February 21, 2022

The list of Open Electives for 2021-22 Even Semester

Sl No	Dept.	Course Code	Course Title	Maximum registration allowed
1.	Civil	19OECV61	Remote Sensing And GIS	50
2.		19OECV62	Engineering Optimization	50
3.		19OECV63	Composites And Smart Materials	50
4.		19OECV64	Urban Design And Regeneration	50
5.	Mechanical	19OEME61	Principles Of Manufacturing	50
6.		19OEME62	Industrial Engineering And Ergonomics	50
7.		19OEME63	Project Management	50
8.		19OEME64	Occupational Health And Safety Engineering	50
9.	E&E	19OEEE61	Basic Power Electronics	50
10.		19OEEE62	Alternate Energy Sources	50
11.	E & C	19OEEC61	Embedded System design	50
12.		19OEEC66	E Waste Management	50
13.		19OEEC67	Data Communication Networks	50
14.	Automobile	19OEAU62	Electric Vehicles Technology	50
15.	I & P	19OEIP62	Total Quality Management and Operational Excellence	50
16.		19OEIP63	Project Management	50
17.	E&I	19OEEI61	Industrial Instrumentation	50
18.		19OEEI63	Analog Signal Conditioning	50
19.	CS &E	19OECS61	Introduction To Cloud Computing	100
20.		19OECS62	Database Fundamentals	100
21.	IS &E	19OEIS61	Web Technologies	50
22.		19OEIS65	Data Science	50
23.	Physics	19OEPH61	Introduction To Nanotechnology And Quantum Science	50
24.	Chemistry	19OECH61	Industrial Chemistry	50
25.	Mathematics	19OEMA63	Advanced Mathematics And Applications	50
			Total	

Note :

- The required minimum registration for a course – 20
- The maximum registration for a course - 50

- All courses are for 3 credits

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Remote Sensing and GIS

Course Code:19OECV61 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 42

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

CO1	Describe the concept of Remote Sensing and Energy interactions	PO2, PO4, PO6
CO2	Discuss Remote sensing Platforms, type of Sensors & data collection	PO3, PO5, PO6
CO3	Learning and understanding geographical information system	PO1, PO4, PO7
CO4	Data interpretation and data processing. Application of RS & GIS	PO5, PO4, PO8

MODULE - 1

Remote Sensing: Basic concept of Remote sensing, Active and Passive Remote sensing (RS), Scope of remote sensing; Electromagnetic radiation and electromagnetic spectrum: Visible, Infra-Red (IR), Near IR, Middle IR, Thermal IR, and Microwave. Black body radiation and radiation laws; Interaction of EMR with atmosphere and Earth's surface features, Resolution, image registration and Image and False colour composite, elements of visual interpretation techniques.
10 Hrs.

Self - study component: Students shall collect the information on space research organizational structure, Types of Indian satellites, and data products

MODULE - 2

Remote Sensing Platforms and Sensors: Indian Satellites and Sensors characteristics, Remote Sensing Platforms, Sensor's resolutions (spatial, spectral, radiometric, and temporal) and Properties of Digital Data, Data Formats & products: IRS, LANDSAT, SPOT, CARTOSAT, IKONOS, ENVISAT etc. Basics of digital image processing, systematic errors (Scan Skew, Mirror-Scan Velocity, Panoramic Distortion, Platform Velocity, Earth Rotation) and non-systematic (random) errors, Image enhancements (Gray Level Thresholding, level slicing, contrast stretching), image filtering.

12 Hrs.

Self-study component: Students shall collect the information on commercial and open-source Remote Sensing data for use in GIS. Download free DEM and LULC data.

MODULE - 3

Geographic Information System: Introduction to GIS; components of a GIS; Geographically Referenced Data, Spatial Data- Attribute Data-Joining Spatial and attribute data, GIS Operations: Spatial Data Input – Attribute data Management, Geographic Coordinate System, Datum; Map Projections: Types of Map Projections, Projected Coordinate Systems. UTM Zones. 10 Hrs.

Self-study component: Students shall collect the information on different commercial and open-source GIS software

MODULE - 4

Data Models: Vector data model: Representation of simple features – Topology and its importance; coverage and its data structure, Shape file; Relational Database, Raster Data Model: Elements of the Raster data model, Types of Raster Data, Raster Data Structure, Data conversion. Integrated Applications of Remote sensing and GIS: Applications in land use land cover analysis, change detection, water resources, urban planning, environmental planning, Natural resource management and Traffic management. Location Based Services and Its Application 10 Hrs.

Self-study component: Students shall collect the information on different GPS system in world and their working.

Text Books:

1. Lillesand, Kiefer, Chipman, Remote Sensing and Image Interpretation, Wiley 2015.
2. Basudeb Bhatta, Remote sensing and GIS, Oxford University Press 2019.

Reference Books:

1. George Joseph, "Fundamentals of Remote Sensing" –Universities Press, Hyderabad, 2018
2. Narayan Panigrahi, "Geographical Information Science", University Press, New Delhi 2010.
3. Kang-Tsung Chang, "Introduction to Geographic Information System". Tata McGraw Hill Education Private Limited 2019.

