The list of Open Electives for 2020-21 even semester

Sl No	Dept.	Course Code	Course Title	Maximum registration allowed
1.	Civil	18OECV62	Engineering Optimization	50
2.		18OECV63	Composites and smart materials	50
3.		18OECV64	Urban Design and Regeneration	50
4.	Mechanical	18OEME61	Principles of manufacturing	50
5.		18OEME62	Industrial engineering and ergonomics	50
6.		18OEME63	Project Management	50
7.		18OEME64	Robotics for engineers	50
8.	E & E	18OEEE61	Basic Power Electronics	50
9.		18OEEE62	Alternate Energy Sources	50
10.	E & C	18OEEC61	Arm Processor	50
11.		18OEEC63	Sensors and Actuators	50
12.		18OEEC66	Elements of Signal Processing	50
13.	Automobile	18OEAU61	Fundamentals of Automotive Engineering	50
14.		18OEAU62	Electric and Hybrid Vehicles Technology	50
15.	I & P	18OEIP61	3D printing and prototyping	50
16.		18OEIP62	Total quality management and operational excellence	50
17.	E&I	18OEEI61	Industrial Instrumentation	50
18.		18OEEI62	Medical Electronics	50
19.	CS & E	18OECS61	Introduction to Cloud Computing	100
20.		18OECS62	Introduction to Data Mining	100
21.	IS & E	18OEIS61	Web technologies	50
22.		18OEIS64	Python programming	50
23.	Physics	18OEPH61	Introduction to Nanotechnology and Quantum Science	50
24.	Chemistry	18OECH61	Industrial Chemistry	50
25.	Mathematics	18OEMA62	Linear Algebra and its Applications	50
			Total	1350

Note :

- The required minimum registration for a course – 20
- All courses are for 3 credits

The Syllabus of Open Electives for 2020-21 Even Semester

ENGINEERING OPTIMIZATION

18OECV672 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-3**
CIE-50 marks, SEE-50 marks **Total Hrs-42**

Course Outcomes (COs)
At the end of the course the student will be able to:

COs	Statement	POs
CO1	Discuss the concept and need of optimization in engineering.	PO2,PO3,PO4
CO2	Use conventional methods of optimization under constraints and the concept of linear programming to typical Engineering problems	PO2,PO3
C03	Apply the numerical methods for design optimization problems	PO1,PO3
CO4	Apply genetic algorithms for optimum design of structural elements	PO2,PO4

MODULE – 1

Classical Optimization Techniques: Engineering applications, Statement of optimization problem, Classification of optimization problems, Optimization techniques. Single variable optimization, Multivariable optimization with no constraints, with equality constraints - Lagrange multiplier - method, constrained variation method. **12 Hrs**

MODULE – 2

Linear Programming: Standard form of Linear programming problem, simplex method, two phase simplex method - application problems. **10 Hrs**

MODULE – 3

Design optimization of structural elements. Application Problems: Optimum design of steel structural elements. Algorithms for optimum designs **10 Hrs**

MODULE - 4

Genetic Algorithms: Introduction – fitness function, crossover and mutation - Application problems. **10 Hrs**

Text Books:

1.Rao.S.S - Optimization Theory and Applications, Wiley Eastern Limited,1978. 2.Fox.R.L. - Optimization Methods for Engineering Design, Addison Wesley, 1971

Reference Books:

1. Stark. R.M. Nicholls.R.L., Mathematical Foundations for Design, McGraw Hill Book Company.
2. NarsingkDeo – System simulation with digital computer, Prentice – Hall of India Pvt, Ltd. New Delhi – 1989.

COMPOSITES AND SMART MATERIALS

Course Code 18OECV673 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-3**
CIE-50 marks, SEE-50 marks **Total Hrs-42**

Course Outcomes (COs)
At the end of the course the student will be able to:

COs	Statement	POs
CO1	Illustrate the basic properties and manufacturing process along with their application in various industries for different types of composites	PO2, PO3, PO4
CO2	Identify different classes of ceramic and polymeric smart materials and development of actuators and sensors and their integration into a smart structure	PO2, PO3, PO4
CO3	Analyze the principles in various fields like automobile, space, medical, automotive, building construction, etc.	PO2, PO4, PO7
CO4	Design embedded & surface mounted, piezoelectric devices	PO1, PO3, PO4, PO8

MODULE - 1

Introduction to Composite materials Classifications and applications of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices. Anisotropic elasticity- Unidirectional and anisotropic lamina, thermo- mechanical properties, micro-mechanical analysis, classical composite lamination theory. **13 Hrs**

Self-Study component: Student shall gain knowledge about the innovative composite materials and their applications in civil engineering domain.

MODULE - 2

Anisotropic elasticity Contd....
Cross and angle–plylaminates, symmetric, antisymmetric and general asymmetric laminates, mechanical coupling and laminate stacking**.** **09 Hrs**

Self-Study component: Student shall explore appropriate websites to observe the behaviour of composite material subject to varying temperature

MODULE - 3

Analysis of simple laminated structural elements
Ply-stress and strain, lamina failure theories - first fly failure, environmental effects and manufacturing of composites. **10 Hrs**

Self-Study component: Student shall learn different types of composite materials and their application in aircraft design

MODULE - 4

Smart materials
Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation. **10 Hrs**

Self-Study component: Student shall learn about self-healing materials used in aircraft industry etc

TEXT BOOKS

1. Robert M Jones, "Mechanic of Composite Materials", McGraw Hill Publishing Co.
2. Bhagwan D Agarval, and Lawrence J Brutman, "Analysis and Performance of Fiber Composites", John Willy and Sons.
3. Lecture notes on "Smart Structures", by Inderjith Chopra, Department of Aerospace Engg., University of Maryland.

REFERENCE:

1. Crawley, E and de Luis, J., "Use of piezoelectric actuators as elements of intelligent structures", AIAA Journal, Vol. 25 No 10, Oct 1987, PP 1373-1385.
2. Crawley, E and Anderson, E., "Detailed models of Piezoceramic actuation of beams", Proc. of the 30th AIAA /ASME/ASCE/AHS/ASC- Structural dynamics and material conference, AIAA Washington DC, April 1989

3.

URBAN DESIGN AND REGENERATION

Course Code 18OECV674 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-3**
CIE-50 marks, SEE-50 marks **Total Hrs-42**

Course Outcomes (COs)
At the end of the course the student will be able to

COs	Statement	POs
CO1	Discuss the strategies involved in Urban regeneration.	PO6, PO7
CO2	Interpret the various planning tools regarding the urban assets.	PO6, PO8
CO4	Review the public and private sector roles and relationships and project phasing in the implementation of the urban regeneration projects	PO7, PO8
CO3	Report on the translation of the concepts of urban regeneration in a case study project.	PO9, PO10, PO12

MODULE - 1

Introduction to urban design, Elements of Urban physical form – The domain of Urban Design, Landuse, building form and massing, circulation and parking, open space, pedestrian ways, activity support, signage and preservation. Introduction and the need for urban regeneration – scoping, planning, financing and Implementation. **22 Hrs**

Self-study component: Study of the Review of the Book " The Urban Design Process" by Hamid Shirvani.

MODULE - 2

Urban assets – land, community and environment. Land planning tools, charrettes, tools for public participation. **07 Hrs**

Self study component: Examine the tools for public participation in case studies from the world Bank report Regenerating Urban Land: A Practitioner's Guide to Leveraging Private Investment.

MODULE - 3

Social equity aspects of regeneration. Tools to mitigate the undesirable social impacts of Urban regeneration. **07 Hrs**

Self-study component: Reading of the book "Uses of Disorder" by Richard Senett and short review writing on any one chapter of the book.

MODULE - 4

Mechanisms of implementation of Urban Regeneration projects. Case studies. **06 Hrs**

Self-study component: Collect information and read about Government of India strategies like Swachh Bharat Mission - Urban (SBM-U), Pradhan Mantri Awas Yojana - Urban (PMAY-U), Smart Cities Mission (SCM), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Deendayal Antyodaya Yojana - National Urban Livelihoods Mission (DAY-NULM) and Heritage City Development and Augmentation Yojana (HRIDAY)

Text Books:

1. Hamid Shirvani, "The Urban Design Process" Van Nostrand Reinhold, 1985
2. Amirtahmasebi, Rana, Mariana Orloff, Sameh Wahba, and Andrew Altman. Regenerating Urban Land: A Practitioner's Guide to Leveraging Private Investment. 2016. Urban Development Series. Washington, DC: World Bank. doi: 10.1596/978-1-4648-0473-1. License: Creative Commons Attribution CC BY 3.0 IGO

Reference Books:

1. Urban Regeneration, A Handbook, edited by Peter Roberts and Hugh Skyes. Sage Publications Limited 2008.
2. Ministry of Housing and Urban Affairs, Government of India, "Transforming Urban Landscape" 2014-19

PRINCIPLES OF MANUFACTURING

Course Code 18OEME61 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-3**
CIE-50 marks, SEE-50 marks **Total Hrs-42**

Course Outcomes (COs):

To equip students of other engineering disciplines with the fundamental aspects of manufacturing processes and their applications

