To learn about marketing process for different types of products and services
3. To understand the tools used by marketing managers in decision situations
4. To understand the marketing environment

Course Content

UNIT 1: Basic Concepts of Marketing

Definition, Concept of Exchange-Needs & Wants, Marketing Concept, Process ,Marketing environment, Elements of macro and micro environment, Competition analysis, Factors contributing to competition, Porters five forces model, identifying and analyzing competitors, Marketing planning process, Market research and information system, Research process, consumer behavior, factors influencing consumer behavior.

UNIT 2: Market segmentation, targeting and positioning

Definition, Bases of segmenting consumer and industrial market, Target market strategies, Market positioning, Market demand forecasting :forecasting tools, short term tools, Moving average and exponential smoothing methods, Long term forecasting tools- time series analysis, Econometric method, Qualitative methods– Buying intention survey, sales force opinion, Delphi techniques, Product planning-Product planning and new product planning process.

UNIT 3: Price decision

Objectives and factors influencing price, Pricing methods and strategies, Integrated marketing communication (IMC), Concept of IMC, The marketing communication process, Promotion mix, Elements of promotion mix, Channel of distribution: types of intermediaries, functions of distribution channels, channel levels, physical distribution, supply chain management (basic only)

Text Books

1. Kotler, P., Keller, K. L., Koshy, A., & Jha, M. (2012), Marketing Management A South Asian Perspective, 14th Edition, Pearson Education, New Delhi.
2. Ramaswamy, V. S., & Namakumari, S. (2017), Marketing Management: Indian Context with Global

Perspective, McGraw hill.

Reference Books

1. Kotler, Philip. Marketing Management, Millennium Edition. Intl ed. US: Prentice Hall, 2002.ISBN: 8120316096.
2. Principles of Marketing, Kotler and Armstrong, Pearson, 12th edition., 2008, ISBN: 978-81- 317-1547-5

Course Outcomes

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

CO 1. Demonstrate strong conceptual knowledge in the functional area of marketingmanagement.
CO 2. Demonstrate effective understanding of relevant functional areas of marketing management and its application.
CO 3. Demonstrate analytical skills in identification and resolution of problems pertaining to marketing management

OEMA6326	Optimization in Engineering	3-0-0	Credit-3

Module-I. **(12 Hours)**

Idea of Engineering optimization problems, Classification of optimization algorithms, modeling of problems and principle of modeling. Linear programming: Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method, Sensitivity analysis in linear programming.

Module-II. **(12 Hours)**

Transportation problems: Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method. Assignment problems: Hungarian method for solution of Assignment Problems Integer Programming: Branch and Bound algorithm for solution of integer Programming Problems.

Module-III. **(13 Hours)**

Non-linear programming: Introduction to non-linear programming. Unconstraint optimization: Fibonacci and Golden Section Search method. Constrained optimization with equality constraint: Lagrange multiplier, Projected gradient method. Constrained optimization with inequality constraint: Kuhn-Tucker condition, Quadratic programming.

Module-IV. **(8 Hours)**

Queuing models: General characteristics, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline. Introduction to Genetic Algorithm.

Text Books:

1. A. Ravindran, D. T. Philips, J. Solberg, Operations Research- Principle and Practice, Second

edition, Wiley India Pvt. Ltd.
2. Prabhakar Pai, Operation Research, Oxford University Press.
3. H.A. Taha, A.M. Natarajan, P. Balasubramanie, A. Tamilarasi Operations Research, Pearson Education, Eighth Edition.

Reference Books:

1. Stephen G. Nash, A. Sofer Linear and Non-linear Optimization, McGraw Hill, 2nd Edition.
2. A. Ravindran, K.M. Ragsdell, G.V. Reklaitis, Engineering Optimization, Wiley India Pvt. Ltd, Second edition.
3. F.S. Hiller, G.J. Lieberman, Operations Research, Tata McGraw Hill, Eighth Edition. .

OEME6327	Industrial Engineering and Operation Research	3-0-0	Credit-3

Product Design and Development: Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, value engineering and analysis, concurrent engineering; comparison of production alternatives.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity – concepts and measurements; method study, micro-motion study, principles of motion economy; work measurement –time study, work sampling, standard data, PMTS; ergonomics; job evaluation, merit rating, incentive schemes, and wage administration.

Facility Design: Facility location factors and evaluation of alternate locations; types of plant layout and their evaluation; computer aided layout design techniques; assembly line balancing; materials handling systems.

Operation Research: Linear programming – problem formulation, simplex method, duality and sensitivity analysis; transportation and assignment models; network flow models, constrained optimization and Lagrange multipliers; Markovian queuing models; dynamic programming; simulation – manufacturing applications. Engineering Economy and Costing: Elementary cost accounting and methods of depreciation; break-even analysis, techniques for evaluation of capital investments, financial statements, time-cost trade-off, resource levelling. Production control: Forecasting techniques – causal and time series models, moving average, exponential smoothing, trend and seasonality; aggregate production planning; master production scheduling; MRP and MRP-II; routing, scheduling and priority dispatching; Push and pull production systems, concept of JIT manufacturing system; Logistics, distribution, and supply chain management;
Inventory – functions, costs, classifications, deterministic inventory models, quantity discount; perpetual and periodic inventory control systems.
Project management – PERT and CPM.