Engineering Optimization

Course Code: 19OECV62 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 42

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

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
CO3	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

Self-study component:

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: 19OECV63 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 42

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

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 & polymeric smart materials & development of actuators & sensors & 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 (Cont'd) - 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.

Urban Design and Regeneration

Course Code: 19OECV64 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 42

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

CO1	Discuss the strategies involved in Urban regeneration.	PO6, PO7
CO2	Interpret the various planning tools regarding the urban assets	PO6, PO8
CO3	Review the public and private sector roles and relationships and project phasing in the implementation of the urban regeneration projects	PO7, PO8
CO4	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. 7 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.
7 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. 6 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: 19OEME61 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 39

Course objectives: To equip students of other engineering disciplines with the fundamental aspects of manufacturing processes and their applications
Course Outcomes (COs) {with mapping shown against the Program Outcomes (POs)) Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	realise the role of manufacturing processes in other engineering branches and learn principles of different metal forming processes	1, 12	-

2	comprehend the basic principles and recent developments of modern manufacturing processes	1, 12	-
3	realize the significance of various joining and assembly techniques	1, 12	-
4	infer the basic concepts and applications of rapid prototyping	1, 12	-

Course Contents:

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. 09 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: 19OEME62 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 39

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

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

Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	explain the fundamental concepts of productivity and work study	1, 6	-
2.	to construct the charts on the basis of present method and develop a new / proposed method and identify the unnecessary movements.	2, 6	-
3.	apply the concepts of work measurement to solve problems related to work measurement and performance of workers	2, 6	-
4.	apply the ergonomic concepts in design of new systems, displays and controls	3, 6	-

Course contents:

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.

09 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: 19OEME63 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 39

Course objectives: To impart comprehensive understanding of how to plan, optimize and efficiently manage projects (or tasks) to implement products, services or developments.
Course Outcomes (COs) {with mapping shown against the Program Outcomes (POs)) Upon successful completion of this course, the student shall be able to:

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	demonstrate the knowledge of project management, lifecycle, tools and techniques for the success of project	9, 11	-
2	explain the important steps of project planning and provide accurate cost estimates to plan various activities	9, 11	-
3	identify the resources required for a project and to produce a work plan for the application of project scheduling tools and techniques	2, 11	-
4	assess the project performance by companies using various techniques for better project management	11	-
5	demonstrate the skills and roles of project managers for software efforts and strategy used to deal with the development of software	5, 11	-

Course Contents:

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, 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.

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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. 09 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-PankajJalote,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.

Occupational Health And Safety Engineering

Course Code: 19OEME64 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 39

Course objectives: To apply the basic concept of occupational health and safety standards in work place scenario.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1.	interpret and apply legislative requirements, industry standards, and best practices in a variety of workplaces.	6, 11	-
2.	apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological and psychosocial hazards.	6, 7, 11	-
3.	identify fire safety hazard and risk in the work place & report deficiencies.	6, 11	-
4.	apply .OSHA exposure limits and work place standard to health hazard.	6, 11	-

Course Contents:

Module – 1

Introduction: Occupational Safety and Health Act, Occupational Safety and Health Administration, Right to know Laws. Indian Acts – Labour Act, Factories Act, OSHA. 10 Hrs.

Module – 2

Occupational Hazard and Control: Hazard Analysis, Human Error and Fault Tree Analysis, Emergency Response. Hazards and their control in different manufacturing and processing industries.

10 Hrs.

Module – 3

Fire Prevention and Protection: Types of Fire, Fire Development and its Severity, Effect, Extinguishing Fire, Electrical Safety, Product Safety. 10 Hrs

Module – 4

Occupational Health: Health Safety Considerations, Personal Protective Equipment. Health problems in different types of industries – construction, textile, steel and food processing, pharmaceutical, occupational Health and Safety considerations in Wastewater Treatment Plants.

09 Hrs.

SELF STUDY:
Prepare a report on: workplace ergonomics, fire safety, workplace violence prevention, employee health resources, environmental safety

Text Book:

1. Goetsch D.L., “Occupational Safety and Health for Technologists”, Engineers and Managers”, Prentice Hall.

Reference Books:

1. Heinrich H.W., “Industrial Accident Prevention”, McGraw Hill Publication, Network.
2. Colling D.A., “Industrial Safety Management and Technology”, Prentice Hall, New Jersey.
3. Della D.E., and Giustina, “Safety and Environmental Management”, Van Nostr and Reinhold International Thomson Publishing Inc.
4. CPHEEO, Manual on Sewerage and Sewage Treatment, M/s.Jain Book Agency, c-9, Connaught place, New Delhi.
5. National Safety Council and Associate (Data) Publishers Pvt. Ltd., “Industrial Safety and Pollution Control Handbook”

Basic Power Electronics

Course Code: 19OEEE61 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

Course objectives: Students will be able to analyse and design simple power electronic converters
Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO	Mapping to PSO's
1	Explain the basic switching principle of various power electronic switching devices and their characteristics.	1	2
2	Analyse various techniques used to control the power electronic switching devices.	1,2	2
3	Describe working principle AC & DC voltage controllers for R & RL loads, AC-DC & DC-AC converters.	1,2	2

Course Contents:

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.