At the end of the course the student will be able to

COs	Statement	POs
CO1	Realize the role of manufacturing processes in other engineering branches and learn principles of different metal forming processes	PO6, PO7
CO2	Comprehend the basic principles and recent developments of modern manufacturing processes	PO6, PO8
CO4	Realize the significance of various joining and assembly techniques	PO7, PO8
CO3	Infer the basic concepts and applications of rapid prototyping	PO9, PO10, PO12

MODULE - 1

Introduction and overview of manufacturing: History and concepts of manufacturing, Materials in manufacturing, Classification of manufacturing processes. **Fundamentals of metal forming:** Overview of metal forming, working principle, advantages, limitations and applications of rolling, forging, extrusion, wire and bar drawing, sheet metal operations – shearing, blanking and punching, bending operations – V and Edge bending, drawing, bending of tube stock. **10 Hrs.**

MODULE - 2

Fundamentals of material removal: Traditional vs. Non-traditional machining process, working principle, advantages, limitations and applications of ultrasonic machining, abrasive jet machining, electrochemical

machining – deburring, grinding and honing, chemical machining, laser beam machining, electron beam machining. **10 Hrs.**

MODULE - 3

Fundamentals of joining and assembly processes: Working principle, advantages, limitations and applications of electron beam welding, laser beam welding and ultrasonic welding. **Adhesive bonding:** Materials and their properties, advantages, limitations and applications. **Coatings:** Painting, paint application methods, chemical conversion coatings, electroplating, anodizing, electroless plating, mechanical plating, porcelain enameling, clad materials. **10 Hrs.**

MODULE - 4

Rapid Prototyping: Fundamentals of rapid prototyping, rapid prototyping technologies, application issues in rapid prototyping. **Applications of rapid prototyping:** Processing of integrated circuits, electronics assembly, and packaging, microfabrication technologies, nanofabrication technologies. **10 Hrs.**

Self-Study Component:

- Traditional machining processes in the laboratory.
- Modern manufacturing processes through online virtual labs.
- Case studies on rapid prototyping applications in different industrial sectors.
- Realization of product by modeling simple machine parts or assembly using 3D printing.

Text Book:

1. Mikell, P. Groover. Fundamentals of modern manufacturing: materials, processes and systems. JOHN WILEY, 2019.

Reference Books:

1. Black, J. Temple, and Ronald A. Kohser. DeGarmo's materials and processes in manufacturing. John Wiley & Sons, 2017.
2. Pham, Duc, and Stefan S. Dimov. Rapid manufacturing: the technologies and applications of rapid prototyping and rapid tooling. Springer Science & Business Media, 2012.
3. Production Technology, HMT TATA McGraw Hill 2001 ISBN-0070764432.
4. Adityan, Modern Machining Process, 2002. ISBN-85143774 -11.

INDUSTRIAL ENGINEERING AND ERGONOMICS

Course Code 18OEME62 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Outcomes (COs):
To provide the basic knowledge of productivity and method study, work measurement and ergonomics in various sectors and its effectiveness in improvement of productivity.

At the end of the course the student will be able to

COs	Statement	POs
CO1	explain the fundamental concepts of productivity and work study	PO1, PO6

CO2	to construct the charts on the basis of present method and develop a new / proposed method and identify the unnecessary movements.	PO2, PO6
CO4	apply the concepts of work measurement to solve problems related to work measurement and performance of workers	PO2, PO6
CO3	apply the ergonomic concepts in design of new systems, displays and controls	PO3, PO6

MODULE - 1

PRODUCTIVITY & WORK STUDY: Definition of productivity, individual enterprises, task of management. Productivity of materials, land, building, machine and power. Measurement of productivity, Factors affecting the productivity, Productivity improvement programmes (Simple Problems). Basic work content. Definition, objective and scope of work-study. Human factors in work study. Work study and management, work study and supervision, work study and worker. **10 Hrs.**

MODULE - 2

Method Study and Tools for Method study: Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation – process charts, flow process charts, travel chart and multiple activity charts (Problems).Charts to record moment at work place – principles of motion economy, classification of moments, two handed process chart, SIMO chart,(Problems) **10 Hrs.**

MODULE – 3

WORK MEASUREMENT: Definition, objectives, techniques of work measurement, work sampling, need of confidence levels, sample size determination, random observation with simple problems.

TIME STUDY: Definition, time study equipments, selection of jobs, steps in time study, breaking jobs into elements, recording information, rating, standard performance, scales of rating, factors affecting rate of working, allowances, standard time determination. **10 Hrs.**

MODULE – 4

Ergonomics and Design of Man-Machine System: Introduction, areas of study under ergonomics, System approach to ergonomics model, Man-machine system. Components of man-machine system and their functions Quantitative, qualitative representation and alphanumeric displays. Controls and their design criteria, Control types, Relation between controls and displays. Design of work place. **10 Hrs.**

Self Study:

A brief history of ergonomics, Attempts to 'humanise' work, Anatomy, posture and body mechanics, Some basic body mechanics, Anatomy of the spine and pelvis related to posture, Postural stability and postural adaptation, Low back pain, Risk factors for musculoskeletal disorders in the workplace, Behavioural aspects of posture.

TEXT BOOKS:

1. Work study, ILO, 3rd edition, 2006. ISBN 81-204-0602-8
2. Work Study & Ergonomics, Suresh Dalela & Saurabh, standard publishers & distributors, 1999. ISBN 9780850660085

REFERENCE BOOKS:

1. Introduction to Ergonomics, R. C. Bridger, McGraw Hill Publications. ISBN 978-0-8493-7309-0
2. Industrial Design for Engineers, Mayall W. H. London Hiffee Books Ltd., 1988. ISBN -10-0592042057
3. Human Factor Engineering: Sanders & McCormick McGraw Hill Publications. ISBN 08403 16240

PROJECT MANAGEMENT

Course Code 18OEME63 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Outcomes (COs):
To impart comprehensive understanding of how to plan, optimize and efficiently manage projects (or tasks) to implement products, services or developments.
At the end of the course the student will be able to

COs	Statement	POs
CO1	demonstrate the knowledge of project management, lifecycle, tools and techniques for the success of project	PO9, PO11
CO2	infer the important steps of project planning and provide accurate cost estimates to plan various activities	PO9, PO11
CO3	identify the resources required for a project and to produce a work plan for the application of project scheduling tools and techniques	PO2, PO11
CO4	assess the project performance by companies using various techniques for better project management	PO11
CO5	demonstrate the skills and roles of project managers for software efforts and strategy used to deal with the development of software	PO5, PO11

MODULE - 1

Introduction to Project Management: Concept of project, characteristic features of a project, various definitions of project management, classification of projects, phases of project management, project manager and his responsibilities, PM as a profession, selection of project manager, The 7S of project management.
Project Planning and Estimation: Project planning steps, objectives and goals of the project, Feasibility reports, preparation of cost estimation, evaluation methods for project profitability. **10 Hrs.**

MODULE - 2

Organizing and Staffing the Project Team: Authorities of project manager, organizational structure and types, accountability in project execution, contracts, 3 'R's of contracting, tendering and selection of contractors.
Project Scheduling Tools and Techniques: Gantt chart, bar chart for combined activities, Critical path method (CPM) and Project evaluation and review technique (PERT), Numerical problems. **10 Hrs.**

MODULE - 3

Coordination and Control: Project direction, communication in a project, PMIS, project coordination control, schedule control.
Performance Measures in Project Management: Performance indicators, performance improvement, The CM & DM companies for better project management, project management environment. **10 Hrs.**

MODULE - 4

Software project management: Introduction, computerized project management, managing software projects, overview of capability maturity model (CMM), project management and the CMM. **Case studies on project management:** Case studies on project planning, scheduling, tools and techniques, performance measurement. **10 Hrs.**

Self Study Component:

- History and Evolution of Project Management
- Group of students to take up one mini project and apply various phases of project management. Prepare a report on it.

- Make survey of various software project management tools and use any one tool.

Text Book:

1. Project Management a System approach to planning Scheduling & Controlling- Harold Kerzner, 10th edition 2009, John Wiley & sons.
2. Chaudhry S, Project Execution Plan- Plan for project Execution interaction, 2001

Reference Books:

1. Software Project Management in Practice-Pankaj Jalote, Pearson education
2. Fundamentals of Project Management: Rory Burke, 2010, Burke Publishing.
3. Project planning scheduling & control, James P.Lawis, Meo Publishing Company, 5th edition 2010.
4. A Management Guide to PERT and CPM, WEIST & LEVY -Eastern Economy of PHI 2002.

ROBOTICS FOR ENGINEERS

Course Code 18OEME64 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course objectives:

To make students apply the concepts of robotics to develop robots for industrial applications.