Text Book:

1. Production & operations management, K. Aswathappa, K.S. Bhat, Himalaya Publishing House, edition 2012.
2. R. Paneerselvam, Production operations Management

3. Operations Research, D.S.Hira, Gupta, S Chand Publisher
4. Industrial Engineering & Management, O P Khanna, Dhanpat Rai & Sons
5. WORK STUDY & amp; TIME STUDY,ILO

OEMT6328	Biomaterials	3-0-0	Credits 3

Objectives of the Course:

1. To introduce the student to the range of biomaterials and the science and engineering of biomaterials.
2. To understand constraints associated with the use of biomaterials

Module 1: **(12 Hours)**

Introduction to basic concepts of Materials Science, Salient properties of important material classes Property requirement of biomaterials, Concept of biocompatibility, Structure and properties of biological cells & tissues, Cell fate processes (cell migration, cell differentiation, cell apoptosis, cell division), Cell signaling processes, Cell-material interactions and foreign body response

Module 2: **(12 Hours)**

Bone tissue–structure, bone tissue-property, assessment of biocompatibility of biomaterials, in vitro biochemical assays (cellular adhesion, cellular viability using MTT, osteogenic differentiation- ALP assay; Biomineralisation - Osteocalcin assay), In vivo testing and histocompatibility assessment, Genotoxicity assessment,

Module 3: **(12 Hours)**

Important biometallic alloys: Ti-based, stainless steels, Co-Cr-Mo alloys Bioinert, Bioactive and Bioresorbable ceramics**,** Processing and properties of different hydroxyapatite (HA)-based biocomposites, Synthesis of biocompatible coatings on structural implant materials, Fabrication of porous scaffold materials using electrospinning and 3D printing, Microstructure and properties of glass-ceramics; biodegradable polymers, Processing and Properties of some Polymer-based Biocomposites,

Module 4: **(06 Hours)**

Design concept of developing new materials for bio-implant applications

Suggested Text Books:

1. Introduction to Biomaterials: Basic Theory with Engineering Applications; C.L Agrawal, J.L. Ong, Mark R Appleford, Gopinath Mani, Canbridge University Press, 2013

Suggested Reference Books:

1. Biological Performance of Materials: Fundamentals of Biocompatibility (Third Edition, Revised and Expanded); Author: Jonathan Black; Publisher - Marcel Dekker, 1999
2. Biomaterials Science and Biocompatibility; Authors: Frederick H. Silver and David L. Christiansen; Publisher: Springer-Verlag New York, 1999

3. Biomaterials Science: An Introduction to Materials in Medicine; Editors: Buddy D. Ratner, Allan S. Hoffman, Fredrick J. Schoen and Jack E. Lemons; Publisher: Elsevier Inc., 2004
4. Molecular Biology of the Cell; Fourth edition; Authors: Bruce Alberts, Alexander Johnson, Julian Lewis, Keith Roberts and Peter Walter; Publisher: Taylor & Francis, New York, 2002
5. B. Basu, D. Katti and Ashok Kumar; Advanced Biomaterials: Fundamentals, Processing and Applications; John Wiley & Sons, Inc., USA, September, 2009.

Course Outcomes:

After completing the course, the student will be able to:

1. Explain the types of Biomaterials and their relative advantages and disadvantages
2. Indicate the constraints placed on the use of materials in biological environments
3. Explain the characterization of materials from the perspective of application as a
4. Biomaterial

OEPD6329	OPERATION RESEARCH	3L-0T-0P	3 Credits

Course Objective

Ability to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively; knowledge of formulating mathematical models for quantitative analysis of managerial problems in industry; skills in the use of Operations Research approaches and computer tools in solving real problems in industry; Mathematical models for analysis of real problems in Operations Research. Identify and develop operational research models from the verbal description of the real system.

Module I **[12]**

Introduction: Definition, Characteristics and phases, Applications of OR. Linear Programming: Problem Formulation, Graphical solution, Simplex method - Artificial variables technique (i.e. Big M method only) - Duality principle, simple problems on dual formulation only, sensitivity analysis.

Module II **[10]**

Transportation Model: Formulation, IBFS-North West Corner method, LCEM, VAM, Unbalanced transportation problem, Optimality test by MODI method.

Assignment Model - Formulation - Optimal solution by Hungarian method – Unbalanced Assignment problem- Restricted case.

Module III **[10]**

Queuing Models: Introduction – Kendall's Lee notation- single channel with infinite population, Multichannel with infinite population

Networking Model: PERT, CPM

Module IV **[08]**

Theory of Games: Introduction-classification of games- 2 person zero sum games- Assumptions -solution of

games with saddle points - Rectangular games without saddle points, dominance principle - 2 X 2 games by Algebraic method, m X 2 & 2 X n games by graphical method.

Text Books:

1. Operation Research by Panarsalvam
2. Operation Research by Kalavathy

Reference Books:

1. Hiller & Libermann, "Introduction to Operations Research", 8th ed., Tata McGraw Hill, 2010.
2. D.S. Hira and R.K. Gupta, "Operations Research", 5th ed., S.Chand & Co., 2008.
3. Taha, "Introduction to Operations Research." 8th ed., PHI Publications, 2008.
4. S.D. Sharma, "Operations Research", 8th ed., Kedarnath Publishers, 2007.

Course Outcomes:

Upon successful completion of the course, student will able to:

1. Recognize the importance and value of Operations Research and mathematical modelling in solving practical problems in industry.
2. Formulate a managerial decision problem into a mathematical model;
3. Understand Operations Research models and apply them to real-life problems;
4. Use computer tools to solve a mathematical model for a practical problem.
5. Cognitive skills (thinking and analysis)
6. Be able to build and solve Transportation Models and Assignment Models.
7. Be able to understand the characteristics of different types of decision.