Self Study: *Selection of power electronic devices of Applications.* 10 Hrs

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).

Self Study: *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.
DC-DC Converters: Introduction, Classes of Choppers, step up chopper, step down chopper.
Self Study: 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).
Inverters: Introduction, Single-phase bridge inverters, 3-phase bridge inverter.

Self Study: Significance of Harmonic reduction and power factor improvement in power electronic converters. 10 Hrs

Text Book:

1. 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.

Alternate Energy Sources

Course Code: 19OEEE62 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

Course Objective: Students will analyse and design the renewable energy conversion system components for real time application
Course Outcomes: At the end of course, student will be able to:

#	Course Outcomes	Mapping to PO	Mapping to PSO's
1	Explain basics of renewable energy sources such as solar wind, tidal etc.	1,6,7	1
2	Describe the concepts of the real time solar PV, Solar thermal and Solar Electric Systems.	1,2,6,7	1
3	Design solar and wind energy system parameters.	1,2,3,7	1

Course Contents:

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.
Self Study: 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.
Self Study: 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.
Self Study: 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.
Self Study: Ocean Currents, Wave Power. 10 Hrs

1. Rai, G D, *Non-conventional sources of energy*, 4th Edition, Khanna publishers, New Delhi, 2007.

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.

2013.
2. **Ethem Alpaydin**, "Introduction to Machine Learning", 2nd Edition, PHI Learning Pvt. Ltd., 2013.

Open Elective (for other branches of Engineering)
Embedded systems Design

Course Code : 19OEEC61 **LTPC: 3-0-0-3**

Exam Hours : **3** Hours / Week : **3**

SEE : **50 Marks** Total hours : 40

Coure objective: To make students familiar with the basic concepts and terminology of the target area, the embedded systems design flow. – To give students an understanding of the embedded system architecture

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

COs	Statements	Pos
1.	Comprehend the requirements for embedded systems to design an embedded system using microprocessor/microcontrollers	PO1 PO2,
2.	Analyse how the memory, peripheral components and buses interact in an embedded system	PO1, PO2
3.	Develop the code to implement the applications of ARM processor.	PO2, PO3
4.	Design and develop the programming skills for embedded devices.	PO1, PO2 PO3

Course Contents:

Module-1	**Teaching Hours**
Introduction to Embedded Systems: Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.	10 Hrs
Module-2	
Typical Embedded System: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory hadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces	10 Hrs
Module-3	
Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.	10 Hrs
Module-4	
RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and multitasking, Task Scheduling.	10 Hrs

TEXT BOOKS: 1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.

REFERENCE BOOKS:

1. Embedded Systems - Raj Kamal, TMH.

2.Embedded System Design - Frank Vahid, Tony Givargis, John Wiley

E Waste Management

Course Code: 19OEEC66 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

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

COs	Statement	POs
1.	Comprehend Multidisciplinary nature of environmental studies and Investigate how and why things happen, and make their own decisions about complex environmental issues by developing and enhancing critical and creative thinking skills.	PO6,PO7 PO12
2.	Analyze how their decisions and actions affect the environment, builds knowledge and skills necessary to address complex environmental issues.	PO6,PO7,PO12
3.	Develop the sense of awareness among the students about the environment and its various problems.	PO6,PO7,PO9,PO12
4.	Acquire the basic knowledge about environment and the social norms that provides unity with environmental characteristics and create positive attitude about the environment.	PO6,PO7,PO12

Course Contents:

Module -1

Multidisciplinary nature of environmental studies- Definition, scope and importance. Need for public awareness. Natural Resources-Renewable and non-renewable resources: Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer, pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources, Case studies. f) Land resources: Land as a resource, land degradation, man induced and slides, soil erosion and desertification Role of individual in conservation of natural resources. Equitable use of resources for sustainable life styles. 10 Hrs

Module -2

Biodiversity and its conservation-Introduction Bio-geographical classification of India, Value of biodiversity: consumptive, productive, social, ethical, aesthetic and option values. India as a mega-diversity nation Hot-spots of biodiversity Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts Endangered and endemic species of India.

Environmental Pollution-Definition Causes, effects and control measures of Air pollution Water pollution Soil pollution Marine pollution Noise pollution Thermal pollution nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution case studies

Disaster management: floods, earthquake, cyclone and landslides. 10 Hrs

Module -3

E-waste growth- An overview, hazards of E-waste, what is E-waste, digital dump yard, how to minimize E-waste, Hazardous substances waste Electrical and Electronic Equipment, characteristics of pollutants, batteries, electrical and electronic components, plastic and flame retardants, circuit boards, pollutants in waste electrical and electronic equipment. 10 Hrs

Module -4

E-Waste Recycling Technologies for recovery of resources from electronic waste, resource recovery potential of e-waste, steps in recycling and recovery of materials-mechanical processing, technologies for recovery of materials. 10 Hrs

Text Book:

1. **Bharucha Erach**, Text Book of Environmental Studies for undergraduate Courses. University Press, IInd Edition 2013
2. E-Waste Managing the Digital Dump Yard, Edited by **Vishakha Munshi**, ICFAI University Press (Chapter 1)
3. E-waste: Implications, Regulations and Management in India and Current Global Best Practices, Edited by **Rakesh Johri**, The Energy and Resources Institute, New Delhi (Chapter 1, 5)

Data Communication Networks

Course Code: **19OEEC67** L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

Course Objective: Overall knowledge gained in this course will enhance the ability of students to deal with analysis and design of computer networks and protocols associated with them in their profession.