Course Outcomes (COs){with mapping shown against the **Program Outcomes (POs)**}
Upon successful completion of this course, the student shall be able to:

COs	Statement	POs
CO1	Explain the basic concepts of robotics and control systems	PO1, PO2
CO2	apply analytical techniques and principles of robotic design for solving kinematics problems and Lagrange-Euler formulation to solve problems of robot arm dynamics	PO2, PO3
CO3	select suitable sensors and robot teaching method for industrial applications	PO1, PO2
CO4	incorporate the concepts of AI, expert systems and RPLs for industrial applications	PO1, PO3

MODULE - 1

Basic concepts in robotics: Introduction, Definitions, Historical development**,** anatomy, classification, basic configuration including SCARA, geometric and dynamic performance of robots, advantages and applications of robots

Trajectory planning and control systems: structure of robots, trajectory planner, control loops, position representation, encoders, wrist/end effector motion and basic robot control systems **10 Hrs.**

MODULE - 2

Co-ordinate transformations and kinematics: coordinate and vector transformations using matrices, 3-D homogeneous transformations for translation, rotation, mirror imaging and scaling. Relative transformation, Post and pre multiplication of matrices, Direct kinematics, problems on relative transformations

D.H method for direct kinematics and particular solutions of inverse kinematics problem: D.H Convention, D.H table for deriving displacement matrices for basic configuration of robots including PUMA and SCARA robots. IK for a 2-axis planar mechanism and 3-axis spherical mechanism and specific DK and IK solution for PUMA **10 Hrs.**

MODULE - 3

Robot arm dynamics: introduction, Lagrange-Euler formulation: joint velocities of robotic manipulator, KE and PE of robotic manipulator, motion equations of a manipulator with rotary joints, a 2-link manipulator example.

Sensors and application of robots: desirable characteristics and classification of sensors, machine vision system. Applications: loading, unloading, handling, spray painting and welding, assembly, machining and inspection **10 Hrs.**

MODULE - 4

Robot teaching: Methods, online lead through teaching, offline programming languages: history, syntax, structure and statements, typical robot programming for PNP and palletizing operations using VAL-II

AI and expert systems for robotics: introduction, goals of AI research and techniques, introduction to LISP programming language, task planning. Expert systems and Knowledge Engineering: construction and rule based system and future robotics. **10 Hrs.**

Self Study:

Fundamentals of Manufacturing: Production System Facilities, Manufacturing Support Systems, Automation in Production Systems, Automation Principles and Strategies. Automation Basics: Basic Elements of Automated System, Advanced Automation Functions, Levels of Automation.

Text book

1. Yoram Koren, Robotics for Engineers, McGraw Hill International. ISBN: 9780070353992

References books:

1. Mikell P Groover, Industrial Robotics, Weiss, Nagel, McGraw Hill International ISBN: 9780071004428
2. Fu, Lee and Gonzalez, Robotics Control Vision and Intelligence, McGraw Hill International. ISBN: 0070226253.
3. Automation Production Systems and CIM – Mikell P Groover, 3rd Edition, PHI, ISBN- 978-81-203-3418-2

BASIC POWER ELECTRONICS

Course Code 18EE671 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Outcomes (COs):

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

COs	Statement	POs
CO1	Explain the basic switching principle of various power electronic switching devices and their characteristics.	
CO2	Analyze various techniques used to control the power electronic switching devices.	
CO3	Describe working principle AC & DC voltage controllers for R & RL loads, AC-DC & DC-AC converters.	

MODULE - 1

Introduction to Power Electronics, Power conditioning systems, Classification, ideal/practical switch characteristics, power semiconductor devices, Applications of power electronics.

Power Diode: Introduction, V-I characteristics, Reverse Recovery Characteristics, types. **10 Hrs.**

SLC: Selection of power electronic devices of Applications.

MODULE - 2

Power Transistors: Power MOSFETs (n channel enhancement type MOSFET) – Structure, Switching characteristics, Necessity of isolation, Isolation techniques, Gate drive requirements. IGBT- Structure.
Thyristors: Types, Characteristics, Turn-on and turn-off, Thyristor firing circuits (RC firing, UJT firing).
SLC: Digital firing circuits for thyristors. **10 Hrs.**

MODULE - 3

AC Voltage Controllers: Introduction, Principle of ON-OFF control, Single phase Bi-directional phase controller with resistive loads, Single phase controllers with inductive loads (Derivations and problems not included).
DC-DC Converters: Buck converter, Boost Converter, Buck-Boost converter (Derivations and problems not included).
SLC: TRIAC-DIAC combination for AC voltage control. **10 Hrs.**

MODULE - 4

Controlled Rectifiers: Introduction principle & operation of phase controlled converter, single-phase full converter (RL load), single-phase dual converter (RL load), 3-phase full converters (R load). (Derivations and problems not included).
Inverters: Introduction, Single-phase bridge inverters, 3-phase bridge inverter (Derivations and problems not included).
SLC: Significance of Harmonic reduction and power factor improvement in power electronic converters.
10 Hrs.

Text Book:

M.H. Rashid, Power Electronics, 2nd edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.

Reference Books:

1. M D Singh &Kanchandani, Power Electronics, TMH publishing company limited, Reprint 2001.
2. Dr. P.S. Bimbhra, Power Electronics, Khanna Publishers 1996.
3. Joseph Vithyathil, Power Electronics, McGraw Hill, 1995.

ALTERNATE ENERGY SOURCES

Course Code 18EE672 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

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

COs	Statement	POs
CO1	Explain basics of renewable energy sources such as solar wind, tidal etc.	1
CO2	Describe the concepts of the real time solar PV, Solar thermal and Solar Electric Systems	1,2
CO3	Design solar and wind energy system parameters.	1

MODULE - 1

Energy Sources: Renewable energy resources-classifications, advantages, limitations; comparison of conventional & non-conventional energy resources. **Environmental and Ecological Effects of Energy Production and Consumption**: The Greenhouse Effect, Major Consequences of the Greenhouse Effect, Remedial Actions for Global Warming

Solar Energy Basics: Solar constant, Basic sun-Earth angles- definitions & their representation, solar radiation geometry, Estimation of solar radiation of Horizontal & Tilted surfaces SLC: Efficiency of Solar Cells. **10 Hrs**

MODULE - 2

Solar Thermal Systems: Solar Flat plat collectors-mathematical models for energy gain and thermal efficiency, solar cookers-box type, concentrating dish type, solar driers, still furnaces.

Solar Electric Systems: solar thermal electric power generation-solar pond & concentrating solar collector (Parabolic trough, Parabolic dish central tower collector) advantages & disadvantages; solar photovoltaic-solar cell fundamentals, characteristics, Environmental Issues of Solar Energy Utilization. SLC: Solar water heater. **10 Hrs**

MODULE - 3

Wind Energy: Introduction, wind & its properties, wind energy scenario-world & India. Basic principles of wind energy conversion systems (WECS), classification of WECS, part of a WECS. Derivation for power in the wind, electrical power output & capacity factor of WECS, wind site selection consideration, advantages & disadvantages of WECS, Future of Wind Power SLC: Efficiency of Wind Turbines. **10 Hrs.**

MODULE - 4

Biomass Energy: Introduction photosynthesis process, biomass fuels, biomass conversion technologies, Methods of Biomass Utilization, Biomass gasification, Biomass to Ethanol production, factors Affecting Biogas generation, types of Biogas plants – KVIC & Janata Model, Biofuels, Environmental Effects.

Energy From Ocean: Tidal energy – principle of tidal power, components of tidal power plant (TPP), classification of tidal power plants, Systems for Tidal Power Utilization estimation of energy – single basin, Advantages & Limitation of TPP. Ocean thermal energy conversion (OTEC) principle of OTEC system, methods of OTEC power generation – open cycle (Claude cycle), Closed cycle (Anderson cycle), Environmental Effects of Tidal Systems. SLC: Ocean Currents, Wave Power **10 Hrs.**

Text Book:

Rai, G D, Non-conventional sources of energy, 4th Edition, Khanna publishers, New Delhi, 2007.
Efstathios E. (Stathis) Michaelides, 'Alternative Energy Sources', Springer.

Reference Books:

1. Khan B H, Non-conventional energy resources, TMH, New Delhi, 2006
2. Mukherjee, D &Chakraborti S, Fundamentals of Renewable Energy Systems, New Age International Publishers, 2005.

ARM PROCESSOR

Course Code 18OEEC61 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

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

COs	Statement	POs
CO1	Understand ARM7TDMI assembly instructions and their formats and usage.	PO1, PO2
CO2	Ability to understand how various coprocessors are interfaced in core extensions.	PO1, PO2
CO3	Understanding thumb instruction set and its internetworking with ARM	PO1, PO2
CO4	Become very conversant and knowledgeable in C compilers for ARM processor.	PO1, PO2

MODULE - 1

ARM Processor: ARM design Philosophy, Embedded system hardware, embedded system Software.
ARM modes: Registers, Current status program register, Pipelines, Exceptions, Interrupts and vector table, Core Extensions, Architecture revisions, ARM processor families. **10 Hrs.**

MODULE - 2

ARM instruction set: Data processing instructions, Load- store instructions, Branch instructions, Software Interrupt instructions, Program status register instructions, loading constants, ARMv5E Extensions, Conditional execution. **10 Hrs.**

MODULE - 3

Thumb instruction set: Thumb register usage, ARM-THUMB interworking, Branch instructions, Data processing instructions, Single register & Multiple register load-store instructions, Stack instructions, Software interrupt instruction.
Overview of C compilers-I: Basic C data types, C looping structures, register allocation, function calls, pointer aliasing. **10 Hrs.**

MODULE - 4

Overview of C compilers-II: structure arrangement, bit fields, unaligned data and endianness, division, floating point, inline functions and inline assembly and portability issues. **10 Hrs.**

Text Books:

1. **Andrew N. Sloss, Domonic Symes and Chris Wright,** "ARM System Developer's Guide designing and optimizing system and software", Elsevier, Morgan Kaufmann Publishers, 2008

Reference Books:

1. **Raj Kamal,** "Embedded Systems: Architecture and Programming", TMH. 2008
2. "ARM Processor manual", ISM, Bangalore, 2005.

SENSORS AND ACTUATORS

Course Code 18OEEC63 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: The objective of the course is educating students in micro technology and its use to fabricate sensors and systems.
Course Outcomes (COs){with mapping shown against the Program Outcomes (POs)}
Upon completion of the course, students shall be able to :

COs	Statement	POs
CO1	Understand basics of sensors, actuators and their operating principle.	PO1,PO2
CO2	Educate the students on different types of microfabrication techniques for designing and developing sensors (Several applications from Electronics to Biomedical will be covered).	PO1
CO3	Explain working of various types of electrochemical sensors and actuators.	PO3
CO4	Provide information about interfacing of sensors and signal conditioning circuits to establish any control system or monitoring system.	PO4,PO5

MODULE - 1

Basics of Energy Transformation: Transducers, Sensors and Actuators
Understanding of thin film physics: Application in MOSFET and its variants **10 Hrs.**

MODULE - 2

Thin Film Deposition Techniques: Chemical Vapor Deposition (APCVD, LPCVD, UHVCVD, PECVD, ALCVD, HPCVD, MOCVD)

Thin Film Deposition Techniques: Physical Vapor Deposition (Thermal Deposition, E-beam Evaporation, Sputtering, Pulsed Laser Deposition) **10 Hrs.**

MODULE - 3

Photolithography: Basics understanding of Photolithography for pattering layer, Detailed overview of Etching methods.

Understanding various gas sensors: Optical gas sensor, Metal oxide semiconductor gas sensor, Field effect transistor gas sensor, Piezoelectric gas sensor, Polymer gas sensor, Nano-structured based gas sensors.

10 Hrs.

MODULE - 4

Design and fabrication process of Microsensors: Force Sensors, Pressure Sensors, Strain gauges and practical applications

Working principles: Working principles of Actuators. Piezoelectric and Piezoresistive actuators, micropumps and micro actuators with practical applications. **10 Hrs.**

Text books

1. **Stefan Johann Rupitsch, Wiley-Blackwell, Jacob Fraden**, Sensors and Signal Conditioning Handbook of modern sensors, Springer 2008 , .
2. **Senturia S. D,** Piezoelectric Sensors and Actuators: Fundamentals and Applications, Springer, 2018.
3. **J.D.Plummer, M.D.Deal, P.G. Griffin,** Microsystem Design, Kluwer Academic Publisher, 2001

Reference books

1. Selected papers in micro sensors, MEMS devices, smart materials and micro actuators.
2. VLSI Technology, 2nd Edition, McGraw Hill, 1988 Madou
3. Fundamentals of Microfabrication, CRC Press, 1997.

ELEMENTS OF SIGNAL PROCESSING

Course Code 18OEEC66 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: The objective of this course is to make the students to design and simulate digital filters and analyze by comparing different signal processing strategies.

Course Outcomes (COs){with mapping shown against the Program Outcomes (POs)}

Upon completion of the course, students shall be able to :

COs	Statement	POs
CO1	Classify, operate and analyze different signals and systems.	PO1, PO2,
CO2	Apply the properties of DFT and IDFT.	PO1, PO2,
CO3	Design and implement FIR Filters using a window techniques and implement IIR filter using digital frequency transformation.	PO1, PO2, PO3
CO4	Identify the applications of digital signal processing and describe the architectural features of digital signal processor.	PO1, PO2, PO3

MODULE - 1

Introduction: Definitions of a signal and a system, classification of signals, basic Operations on signals, elementary signals, Systems viewed as Interconnections of operations, properties of systems. **10 Hrs.**

MODULE - 2

Discrete Fourier Transform: Frequency domain sampling and reconstruction of discrete time signals. **Properties of DFT**, multiplication of two DFTs –linear convolution, additional DFT properties, Overlap save and add method**. (Text1)** **10 Hrs.**

MODULE - 3

Fast Fourier Transform (FFT) algorithms: Direct computation of DFT, Radix -2 FFT algorithms for the computation of DFT and IDFT –decimation in time (DIT) algorithm**.**
FIR filter design: Introduction to FIR filters using – Rectangular window, FIR filter design using frequency sampling technique. **10 Hrs.**

MODULE - 4

IIR filter design: Characteristics of analog filter- Butterworth filter, Bilinear transforms.
Applications: Audio, image, industrial and medical applications (Theoretical approach only)
Digital Signal Processors: General Architectural features of a Digital Signal Processor. **10 Hrs.**

Text Books:

1. **S.Salivahanan,** "Digital signal processing", TMH, New Delhi, 2nd Edition,2000.
2. **Ganesh D.Rao "**Digital Signal Processing", Pearson Education India, 2010

Reference Books:

1. **P Ramesh Babu,** "Digital Signal Processing", Scitech Publications Pvt. Ltd., 2nd edition,2006
2. **Proakis and Monalakis,** "Digital signal processing--- Principles algorithms and applications", Pearson education, 4th edition, 2007.
3. **Monsoon H Hayes**, "Digital signal processing", Tata McGraw-Hill, New Delhi, 3rdedition, 2008

FUNDAMENTALS OF AUTOMOTIVE ENGINEERING

Course Code 18OEAU61 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: To empower the students to realize fundamental systems of Automotive
Course Outcomes (Cos)
Upon completion of the course, students shall be able to:

COs	Statement	POs
CO1	Identify and describe the basic components of engine and their functions.	1,2
CO2	Explain the gasoline and diesel fuel injection systems.	1
CO3	Explain and familiar with transmission systems of a vehicle.	1,2
CO4	Describe brake, steering and suspension systems	1

MODULE - 1

Basic Engine Components:
Classification of IC Engines, working Principle of Engines [4and2-stroke Petrol and Diesel engine], basic **Engine components** and their functions, Application of IC Engines.
Carburetion and Injection Systems:

Mixture Requirements, Simple Carburetor, Limitations, **Gasoline injection**- Requirements of Fuel Injection systems, Electronic Fuel Injection System-Throttle Body Injection System, MPFI and GDI. **Diesel injection**- Air Injection system, Solid Injection -Individual Pump, Distributor system, Unit Injector system, Common Rail Direct Injection (CRDI), injector types, Mechanical and Pneumatic governors. **10 Hrs.**

MODULE - 2

Ignition System for SI Engines:
Requirements of an Ignition System, types Ignition system[Battery &Magneto], Ignition timing, spark plug, Spark advance Mechanisms, firing order, Electronic Ignition system [TCI and CDI].

Lubrication & Cooling Systems: Lubrication principles, functions of lubricating system, Properties of lubricating oils, additives, classification of lubricating oils, lubricating systems, Need for cooling, Effects of overcooling, Air cooling, Water /fluid cooling, components of fluid cooling, cooling additives. **10 Hrs.**

MODULE - 3

Clutch:
Necessity of clutch, different types of clutches, Clutch materials, Clutch adjustment, fluid coupling, over running clutch, fluid coupling, torque converters, comparison between fluid coupling and torque converters, Clutch troubles and their causes.

GEAR BOX & DIFFERENTIAL
Necessity of gear box, Principle of operation, types of gear boxes-sliding mesh, constant mesh, synchromesh,(Manual and Automatic), description and working of Borg-Warner and general arrangements, electric transmission-working principle. Propeller shaft, types, universal joint, Differential unit, construction and working of differential. **10 Hrs.**

MODULE - 4

Brakes: Functions of brakes, Drum brakes, construction and working, Disc brake, types, construction, comparison between disc and drum brakes. Brake shoes, properties of brake liners, brake liner materials, Mechanical braking system, hydraulic braking system, vacuum servo brakes, engine exhaust brakes, air brakes and hand brakes. Antilock Braking System. **Steering system:** functions of steering system, Components of steering system, steering linkage for rigid axle front suspension and independent front suspension. Types of steering gears, worm and wheel type, cam and roller type, worm and nut type, recirculating ball type. Power steering, electronic power steering system, **Suspension:** Functions of suspension system, types of suspension springs, shock absorber- types of shock absorber, front independent suspension, rear independent suspension, antiroll device, air suspension, hydroelastic suspension. **10 Hrs.**

Text Book:

1.Kripal Singh –"Automobile Engineering – Volume I & II", Standard publishers distributers, New Delhi-2006.

2.R.B Gupta–"Automobile Engineering" – Sathya Prakashan Publishers, New Delhi-2016.