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

COs	Statement	POs
1.	Explain the functions of various layers of OSI and TCP/IP model .	PO1,PO2
	Analyze and implement line coding techniques, multiple access techniques, IPv4 and IPv6 addressing.	PO1,PO2, PO3
	Comprehend the functionalities associated with transport layer and application layer.	PO1,PO2
0.	Analyze the concepts of data security.	PO1,PO2, PO3

Course Contents :

Module-1

Introduction- OSI Model and TCP/IP model (Functions of each layers in both models), Examples of Data communication networks- Mobile networks, DSL network, FTTH networks, Bluetooth networks. **Physical layer-**Analog and digital signals, Bandwidth and channel capacity, Data transfer nodes, Line coding techniques. 10 Hrs

Module-2

Datalink Layer: -Multiple access Techniques (ALOHA, Slotted ALOHA,CSMA, CSMA/CD, CSMA/CA), connecting devices- Hub/repeater, switch, router. **Network layer**- Concepts of delivery, forwarding and routing,IPv4 and IPv6 addressing, transition from IPv4 to IPv6. 10 Hrs

Module-3

Transport Layer- UDP- Features and datagram formats, TCP- Features, connection establishment, data transfer and connection termination and datagram format.
Application layer– DNS-Need for DNS, resolution in DNS, FTP- Control and Data connections, SMTP

10 Hrs

Module-4

Application layer- Features of application layer protocols HTTP, VOIP, IP TV,RTP.
Data Security-Need for data security, symmetric and asymmetric encryption and decryption, IDEA algorithm, concept of firewall,
Cloud computing- Concepts and features (Block diagram approach)

10 Hrs

Text Book:

1. **Forouzan** B A, "Data communications and Networking", TMH, 4th edition, 2010.

Reference Books:

1. **Gopalan and SivaSelvan,** "TCP/IP Illustrated", PHI, New Delhi,2008.
2. **A. Tanenbaum,** "Computer Networks", 3rd Edition, PHI,1993.
3. **William Stallings**, "Network Security and Cryptography", 7th Edition, Pearson India.

Electric Vehicles Technology

Course Code: 19OEAU62 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

Course Objective: To understand the principle, working and design of electric and hybrid vehicles
Course outcomes: At the end of the course, student will be able to

1 Describe electric vehicle technology and electric vehicles
2. Explain the basics of hybrid and electric drive trains
3. Perform design calculations of hybrid system under study
4. Design the various vehicle power sources in hybrid vehicle technology

Module - 1

Electric Vehicle Propulsion and Energy Sources
Introduction Electric Vehicles, 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 Motor Drives. Permanent Magnet Motor Drives, Switch Reluctance Motor Drives, Drive System Efficiency

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 H eavy Duty Vehicles.

10 Hrs

Module - 4

Electric and Hybrid Vehicle Design: Introduction to Hybrid Vehicle Design. Matching the Electric Machine and the Internal Combustion Engine Sizing of Propulsion Motor, Power Electronics, and 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 Husain, "*Electic and Hybrid vehicles Design Fundamentals*" , CRC Press, second edition 2013
2. James Larminie, John Lowry, "*Electric vehicle techonology Explained*" second Edition,Wiley 2012

Reference Books/Other Reading Material

3. Ali Emadi, "*Hand book of Automotive Power Electronics and Motor Drives*" ,CRC Press 2005
4. Ali Emadi, Mehrdad Ehsani, John M. Muller,"*Vehicular Electric Power Systems*" Marcel Dekker, Inc., 2004

Total Quality Management And Operational Excellence

Course Code: 19OEIP62 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

To understand the philosophy and core values of Total Quality Management (TQM),determine the voice of the custome 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 Outcome: At the end of the course, student will be able to:

1. Describe the contribution of various quality Gurus to achieve total quality management. (PO1,PO2)
2. implement quality concepts and techniques to improve process performance in all aspects of firms operation(PO1,PO3)
3. utilize basic tools and develop strategies for continuous process improvement considering customers requirements(PO1,PO5)
4. Implementation of proactive improvement using QC steps and its tools(PO2,PO4).
5. describe the importance of Total participation and utilize various strategies for Total participation (PO4,PO9)
6. learn from the network companies, customers, suppliers from others and improve quality

practices(PO3,PO4)

Module1

Overview of Total Quality Management: History of TQM, contribution of quality gurus-Deming's approach, Juran's quality trilogy, Cross by 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.