Reference Books:

1.Grouse W H., D.L.Anglin " Automotive Mechanics" **,** McGraw Hill Co. 10thEdn., 2015

2.Crouse W.H. "Automotive Transmissions and Power Trains", McGraw Hill Co. 5thEdn., 2000.

3.Newton K and Steeds. W. "Motor Vehicle", Butter Worths& Co., Publishers Ltd, 1997.

4.Joseph I Heitner, "Automotive mechanics", Affiliated East West Press, New Delhi.

5.N.K Giri, "Automotive Mechanics", Khanna Publication, New Delhi, 2004.

ELECTRIC AND HYBRID VEHICLES TECHNOLOGY

Course Code 18OEAU62 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: To empower the students to realize fundamental systems of Automotive

Course Outcomes (Cos)

Upon completion of the course, students shall be able to:

COs	Statement	POs
CO1	Explain principles of electric vehicle technology and their components.	1
CO2	Explain the basics of hybrid and electric drive trains.	2
CO3	Perform design calculations of hybrid systems.	1,2
CO4	Design the various vehicle power sources in hybrid vehicle technology.	2

MODULE - 1

Electric Vehicle Propulsion and Energy Sources

Introduction, vehicle Mechanics - Kinetics and Dynamics, Roadway, Fundamentals, Propulsion System Design - Force Velocity Characteristics, Calculation of Tractive Power and Energy Required. Electric Vehicle Power Source - Battery Capacity, State Of Charge and Discharge, Specific Energy, Specific Power, Ragone Plot Battery Modelling - Run Time Battery Model, First Principle Model, Battery Management System- SOC Measurement, Battery Cell Balancing. Traction Batteries - Nickel Metal Hydride Battery, Li-Ion, Li-Polymer Battery. **10 Hrs.**

MODULE - 2

Electric Vehicle Power plant and Drives

Introduction, Electric Vehicle Power Plants, Induction Machines, Permanent Magnet Machines, Switch Reluctance Machines, Power Electronic Converters-DC/DC Converters - Buck Boost Converter, Isolated DC/DC Converter, Two Quadrant Chopper and Switching Modes, AC Drives- PWM, Current Control Method , Switch Reluctance Machine Drives - Voltage Control, Current Control. **10 Hrs.**

MODULE - 3

Hybrid and Electric Drive trains

Introduction, Hybrid Electric Vehicles, History and Social Importance. Impact of Modern Drive Trains in Energy Supplies, Hybrid Traction and Electric Traction. Hybrid and Electric Drive Train Topologies. Power Flow Control and Energy Efficiency Analysis, Configuration and Control of DC Motor Drives and Induction to Motor Drives. Permanent Magnet Motor Drives, Switch Reluctance Motor Drives, Drive System Efficiency. **10 Hrs.**

Electric and Hybrid Vehicles

Parallel Hybrid, Series Hybrid -Charge Sustaining, Charge depleting Hybrid Vehicle Case Study –Toyota Prius, Honda Insight, Chevrolet Volt V System for Traction Applications. Lightly Hybridized Vehicles and Low Voltage System. Electric Vehicle Case Study - GM EV1,Nissan Leaf, Mitsubishi Miev, Hybrid Electric Heavy Duty Vehicles, Fuel Cell Heavy Duty Vehicles **10 Hrs.**

MODULE - 4

Electric and Hybrid Vehicle Design

Introduction, Hybrid Vehicle Design. Matching the Electric Machine and The Internal Combustion Engine Sizing of Propulsion Motor, Power Electronics, Drive System. Selection of Energy Storage Technology, Communications, Supporting Subsystem. Energy Management Strategies In Hybrid And Electric Vehicles - Energy Management Strategies- Classification, Comparison, Implementation, Design Of A Hybrid Electric Vehicle. Design of A Battery Electric Vehicle. **10 Hrs.**

Text Books

1. Iqbal Hussain, "Electric and Hybrid vehicles Design Fundamentals", CRC Press, second Edition, 2013.
2. James Larminie, John Lowry, "Electric vehicle Technology Explained" second Edition, Wiley, 2012.

Reference Books/Other Reading Material

1. Ali Emadi, "Handbook of Automotive Power Electronics and Motor Drives", CRC Press 2005.
2. Ali Emadi, Mehrdad Ehsani, John M. Muller,"Vehicular Electric Power Systems" Marcel Dekker, Inc., 2004.

3D PRINTING AND PROTOTYPING

Course Code 18OEIP61 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: The course enable students to conceive, design, and implement products quickly and effectively, Using the latest Additive Manufacturing methods and CAD/CAM technology .The students learn to Differentiate various process and process parameters associated with Additive Manufacturing (AM) techniques

Course Outcomes (Cos)

Upon completion of the course, students shall be able to:

COs	Statement	POs
CO1	describe the concepts of AM design stages and methods	PO1, PSO1
CO2	assess and implement rapid tooling technologies available	PO1, PSO5
CO3	apply the basic principles of Rapid Prototyping (RP), Rapid Tooling (RT), technologies to product development	PO1, PSO5
CO4	apply the Rapid Prototyping for engineering and medical applications	PO1
CO5	utilize the process of Additive Manufacturing in a manufacturing process, such as tool-making, model-making or pattern-making	PO2, PSO3
CO6	apply the technology for optimizing geometries with multiple components in assembly and simplifying it into fewer sub components or assemblies	PO1, PSO12, PSO1

MODULE - 1

Development of Additive Manufacturing (AM) Technology: Introduction, The Generic AM Process, Why Use the Term Additive Manufacturing, The Benefits and Limitations of AM, Distinction between AM and CNC Machining, Related Technologies. Classification of AM Processes, Design for AM.

Rapid Prototyping Introduction: Rapid prototyping-An integral part of time compression Engineering, RP Data Formats, RP Information workflow, Role of prototype, types of prototypes **10 Hrs**

MODULE - 2

Rapid Prototyping Processes: Classification of Rapid prototyping processes, Stereo Lithography Systems: Principle, Process of operation, Technical characteristics and Machine details, Stereo Lithography build pattern, Advantages, Limitations, Application

Solid Ground Curing: Principle of operation, Technical characteristics Machine details, Advantages, Limitations, Applications. Ballistic Particle Manufacture.

Fusion Deposition Modeling: Principle, Process Parameter, Advantages, Limitations, Applications.

10 Hrs

MODULE - 3

Selective Laser Sintering: Type of machine, Principle of operation, process Parameter, raw materials used, Advantages and Limitations, Applications. Three-Dimensional Printer.

Laminated Object Manufacturing: Principle of operation, LOM materials Process details, Application and Laser Engineering Net Shaping process.

Direct Methods and Indirect Methods for Rapid Tool Production: Classification of direct rapid tool methods, Laminated Object manufactured tools, rapid steel, 1.0, Metal deposition tool, cast metal tools, investment casting, sand casting, keltool Process. **10 Hrs**

MODULE - 4

Powder Metallurgy: Basic steps in Powder Metallurgy, Brief description of methods of production of metal powders, Conditioning and blending of powders, Compaction and sintering, Applications and advantages and limitation

Application of Rapid Prototyping and Tooling Technology: Pattern for investment and Vacuum casting, medical models, Engineering analysis models. Insert Design and Insert Finishing. **10 Hrs**

Text Books

1. Gibson l D, W. Rosen , B. Stucker **Additive Manufacturing Technologies,** ISBN: 978-1-4419-1119-3, Springer.
2. D.T. Pham and S.S. Dimov – **Rapid Manufacturing, Springer London, Limited.**
3. Paul F.Jacobs **– " Stereo lithography and other RP & M Technologies",** SME.

References

Flham D.T &Dinjoy S.S –**" Rapid Manufacturing "** Verlog London.

TOTAL QUALITY MANAGEMENT AND OPERATIONAL EXCELLENCE

Course Code 18OEIP62 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: To understand the philosophy and core values of Total Quality Management (TQM), determine the voice of the customer and the impact of quality on economic performance and long-term business success of an organization, apply and evaluate best practices for the attainment of total quality.

Course Outcomes (Cos)

Upon completion of the course, students shall be able to:

COs	Statement	POs
CO1	describe the contribution of various quality Gurus to achieve total quality management.	PO1, PO2
CO2	implement quality concepts and techniques to improve process performance in all aspects of firms operation	PO1, PO3
CO3	utilize basic tools and develop strategies for continuous process improvement considering customers requirements	PO1, PO5
CO4	implementation of proactive improvement using QC steps and its tools	PO2, PO4
CO5	describe the importance of Total participation and utilize various strategies for Total participation	PO4, PO9
CO6	learn from the network companies	PO3, PO4

MODULE - 1

Overview of Total Quality Management: History of TQM, contribution of quality gurus-Deming's approach, Juran's quality trilogy, Crosby and quality treatment, Ishikawa's company wide quality control and Feigenbaum's theory of TQC.

Evolution of Quality Concepts and Methods:Quality concepts, development of the four fitness, evolution of methodology, quality of conformance versus quality of design, from deviations to weaknesses to opportunities, future fitness. Four revolutions in management thinking and four levels of practice. **10 Hrs.**

MODULE - 2

Focus on Customers: Change in the work concept, Market-in, customers, continuous improvement, Improvement as a problem solving process, management by process, WV model of continuous improvement, process control, process control and process improvement, process versus creativity.

Reactive improvement: Identifying the problem, the Standard 7 QC Steps and the 7QC Tools. **10 Hrs**

MODULE - 3

Proactive Improvement: Introduction to Proactive Improvement, Toward standard steps for proactive improvement, Semantics, Customer Visitation, Seven key points of customer visitation, Applying Proactive Improvement to develop new products: three stages and nine steps.

Total Participation: Teamwork Skill, The Dual function of work, Teams and Teamwork, Participation, Principles of Activating Teamwork, Creativity in Team processes, Initiation strategies, CEO involvement.

10 Hrs.

MODULE - 4

Infrastructure for Mobilization: Goal setting, Organization setting, Training and Education, Promotional Activities, Diffusion of success stories, Awards and Incentives, Phase-In, Orientation phase, Empowerment phase and Alignment phase.

Societal Networking: Networking and societal diffusion – regional and nation wide networking, infrastructure for networking, openness with real cases, change agents, dynamics of a societal learning system.

Performance measurement Frameworks: Performance Measurement and Improvement Cycle, Cost of Quality (CoQ), Drivers of CoQ, The Process model for quality costing, A performance measurement frame work. Implementation of performance measurement systems. **10 Hrs**

Text Books

1. ANew American TQM Four Practical Revolutions in Management, Shoji shiba, Alan Graham and David Walden, Productivity Press, Portlans (USA). 2010
2. Management for Total Quality, N Logothetis, Prentice Hall of India, New Delhi 2013
3. Total Quality Management and Operational Excellence, John S Oakland , Routledge, Taylor and Francis Group, London and New York 2014

References Books

1. The Quality Improvement Hand Book, Roger C Swanson, Publisher Vanity books International, New Delhi 2015

INDUSTRIAL INSTRUMENTATION

Course Code 18OEEI61 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Outcomes (Cos)

Upon completion of the course, students shall be able to:

COs	Statement	POs
CO1	Distinguish functional elements of a system and classify the transducer.	
CO2	Define the static characteristics of instruments.	
CO3	Explain resistive, capacitive and inductive transducer based on their working principle.	
CO4	Illustrate various techniques for temperature, low and medium pressure measurement	
CO5	Employ specified flow and level meters for industrial applications based on their classification	

MODULE-1

Introduction: Functional elements of an instrument: analog & digital modes of operation, I/O configuration of measuring instruments & instrument system- methods of correction for interfering & modifying inputs

Definition of a transducer, Active and Passive Transducers, Primary and Secondary Transducers, Advantages of Electrical Transducers and Selection of Transducers. **Static Characteristics of Instruments:** Definition, Static Calibration, Static Error & correction, accuracy & Precision, linearity, Resolution & Threshold, Sensitivity, Reproducibility, Repeatability, Range, Span and Bias, Drift, Dead time & Dead zone, Hysteresis, Stability.

Self-study component: Study of various types of errors, Relationship with various static characteristics.

10 Hrs

MODULE-2

Displacement and Force Transducers: Potentiometers: Characteristics, loading effect, Linearity & sensitivity, advantages & disadvantages of Resistive potentiometers, Strain gauge: theory, Linear variable differential Transformer (LVDT): Principles, characteristics, advantages, disadvantages, applications

Capacitive Transducers using change in area of plates, distance between plates, & change of dielectric constants, advantages and disadvantages of Capacitive Transducers

Self-study component: RVDT, Variable Inductance and Reluctance pickups.

10 Hrs

MODULE-3

Temperature Measurement: Thermistors, RTD, Thermoelectric sensor – laws and effects of thermocouples, reference junction consideration, Black body-tipped fiber optic radiation thermometer.

Pressure Measurement: Introduction, manometers, Bourdon Pressure Gauge, Low pressure measurement-thermocouple vacuum gauge, pirani thermal conductivity gauge, ionization gauge, Knudsen gauge.

Self-study component: McLeod gage.

10 Hrs

MODULE-4

Flow Measurement: Bernoulli's principle, orifice meters, rotameter, target flow meter, turbine flow meter, , Electromagnetic flow meters.

Level Measurement: Direct Liquid Level measurements: Dip-stick method, sight glass method, hook gauge, float gauge indirect Liquid Level measurements: hydrostatic pressure level measurement device, capacitance level gauge, ultrasonic level gauge, nucleonic gauge.

Self-Learning Component: venture meters, flow nozzle and ultrasonic flow meters.

Text Books:

1. **Electrical & Electronic Measurements &Instrumentation**, A.K. Sawhney, 17th edition.
2. **Instrumentation Measurement and analysis**, B.C.Nakra and K.K.Chaudhry, TMH,2002.

Reference Books:

1. **Measurement Techniques**, E.O.Doeblin, 6th edition, McGraw Hill publications
2. **Transducers and Instrumentation**, D.V.S Murthy, PHI.

E Books:

1. http://nptel.ac.in/courses/112103174/pdf/mod2.pdf
2. http://nptel.iitg.ernet.in/courses/Elec_Engg/IIT%20Bombay/Electrical%20and%20Electronic%20Measurements.html
3. http://www.nptelvideos.in/2012/11/industrial-instrumentation.html
4. http://onlinevideolecture.com/?course_id=385&lecture_no=32
5. http://nptel.iitg.ernet.in/courses/Elec_Engg/IIT%20Bombay/Electrical%20and%20Electronic%20Measurements.htm
6. http://www.nptelvideos.in/2012/11/industrial-instrumentation.html

MOOCs:

1. http://nptel.ac.in/courses/112103174/3
2. http://nptel.ac.in/courses/112103174/3

MEDICAL ELECTRONICS

Course Code 18OEEI62 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-04**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Outcomes (Cos)
Upon completion of the course, students shall be able to:

COs	Statement	POs
CO1	Explain fundamentals of nature, behavior and acquisition of biomedical signals	
CO2	Measure cardiac parameters using ECG	
CO3	Apprehend working of EEG and its computerized analysis	
CO4	Explain functioning of various instruments in patient monitoring systems	
CO5	Use of various life saving biomedical instruments on humans	
CO6	Adopt safety aspects and testing of biomedical equipments	

MODULE 1

Fundamentals: Sources of biomedical signals, basic medical instrumentation system, general constraints in design of biomedical instrumentation systems. electrodes for ECG, EEG, EMG.
Electrocardiograph: Electrical activity of heart, block diagram of electrocardiograph, ECG Leads system, effects of artifacts on ECG recordings. Electroencephalograph: Typical EEG signal waveform, block diagram of Electroencephalograph.
Self study: Bioelectric signals and electrodes: Origin of bioelectric signals, recording electrodes, Electrode-tissue interface, polarization, Computerized EEG analysis

10 Hrs

MODULE 2

Patient monitoring system: Bedside patient monitoring system, , heart rate measurement-, instantaneous heart rate meter, measurement of pulse rate.
Blood pressure and respiration rate measurement: Direct method of BP measurement (fluid filled system), indirect methods-Korotkoff method, Rheographic method, and Ultrasonic Doppler shift method. Measurement of respiration rate, CO2 method.
Self study: central monitors, average heart rate meter, Oscillometric method, Impedance pneumography.

10 Hrs

MODULE 3

Blood flow meters: Ultrasonic Doppler shift blood flow meter, NMR blood flow meter, Laser Doppler blood flow meter.
Cardiac pacemakers: Need for cardiac pacemakers, External pacemakers, Types of implantable pacemakers, Ventricular synchronous demand pacemakers.
Self study: Square wave Electromagnetic blood flow meter, , programmable pacemaker, , rate responsive pacemakers

10 Hrs

MODULE 4

Cardiac Arrhythmia: Arrhythmia monitor, ST/AR Arrhythmia algorithm, , detection of ventricular fibrillation, exercise stress testing.
Patient safety: Electric shock hazards, Gross shock, effects of electric currents on human body, micro current shock, types of leakage currents, precautions to minimize electric shock hazards,
Self study: data compression and processing of ECG by AZTEC, , electro physiology of ventricular fibrillation, testing of biomedical equipment.

10 Hrs

Text Book:

1. **Handbook of Biomedical Instrumentation**, -R.S.Khandpur- Tata Mc-grawhill Co.2003 2nd Edition

Reference Books:

1. **Introduction to biomedical equipment technology**-Joseph.J.Corr and John.M.Brown,, Pearson education., 4th Edition, 2001

2. **Principles of applied biomedical Instruments**-Leslie Cromwell and John M Brown,Pearson education, 4th Edition, 2004

E-Books:

1.http://www.ebook3000.com/Introduction-to-Biomedical-Instrumentation--The-Technology-of-Patient-Care_51854.html

2. Barbara Christe, Introduction to Biomedical Instrumentation: The Technology of Patient Care, Cambridge University Press | 2009 | ISBN: 0521515122

MOOCs:

1. Ma, Hongshen. 2.996 Biomedical Devices Design Laboratory, Fall 2007. (MIT OpenCourseWare: Massachusetts Institute of Technology), http://ocw.mit.edu/courses/mechanical-engineering/2-996-biomedical-devices-design-laboratory-fall-2007 (Accessed 27 Jul, 2014). License: Creative Commons BY-NC-SA

2. Lauffenburger, Douglas, Paul Matsudaira, Biological Engineering Faculty, and Angela Belcher. 20.010J Introduction to Bioengineering (BE.010J), Spring 2006. (MIT OpenCourseWare: Massachusetts Institute of Technology), http://ocw.mit.edu/courses/biological-engineering/20-010j-introduction-to-bioengineering-be-010j-spring-2006 (Accessed 26 Jul, 2014). License: Creative Commons BY-NC-SA

INTRODUCTION TO CLOUD COMPUTING

Course Code 18OECS61 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: To provide students with the fundamentals and essentials of Cloud Computing.