10Hrs

Module2

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 andthe7QCTools

. 10Hrs

Module3

ProactiveImprovement:IntroductiontoProactiveImprovement,Towardstandardsteps 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.

10Hrs

Module4

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 framework. Implementation of performance measurement systems.

10Hrs

TextBooks

1. A New American TQMF our Practical Revolutions in Management, Shojishiba, Alan Grahamand David Walden, Productivity Press, Portlans(USA).2010
2. Management for Total Quality, NLogothetis, Prentic eHall of India, New Delhi 2013
3. Total Quality Managementand Operational Excellence, JohnS Oakland, Routledge, Taylorand Francis Group, London and NewYork 2014

References

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

PROJECT MANAGEMENT

Course Code: **19OEIP63** L-T-P-C: 3-0-0-3

Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

Course Objectives: To make them understand the concepts of Project Management for planning to execution of projects. To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.

Course Outcome: Upon successful completion of this course, students should be able to:

CO1. Select, prioritize and initiate individual projects and apply strategic role of project management. (PO1)

CO2. Create work breakdown structure by integrating it with organization. Execute scheduling and uncertainty in projects. (PO1, PO5)

CO3. Execute risk management planning using project quality tools. (PO1)

CO4. Perform the purchasing, acquisitions, contracting, partnering and collaborations related activities of a project. Determine project progress and results through balanced scorecard approach (PO1, PO3)

CO5. Draw the network diagram to calculate the duration of the project and reduce it using crashing. (PO1, PO5)

Module 1

Introduction: Definition of project, history of project management, project life cycle, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles.

Project Selection And Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.

10 Hrs

Module 2

Planning Projects: Introduction, developing the project management plan, understanding stake holders, communication planning, project meeting management, communication needs of global and virtual project teams, communication technologies, Constructing Work Breakdown Structures – scope planning, scope definition, work breakdown structures (WBS), Using Microsoft project for work breakdown structures, Project, Resource Planning and Management.

Scheduling Projects: purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt Chart, Using Microsoft Project for critical path schedules. **10 Hrs**

Module 3

Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project ream composition issues, assign resource to each activity, resource overloads, critical chain project management (CCPM), compress the project schedule, Using Microsoft Project for resource allocation.

Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control, using Microsoft Project for Project Budgets.

Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kickoff: Development of quality concepts, project

quality management plan, project quality tools, kickoff project, baseline and communicate project management plan, using Microsoft Project for project baselines. **10 Hrs**

Text Books

1. **Project Management**, Timothy J Kloppenborg, Cengage Learning, Edition 2009.
2. **Project Management**, A systems approach to planning schuduing and controlling by Harold kerzner, CBS publication.

References

1. **Project Management, S. Choudhury, Mc. Graw Hill**
2. **Project Management, Bhavesh M. Patal, Vikas publishing House,**

Industrial Instrumentation

Course Code: 19OEEI61 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

Course Outcomes: Upon the completion of this course student will be able to:

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. 10 Hrs

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%20 Measurements.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

Analog Signal Conditioning

Course Code: 19OEEI63 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

Prerequisites: Basic Electronics
Course outcomes: Upon the completion of this course student will be able to:
CO1: Explain fundamentals of Opamp and its behavior in open loop configuration
CO2: Design of Opamp circuits with positive and negative feedback and their applications.
CO3: Measure basic performance parameters of Opamp.
CO4: Use of Opamp with diodes and capacitors for special applications.
CO5: Design circuits to generate basic signals using Opamp and timer.

CO6: Design SCC for specified instrumentation applications.

MODULE 1

Introduction to OPAMPs: Basic internal circuit of OPAMP (Differential Amplifier), Block diagram representation of a typical OPAMP, OPAMP terminals and its ideal characteristics /Specifications; OPAMP in Open loop configuration: Open loop voltage gain, Zero Crossing detector: Inverting & Non Inverting ZCDs; Positive and Negative voltage level detectors, LM 339-Quad Comparator, Generation of PWM using LM339. OPAMPs with negative feedback and its applications: Inverting and Non Inverting amplifier: Closed loop voltage gain, Input impedance, Output impedance, Bandwidth with feedback, Applications: Adder (Multichannel amplifier), Inverting averaging amplifier, Non Inverting Adder, Voltage follower, Difference amplifier: Subtractor and design problems.

Self -study component: Ideal voltage source 10 Hours

MODULE 2

OPAMPs with positive feedback and its applications: Effect of noise on comparator circuits, Design aspects of ZCD with Hysteresis (Schmitt trigger),(Design aspects of Voltage level detectors with Hysteresis (both Inverting and Non Inverting), Applications: independently adjustable set point controller. DC performance and AC performance of OPAMPs: Measurement and effect of OPAMP Parameters: Input bias current, Input offset current, Input offset voltage, Frequency response of OPAMP: Open loop and Closed loop configurations.

Self -study component: Slew rate and output voltage. 10 Hours

MODULE 3

Special Applications of OPAMPs: V-I (both floating load and grounded load) converter and their Applications: Diode match finder, design of high input impedance DC/AC voltmeter using ammeter, I-V converter and its applications; design of I-V circuit for Photo based sensor, Precision rectifiers: Half wave and Full wave;, Frequency response of Integrator, Differentiator and their Design. Waveform Generators: Multivibrators using OPAMPs: Free running (square wave generator) and oneshot multivibrators, Triangular wave generator, Design problems, 555 Timer: Introduction, Astable multivibrators and Mon stable multivibrators: applications and their applications.

Self- study component: Zener diode tester, Phase shift oscillator 10 Hours

MODULE 4

Active Filters: Introduction to Filters: Design aspects of Low pass Butterworth filter; first order and Second order filters, Design aspects of High pass Butterworth filter; first order and Second order filters, Higher order filters, Design aspects of Band pass filter and Band rejection filter. Signal conditioning circuits: Basic differential Amplifiers, differential versus single input amplifiers, Instrumentation amplifier, Basic Bridge Amplifiers, Balancing and linearization techniques for the bridges.

Self-study component Design of Signal conditioning circuits for Strain gauge, Thermistor

10 Hours

Text Books:

1. Operational Amplifiers and Linear Integrated Circuits, Robert. F. Coughlin & Fred.F. Driscoll, , PHI/Pearson, 2006
2. Operational Amplifiers and Linear Integrated Circuits, Ramakant A. Gayakwad, , 4th edition, PHI

Reference Book:

1. Linear Integrated Circuits, D. Roy Choudhury and Shail B. Jain, , 2nd edition, Reprint 2006, New Age International

E Books:

1. http://freevideolectures.com/Course/2321/Electronics-for-Analog-Signal-Processing-I
2. http://freevideolectures.com/Course/2322/Electronics-for-Analog-Signal-Processing-I

MOOCs:
1. http://ocw.tudelft.nl/courses/microelectronics/analog-integrated-circuitdesign/course-home/
2. Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware |Reviews and Ratings
3. http://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/

	INTRODUCTION TO CLOUD COMPUTING		
Course Code	**19OECS61**	**L-T-P-C**	**3-0-0-3**
Exam Hours	**3 Hrs**	**Hours / Week**	**03**
SEE	**50Marks**	**Total hours**	**40**

#	Course outcomes	Mapping to PO's	Mappin to PSO's
1.	Apply the knowledge for the identification of architecture and infrastructure for Cloud Computing.	PO2, PO4	
2.	Assessment of the economics, financial, and technological implications for selecting cloud deployment model	PO2, PO4	
3.	Choose appropriate cloud model for a given application	PO3, PO5	
4.	Identify security management in cloud	PO6, PO8	
5.	Develop applications for cloud computing	PO5, PO7	

Course Contents:

MODULE 1	10 Hrs
Introduction: Cloud computing at a glance, historical developments, building cloud computing environments, computing platforms and technologies. **Principles of parallel and Distributed computing:** Eras of computing, parallel vs. Distributed computing, elements of parallel computing, elements of distributed computing, technologies for distributed computing	
MODULE 2	**10 Hrs**
Virtualization: Introduction, characteristics of virtualized environments, Taxonomy of virtualization techniques, virtualization and cloud computing, pros and cons of virtualization technology **Cloud Computing architecture:** Introduction, Cloud reference model, types of clouds, economics of the cloud, open challenges	
MODULE 3	**10 Hrs**
Cloud platforms in industry: Amazon Web Services, Google App Engine, Microsoft Azure **Advanced topics in cloud computing:** Energy efficiency in clouds, Market based management of clouds, federated clouds/inter clouds, third party cloud services	
MODULE 4	**10 Hrs**

Infrastructure security, IAM: Infrastructure security: network level, host level, application level, **Identity and Access management**: trust boundaries and IAM, why IAM? IAM challenges, IAM definitions, IAM architecture and practices, getting ready for cloud, IAM standards and protocols for cloud services, IAM practices in the cloud, cloud authorization management.

Security management in the cloud: Security management standards, security management in the cloud, availability management, Saas, Paas, Iaas availability management, access control, security vulnerability, patch and configuration management. **Privacy:** What is privacy? What is data life cycle? What are the key privacy concerns in cloud? Who is responsible for protecting privacy?

Text Books:

1. Mastering Cloud Computing, McGraw Hill publication, Rajkumar Buyya, Christian Vecchiola, S.ThamaraiSelvi
2. Cloud security and privacy an enterprise perspective on risks and compliances,2013, Tin Mather, Subra kumarswamy, shahed Latif

Course Title	**DATABASE FUNDAMENTALS**		
Course Code	**19OECS62**	**L-T-P-C**	**3-0-0-3**
Exam.	**3 Hrs**	**Hours/Week**	**03**
SEE	**50 Marks**	**Total hours**	**40**

Course Objective: Design a database and write SQL queries.