Course Outcomes (Cos)
Upon completion of the course, students shall be able to:

COs	Statement	POs
CO1	Apply the knowledge for the identification of architecture and infrastructure for Cloud Computing.	PO2,PO5
CO2	Understand the cloud computing technology and cloud storage	PO2,PO4
CO3	Understanding the systems, protocols and mechanisms to support cloud computing	PO5,PO8
CO4	Understand concept of software plus services, local clouds and thin clients	PO3,PO5
CO5	Develop applications for cloud computing	PO7,PO6

MODULE – 1

Cloud computing basics: cloud computing overview, deployment models applications, intranets and the cloud first movers in the cloud**. Your organization and cloud computing:** when you can use cloud computing, benefits limitations, security concerns, regulatory issues **10 Hrs**

MODULE – 2

Cloud computing with the titans: google, Microsoft, Amazon, salesforce.com **the business case for going to the cloud:** cloud computing services, how those applications help your business, deleting your datacenter, thomsons routers .**Cloud computing technology:** hardware and infrastructure: clients, security, network, services, **Accessing cloud**: platforms, web applications, web APIs, web browsers.

10 Hrs

MODULE – 3

Cloud storage: overview, cloud storage providers, **standards**: application, client, infrastructure, service.
Cloud computing at work: software as a service: overview, driving forces, company offerings, industries.

Software plus services: overview, mobile device integration, providers, Microsoft online.

10 Hrs

MODULE – 4

Software plus services(contd…) Developing applications: Google, Microsoft, troubleshooting, Application management. **Local clouds and thin clients**: virtualization in your organization, server solutions, thin clients, case study. **Migrating to the cloud:** cloud services for individuals, cloud services aimed at mid market, enterprise class cloud offerings, migration. **10 Hrs**

Text Books:

1. Cloud Computing- A practical approach, McGraw Hill publication, Anthony T. Velte, Toby J. Velte, Robert Elsenpeter

Reference Books:

1. Cloud Computing: Theory and Practice, Dan C Marinescue, first edition, MK publishers
2. Mastering Cloud Computing, McGraw Hill publication, RajkumarBuyya, Christian Vecchiola, S.ThamaraiSelvi

INTRODUCTION TO DATA MINING

Course Code 18OECS62 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: To develop skill in selecting the appropriate data mining algorithm for solving practical problems.

Course Outcomes (COs): At the end of the course the student will be able to:

COs	Statements	POs
CO1	Describe different data mining tasks and the algorithms and hence carry out data mining projects.	PO1,PO2, PO3
CO2	Deal with data related issues that need to be addressed for successful data mining to be carried out.	PO1,PO3
CO3	To characterize the kinds of patterns that can be discovered by association rule mining, classification and clustering	PO1,PO3
CO4	Identify the scenarios for applying data mining	PO3,PO4

MODULE - 1

What is Data Mining? Motivating Challenges; The origins of data mining; Data Mining Tasks. Types of Data; Data Quality.

Data Pre-processing- Sampling, Aggregation, Dimensionality reduction, Feature subset selection, Discritization & binarization Measures of Similarity and Dissimilarity. **10 Hrs**

MODULE - 2

Classification

Preliminaries; General approach to solving a classification problem; Decision tree induction – Hunts algorithm, Decision tree induction algorithm.Rule-based classifier How to build a rule based classifier, Direct and indirect methods for rule extraction; Nearest-neighbor classifier.

Association Analysis Problem Definition; Frequent Itemset generation **10 Hrs**

MODULE - 3

Association Analysis Continued -

Rule Generation; Compact representation of frequent itemsets Alternative methods for generating frequent itemsets. FP-Growth algorithm, Evaluation of association patterns, Effect of skewed support distribution; Sequential patterns**.** **10 Hrs**

MODULE - 4

Cluster Analysis

Overview, K-means, Agglomerative hierarchical clustering, DBSCAN.

Applications- Data mining applications; Data mining system products and research prototypes; Additional themes on Data mining; Social impact of Data mining; Trends in Data mining. **10 Hrs**

Text Books:

Pang-Ning Tan, Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Pearson Education, 2017.

Reference Books:

1. K.P.Soman, ShyamDiwakar, V.Ajay, Insight into Data Mining – Theory and Practice, PHI, 2006.
Jiawei Han and MichelineKamber, Data Mining – Concepts and Techniques, Morgan Kaufmann, 2nd Edition, 2006

WEB TECHNOLOGIES

Course Code 18OEIS61 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: Students will be able to develop web applications.
Course Outcomes: At the end of the course, student will be able to:

COs	Statements	POs
CO1	Explain the fundamentals of world wide web and web programming languages such as HTML, XHTML, Java script, PHP, AJAX and mysql database system.	PO1
CO2	Apply the different scripting languages for dynamic web page development.	PO1,
CO3	Design and develop web solutions for given requirements.	PO2, PO3

MODULE - 1

Fundamentals of Web: A Brief Introduction to the Internet, The World Wide Web, Web Browsers, Web Servers, Uniform Resource Locators, Multipurpose Internet Mail Extensions, HTTP, Security.

XHTML: Origins and Evolution of HTML and XHTML, Basic Syntax, Standard XHTML Document Structure, Basic Text Markup, Images, Hypertext Tables, Forms, The Audio Element, The Video Element, Syntactic Difference between HTML and XHTML**.** **10 Hrs**

MODULE - 2

Cascading Style Sheets: Sheets, Style Specification Formats, Selector Forms, Property Value Forms, Font Properties, List Properties, Colour, Alignment of Text, The Box Model, Background Images, The and Tags, Conflict Resolution.

The Basics of JavaScript: Overview of JavaScript, Object Orientation and JavaScript, General Syntactic Characteristics, Primitives, Operations, and Expressions, Screen Output and Keyboard Input, Control Statements, Object Creation, and Modification, Arrays, Functions, Constructors, Pattern Matching Using Regular Expressions, Errors in Scripts. **10 Hrs**

MODULE - 3

JavaScript and XHTML Documents: The JavaScript Execution Environment, The Document Object Model, Element Access in JavaScript, Events and Event Handling, Handling Events from Body Elements, Handling Events from Button Elements, Handling Events from The Text Box and Password Elements

Dynamic Documents with JavaScript: Introduction, Positioning Elements, Moving Elements, Element Visibility, Changing Colours and Fonts.

Introduction to XML: Introduction, uses of XML, The Syntax of XML, XML Document Structure, Namespaces, XML Schemas, Displaying Raw XML Documents, Displaying XML Documents with CSS. **10 Hrs**

MODULE - 4

Introduction to PHP: Origins and Uses of PHP, Overview of PHP, General Syntactic Characteristics, Primitives, Operations and Expressions, Output, Control Statements, Arrays, Functions, Pattern Matching.

Database Access Through the Web: Relational Databases, An introduction to Structured Query Language (Review), Architectures for Database Access, The MySQL Database System, Database Access with PHP and MySQL**.** **10 Hrs**

Text Books:

1. Robert W. Sebesta, "Programming the World Wide Web", 8th Edition, Pearson Education, 2014.

Reference Books:

1. Chris Bates, "Web Programming Building Internet Applications", 3rd Edition, Wiley India, 2014
1. James Lee, Brent Ware, "Open Source Web Development with LAMP", Pearson Education, 2013

PYTHON PROGRAMMING

Course Code 18OEIS64 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: Students will be able to develop web applications.

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

COs	Statements	POs
CO1	Describe Syntax, Semantics, create Functions, Handle Strings and Files, Lists Dictionaries and Regular expressions in Python	PO1, PO2
CO2	Implement Object Oriented Programming concepts in Python	PO2, PO3
CO3	Build Web Services and introduction to Network and Database Programming in Python	PO1, PO2, PO3

MODULE - 1

Why should you learn to write programs, Variables, expressions and statements, Conditional execution, Functions, Iteration.

10 Hrs

MODULE - 2

Strings, Files, Lists, Dictionaries, Tuples, Regular Expressions

10 Hrs

MODULE - 3

Classes and objects, Classes and functions, Classes and methods

10 Hrs

MODULE - 4

Networked programs, Using Web Services, Using databases and SQL.