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

Course Contents:

MODULE-1 **10 Hrs**

Introduction: Introduction; An example; Characteristics of Database approach; Actors on the screen; Workers behind the scene; Advantages of using DBMS approach; when not to use a DBMS. Data models, schemas and instances; Three-schema architecture and data independence; Database languages and interfaces; The database system environment; Centralized and client-server architectures; Classification of Database Management systems.

MODULE – 2 **10 Hrs**

Entity-Relationship Model: Using High-Level Conceptual Data Models for Database Design; A sample Database Application; Entity Types, Entity Sets, Attributes and Keys. Relationship types, Relationship Sets, Roles and Structural Constraints; Weak Entity Types; ER Diagrams, Naming Conventions and Design Issues; Relationship types of degree higher than two.

MODULE – 3 **10 Hrs**

Relational Model and Relational Algebra: Relational Model Concepts; Relational Model Constraints and Relational Database Schemas; Update Operations, Transactions and dealing with constraint violations;

Unary Relational Operations: SELECT and PROJECT; Relational Algebra Operations from Set Theory; Binary Relational Operations: JOIN and DIVISION.

SQL: SQL Data Definition and Data Types; Specifying basic constraints in SQL; Basic Retrieval queries in SQL; Insert, Delete and Update statements in SQL;	
MODULE – 4	**10 Hrs**
SQL: Additional features of SQL, More complex SQL Retrieval Queries; Views; Schema Change Statements in SQL. **Database Design:** Informal Design Guidelines for Relation Schemas; Functional Dependencies; Normal Forms Based on Primary Keys; General Definitions of Second and Third Normal Forms; Boyce-Codd Normal Form. **Concurrency control techniques:** Two-Phase Locking Techniques for Concurrency control; Concurrency Control Based on Timestamp Ordering**.**	
Text Books : 1. Elmasri and Navathe, Fundamentals of Database Systems, Addison-Wesley, 7th Edition, 2015. 2. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems, McGraw-Hill, 3rd Edition, 2007	
Reference Books: 1. Silberschatz, Korth and Sudharshan, Data base System Concepts, 5th Edition, Mc-GrawHill, 2006 C.J. Date, A. Kannan, S. Swamynatham, A Introduction to Database Systems, Pearson education, 8th Edition, 2006	

Web Technologies

Course Code: 19OEIS61 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Explain the fundamentals of world wide web and web programming languages such as HTML, XHTML, Java script, PHP, AJAX and mysql database system.	1	-
2	Apply the different scripting languages for dynamic web page development.	1	-
3	Design and develop web solutions for given requirements.	3	2

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 Mark up, 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
2. James Lee, Brent Ware, "Open Source Web Development with LAMP", Pearson Education, 2013

Data Science

Course Code: 19OEIS65 L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 40

Course objective: Apply the principles of data science for solving real time problems.

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

#	Course Outcomes	Mapping to POs	Mapping to PSOs
1	Describe various Data Science process like statistical modelling, Exploratory data analysis, Data visualization.	1,2	-
2	Identify the appropriate Machine Learning Algorithms to use in applications to fit a model to the given data.	3, 5	1
3	Apply various feature selection algorithms for effective decision making.	3,4	1
4	Create effective visualization for the given data using R	4	1

Module - 1

Introduction: What is Data Science? Big Data and Data Science hype - and getting past the hype, Why now? – Data fiction, Current landscape of perspectives, Skill sets needed.

Statistical Inference - Populations and samples, Statistical modelling, probability distributions, fitting a model.

10 Hrs

Module - 2

Exploratory Data Analysis and the Data Science Process - Basic tools (plots, graphs and summary statistics) of EDA, Philosophy of EDA.

The Data Science Process, Case Study: Real Direct (online real estate firm). Three Basic Machine Learning Algorithms - Linear Regression . 10 Hrs

Module - 3

k-Nearest, Neighbours (k-NN), k-means. One More Machine Learning Algorithm and Usage in Applications - Motivating application: Filtering Spam

Why Linear Regression and k-NN are poor choices for Filtering Spam, Naive Bayes and why it works for Filtering Spam Data Wrangling: APIs and other tools for scrapping the Web. 10 Hrs

Module - 4

Feature Generation and Feature Selection Motivating application: user (customer) retention, Feature Generation Feature Selection algorithms, Filters; Wrappers; Decision Trees, Random Forests

Data Visualization - Data Visualization History, What Is Data Science, Redux?, A Sample of Data Visualization Projects 10 Hrs

Text Book:

1. Cathy O'Neil and Rachel Schutt. Doing Data Science, Straight Talk from The Frontline. O'Reilly. 2014.

Reference Books:

2. Jure Leskovek, Anand Rajaraman and Jeffery Ullman. Mining of Massive Datasets. V2.1, Cambridge University Press. 2004.
3. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. ISBN 0262018020. 2013.
4. Foster Provost and Tom Fawcett. Data Science for Business: What You Need to Know about Data Mining and Data-analytic Thinking. ISBN 1449361323. 2013.

MOOC:

1. Introduction to data Analytics nptel.ac.in/courses/110106064/E-Books: a) An Introduction to Data Science. By J. Stanton, 2013.
2. Data Sciencehttps://drive.google.com/file/d/0B6iefdnF22XQeVZDSkxjZ0Z5VUE/edit

Introduction to Nanotechnology and Quantum science

Course Code: **19OEPH61** L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 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 computing.

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

COs	Statement	POs
1.	Interpret the basic interdisciplinary nature of nanotechnology.	PO1, PO2
2.	Illustrate the synthesis and characterization methods of nanomaterials.	PO1, PO2
3.	Discuss the properties and applications of nanotechnology.	PO1, PO2
4.	Demonstrate the usage of basic principles in quantum computing.	PO1, PO9

Course Contents:

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. Quantum dots, Influence of size on properties and their characterization of materials 8 Hrs

MODULE 2

Synthesis of Nano materials Synthesis approaches; Bottom-up and top-down.
Physical methods: vacuum evaporation method, general sputtering techniques
Chemical methods: Electroplating, spray pyrolysis, chemical vapor deposition (CVD), hydrothermal method, spin coating. Mention of other methods 8 Hrs

MODULE 3

Characterizations and applications of nanomaterials

UV-Visible spectroscopy, Fourier Transform infrared spectroscopy (FTIR) and modes of different molecules, X-Ray Diffraction (XRD) and usage of it in prediction of some crystallinity of some nanoparticles. **Microscopy:** Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Transmission Electron Microscopy (TEM).

Applications of Nanotechnology: LED, Solar cell, Transistors (Qualitative discussion) 8 Hrs

MODULE 4

Quantum nanoscience Principles of quantum mechanics, introduction to quantum computers, Quantum superposition, prediction on quantum systems related to quantum superposition, quantum entanglement. Qubits, physical realization of different types of qubits, Bloch sphere, single qubit quantum logic gates and their operations on |0> and |1> ket states of a qubit. 8 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.
3. **Quantum computation and quantum information** - Michael A. Nielsen, Isaac L. Chuang - Cambridge University Press, 2004.

Reference Books:

1. **Introduction to Nanotechnology**, Charles P. Poole Jr and Frank J. Owens, Wiley Inter science, 2003.
2. **Principles of Nanotechnology,** Phani kumar (Scitech Publications, Chennai).

Industrial Chemistry

Course Code: **19OECH61** L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 42

Module 1

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). **12 Hrs**

Module 2

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 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.

Advanced Mathematics and Applications

Course Code: **19OEMA63** L-T-P-C: 3-0-0-3
Exam Hours: 3 Hours/week : 3
SEE-50 marks Total hours : 42

Course Objective: Students will be trained to acquire knowledge in linear algebra, graph theory and its applications.
Course outcomes: Having studied this course, students will be able to**:**

COs	Outcomes	PO1	PO2	PO3
CO1	Apply suitable solution procedure to solve the linear models of business, engineering, economics.	3	2	1
CO2	To compute suitable matrices arising in magnification, rotation of images using the knowledge of vector space, matrix of linear transformations.	3	2	1
CO3	Analyze the application-oriented problems connected with difference equations, Markov chain, discrete dynamical systems by using the concept of Eigen values, Eigen vectors.	3	2	1
CO4	Apply suitable shortest path algorithm to applications problems connected with graph theory.	3	2	1
CO5	Apply the techniques of singular value decomposition, PCA, to analyse the process of data compression/image processing.	3	2	1

Course Content:

Modules	Contents	No. of hours
Module 1	Applications of system of equations to business and economics introduction to linear transformation, rank, nullity of linear transformations, matrix of a linear transformation.	10 hours
Module 2	Eigen value, Eigen vectors, diagonalization, application to discrete dynamical systems and difference equations. Applications to web page ranking, applications of diagonalization, Jordan Canonical Form.	10 hours
Module 3	Orthogonal sets, orthogonal projections, Gram Schmidt process, QR-factorization, multiple regressions through matrix approach, singular value decomposition theorem, examples. Principal component analysis- applications of PCA to data compression, image processing.	10 hours
Module 4	**Graph theory**- Introduction to graph theory, definition of cut sets, trees, matrix representation of graphs, shortest path algorithms- prims, Kruskal, Dijkstra algorithm. **Numerical Methods**- Solution of system of linear equations by SOR and Gauss Seidel iteration method, ill conditioned system, condition number, discussion on the convergence of iterative methods. **MATLAB programming** - To find the Eigen values of system of differential equations which governs the telescopic position control, seismograph, rotating masses and torsional springs, mass spring damper system, planar truss problem, population growth model.	12 hours

Text Books:

1. David C. Lay, Steven R. Lay and J.J. Mc Donald: Linear Algebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.
2. Narasingh Deo, Graph theory, PHI publications, 1st Edition

3. R. K. Jain and S. R. K. Jain & S. R. K. Iyengar, Numerical methods, New age International pvt. Publishers, 6th edition, 2014.

Reference Books:

1. E. Kreyszig, "Advanced Engineering Mathematics", 10th edition, Wiley, 2015.
2. Gilbert Strang: Linear Algebra and its Applications, 4th Edition, Cenage publications, 2014.