10 Hrs

Text Books:

1. Charles R. Severance, "Python for Everybody: Exploring Data Using Python 3", 1st Edition, Create Space Independent Publishing Platform, 2016. (http://do1.drchuck.com/pythonlearn/EN_us/pythonlearn.pdf)

2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2ndEdition, Green Tea Press, 2015. (http://greenteapress.com/thinkpython2/thinkpython2.pdf) (Download pdf files from the above links)

Reference Books:

1. Gowrishankar S, Veena A, "Introduction to Python Programming", 1st Edition, CRC Press/Taylor & Francis, 2018. ISBN-13: 978-0815394372

INTRODUCTION TO NANOTECHNOLOGY AND QUANTUM SCIENCE

Course Code 18OEPH01 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-40**

Course Objective: Objective of the course is to make the students learn basic principles of nanoscience and application of as derived understanding in advanced nanotechnology and quantum science.

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

COs	Statements	POs
CO1	Interpret the basic interdisciplinary nature of nanotechnology.	PO1, PO2
CO2	Illustrate the synthesis and characterization methods of nanomaterial.	PO1, PO2
CO3	Discuss the properties and applications of nanotechnology.	PO1, PO9
CO4	Demonstrate the usage of basic principles in quantum computing.	PO1, PO2

MODULE - 1

Introduction:
Origin of nanotechnology, types of nanomaterials (including free stand and substrate supported), properties of nanomaterials, nanoparticles and quantum confinement – 0D, 1D & 2D. Influence of size on properties and their characterization of materials. **08 Hrs.**

MODULE - 2

Synthesis of Nanomaterials

Synthesis approaches; Bottom-up and top-down.

Physical methods: vacuum evaporation, sputtering techniques (DC, RF, thermal evaporation).

Chemical methods: Electroplating, spray pyrolysis, chemical vapour deposition (CVD), sol-gel process: screen printing, solution based techniques, hydrothermal method. **08 Hrs.**

MODULE - 3

Characterizations and applications of nanomaterials

UV-Visible spectroscopy, Fourier Transform infrared spectroscopy (FTIR), X-Ray Diffraction (XRD). **Microscopy:** Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM).

Applications of Nanotechnology: LED, Solar cell, Transistors, MEMS and NEMS. **08 Hrs.**

MODULE - 4

Quantum nanoscience

Principles of quantum mechanics, introduction to quantum computers, qubits and working principle of their different types, Bloch sphere, quantum logic gates, quantum algorithms, construction of quantum computers. **08 Hrs.**

Text Books:

1. **Nano: The Essentials: Understanding Nanoscience and Nanotecnology**, T. Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
2. **Nanoscale Science and Technology**, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.

Reference Books:

1. **Introduction to Nanotechnology**, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
2. **Principles of Nanotechnology,** Phanikumar (Scitech Publications, Chennai).
3. **Quantum computation and quantum information** - Michael A. Nielsen, Isaac L. Chuang - Cambridge University Press, 2004.

INDUSTRIAL CHEMISTRY

Course Code 18OECH01 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-100 marks **Total Hrs-42**

MODULE - 1

Ceramics, cement and paints

Ceramics: Introduction: Classification, general properties of ceramics - permeable and impermeable wares and distinguish between permeable and impermeable wares. Basic raw material for clay - feldspar and sand. Properties of clay. Manufacturing process of clay. Applications of earthen wares, stone wares, porcelain, sanitary wares and tiles.

Cement: Introduction: types of cement, sulphate resistant cement, water proof cement, slag cement, acid resistant cement, super sulphate cement, white cement, raw materials, manufacture with reactions in the kiln, mixing of additives to the cement, properties of the cements – quality, shrinkage, setting and hardening of cement, testing of the cement and applications. Use of fly ash as cementing material.

Paints: Introduction: classification, requirements of good paints, raw material, manufacturing of paints, setting of paints, importance of PVC, paint failure, types of paints - distemper, emulsion paints, latex, luminescent paints, fire retardant and heat retardant paints. Methods of applying paints, varnishes, raw materials, manufacture of varnishes, solvents and thinners. **12 Hrs**

MODULE - 2

Corrosion and its control

Introduction to corrosion, theories of corrosion – chemical and electrochemical theory of corrosion, types of corrosion- galvanic corrosion, pitting corrosion, differential aeration corrosion (waterline corrosion & stress corrosion), differential metal corrosion and caustic embrittlement, galvanic series, passivity, factors affecting corrosion – nature of metal, nature of the corrosion product, the ratio of anodic to cathodic area, hydrogen over voltage, temperature, pH, difference in potential between anodic and cathodic areas, presence of oxidizing agents, **Corrosion control** – protective coatings (Electroplating and electroless coating), metallic, organic, inorganic (phosphate coating and chromate coating), corrosion inhibitors (cathodic and anodic), cathodic and anodic protection. Corrosion and scale resistant alloys (introduction with examples).

10 Hrs

MODULE - 3

Sewage treatment

Introduction: sources, constituents of sewage, aerobic and anaerobic oxidations. Types of sewage treatment - primary treatment, secondary treatment, and tertiary treatment, primary treatment- screening, sedimentation. Secondary treatment- coagulation, trickling filter method, activated sludge method. Tertiary treatment- disinfection by chlorination, chloramine, passing ozone and UV radiation.

Biological Oxygen Demand (BOD) – Definition, parameters and determination.

Chemical Oxygen Demand (COD) – Definition, parameters and determination. Numerical problems on COD. Water for municipal supply. **Chemical analysis of water** – determination of total hardness, alkalinity, nitrate, sulphate, chloride, fluoride and total dissolved solids (TDS). **10 Hrs**

MODULE - 4

Pollution and its control

Introduction: Environmental segments – atmosphere, hydrosphere, lithosphere and biosphere. Environmental pollution: Types of pollution - air pollution, water pollution, thermal pollution, noise pollution, radioactive pollution. Types of pollutants – primary pollutants [$(CO)_x$, $(NO)_x$, $(SO)_x$, dust, smoke, smog] and secondary pollutants. Air segments - troposphere, stratosphere, mesosphere and thermosphere. Greenhouse effect, acid rain, photochemical smog, chlorofluorocarbons, ozone and its importance, particulate matters - sources, ill effects, reactions and control of pollution. Effect of air pollution on human beings, animals, plants, materials and on climate.

Solid waste management: Sources, types of solid wastes, processing of solid wastes, recycling of solid wastes, **E wastes –** sources and ill effects.

Environmental laws and regulations: Central pollution control board, ministry of environment and forest, center for science and environment, environmental laws – water and air. **10 Hrs**

Text Books

1. Industrial Chemistry by B. K. Sharma, Krishna prakashan media (P) Ltd. Meerut (UP)
2. Engineering Chemistry by Shika Agarwal, Cambridge university press. Daryaganj. delhi

Reference Books

1. Environmental Chemistry by A. K. De, Eight edition, New age international publishers. New Delhi.
2. A textbook of Engineering Chemistry by Dr. Sunitha Rattan, S. K. Kataria& sons. New Delhi.
3. A text book of Engineering chemistry by Jain & Jain, Dhanpatatrai publications, New delhi.

LINEAR ALGEBRA AND ITS APPLICATIONS

Course Code 18OEMA02 **L-T-P-C 3-0-0-3**
Exam Hrs-3 **Hrs/week-03**
CIE-50 marks, SEE-50 marks **Total Hrs-42**

Course Objective:

Students will learn advanced methods in linear algebra and its applications.

Course outcomes: Having studied this course, students will be able to**:**

COs	Statements	PO1	PO2	PO3
CO1	Apply suitable solution procedure to solve the linear models of business, engineering and matrix factorisation to applications such as computer graphics	2	2	1
CO2	To compute suitable matrices arising in magnification, rotation of images using the knowledge of vector space, matrix of linear transformations	2	2	1
CO3	Solve the application-oriented problems connected with difference equations, Markov chain, discrete dynamical systems by using the concept of Eigen values, Eigen vectors	2	1	1
CO4	Apply the techniques of QR and singular value decomposition, for data compression.	2	1	1

MODULE – 1

Solution sets of Linear systems-homogeneous and non-homogeneous, applications of linear systems, linear independence of vectors, linear models in business and engineering, Partioned matrices, Matrix factorization, The lenov input –output model, application to computer graphics. **10 Hrs.**

MODULE – 2

Vector space, subspace, basis of a vector space, dimension of a vector space, introduction to linear transformation, rank, nullity of a linear transformations, matrix of a linear transformation, application to difference equations and Markov chain. **10 Hrs.**

MODULE – 3

Eigen value, Eigen vectors, diagnolization, application to discrete dynamical systems and difference equations. **10 Hrs.**

MODULE – 4

Orthogonal sets, orthogonal projections, gram schmid process, lest square problems, application to linear models, inner product space, application to inner product space, singular value decomposition theorem, application to image processing and statistics-principal component analysis. **10 Hrs.**

Textbooks

1. David C.Lay, Steven R. Lay and J.J.McDonald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.
2. Gilbert Strang: Linear Algebra and its Applications, 4th Edition, Cenage publications., 2014.

Reference books:

1. E. Kreyszig, “Advanced Engineering Mathematics”, 10th edition, Wiley, 2015.
3. R. K. Jain and S. R. K. Jain & S. R. K. Iyengar, Numerical methods, New age International pvt. Publishers, 6thedition, 2014.

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Date : 28-1-2021