BMS COLLEGE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

Syllabus of Institutional Electives

Course Name	Remote Sensing And GIS	**Course Code**	16CV7IERSG	**SEE Duration**	SEE+ CIE
Credits	03	**L:T:P:S**	3:0:0	**3 hours**	**50+50**

COURSE OBJECTIVES

To introduce remote sensing and GIS as a Vital tool for faster decision making. The main aim of the course is to impart knowledge on the concepts and application of remote sensing and GIS for general and specific tasks.

COURSE OUTCOMES

An Ability to

CO1: Explain the principles of Geodatabase

CO2: Discuss the application of multicriteria decision analysis for various issues.

CO3: Recognize the various advances in GIS

CO4: Outline the applications of enterprise and expert GIS

UNIT I

Geodatabase: Types of geodatabase, Advantages of geodatabase, Basic geodatabase structure, Topology, Relational classes, geometric networks, raster data - Creating geodatabase, organizing data, defining databaseStructure - Understanding spatial reference in geodatabase - Modifying spatial domain, Simple feature creationin geodatabase, Creating and editing map topology , Types of geodatabase annotation - Adding behavior to a Geodatabase 6 hrs

UNIT II

Multi-Criteria Decision Analysis and SDSS: Elements of multi-criteria decision analysis, classification of decision problems, evaluation criteria, hierarchical decision alternatives and constraints, alternatives anddecision variables, deterministic variables, criteria weighting , estimation weights, ranking methods, decisionrules, multi-attribute decision rules, sensitivity analysis, multi-criteria spatial decision support systems (SDSS).

SDSS for location planning, application-specific capabilities; requirements of a SDSS. 8 hrs

UNIT III

Advanced GIS

Introduction to Geographic Resources Analysis Support System (GRASS) GIS Raster data handling Reclassification, recode map algebra Resampling and interpolation of raster data. Overlaying Spatial analysis Neighborhood analysis and cross-category statistics -buffering Cost surfaces --Terrain and watershed analysis –Modeling raster data-Vector data handling-Topological operations - Buffering –Overlay –Dissolve –clip, union intersect –Network analysis–Spatial interpolation–handling lidar point cloud data. 8 hrs

UNIT IV

Expert GIS: Introduction to concepts of Expert GIS, Data formats, Proprietary file formats, translator and Transfer formats, open formats, standards, metadata, standards gazetteer, XML and GML, Spatial databases, Relational databases, object databases, GIS and databases, advanced database technology, derived mapping.
Generalization, text placement, automated cartography, data from imagery, Web GIS, simple maps in webpages, internet mapping sites, internet softwares, Mobile GIS –positioning, location based services, personal and Vehicle navigation, LBS for mass market, telematics. –Applications **6 hrs**

UNIT V
Enterprise GIS: User need assessment; old and new spatial database models, SDE layers, Geo database, Architecture design, capacity planning (Hardware), security planning, RDBMS software selection, GIS software selection, planning for migration. Enterprise GIS management. **6 hrs**

UNIT VI
Case Studies: GIS analysis in transportation, GIS analysis in water management, urban development, environmental analysis, hydrological modeling, Habitat suitability modeling, virtual cities 3D modeling and visual simulation, Automata based models of Urban system, Other applications. **6hrs**

TEXT BOOKS
1.GIS and Multi-criteria decision analysis by JacekMalczewski, John Wiley and sons.2015
2.Concepts and Techniques of Geographic Information Systems CP Lo Albert K WYeung, 2015 Prentice Hall of India.
3.Geographic Information Systems – An introduction by Tor Bernhardsen, John Wiley and Sons, Inc,New York, 2014.

REFERENCE BOOKS
1.Remote sensing and Image interpretation by Thomas M. Lillesand and Ralph W. Kiefer, JohnWiley and Sons Inc., New York, 2014
2.Geographical Information Systems – Principles and Applications, Volume I edited by David J.
Maguire, Micheal F Goodchild and David W Rhind, John Wiley Sons. Inc., New York 2014
3.Geographical Information Systems – Principles and Applications, Volume II edited by David J.
Maguire, Micheal F Goodchild and David W Rhind, John Wiley Sons.Inc., New York 2014.
4. nptel.ac.in/courses/105102015/50
5. www.gistutor.com › ESRI ArcGIS

Course		Credits : 03			Marks	
Name	**Consumer Behaviour**	**L**	**T**	**P**	**CIE**	**SEE**
Code	**21ME7OECOB**	**3**	**0**	**0**	**50**	**50**

SYLLABUS:

UNIT – 1

Introduction: The impact of the Digital revolution on consumer behaviour :: Definition and scope, Developing of marketing concept and discipline, customer value, satisfaction, retention, ethics, decision making model, Consumer research paradigms, consumer research process, Case studies

06 Hours

UNIT – 2

The consumer as an individual: Motivation as a psychological force, dynamics, types and systems of needs, measurement of motives, Personality and consumer behaviour, nature and theories, understanding consumer diversity, brand personality, self and self-image, virtual personality, elements and dynamics of perception, consumer imagery

Consumer learning: elements of consumer learning, behavioural learning theories, cognitive learning theory, measures of consumer learning, Case studies **11 Hours**

UNIT – 3

Consumers in their social and cultural settings: Social class and consumer behaviour, measurement, life style profiles, mobility, geo-demographic clustering, affluent and middle-class consumer, working class and non-affluent consumers, selected consumer behaviour applications, culture, needs, culture is dynamic

Subcultures: Age subcultures, sex as a subculture, sub-cultural interaction, cross cultural consumer behaviour-international perspective, consumer analysis, alternative multi-national strategies, psychographic segmentation, marketing mistakes, case studies **10 Hours**

UNIT – 4

The consumer's Decision making process: Introduction, opinion leadership, dynamics, motivation, measurement, profile, frequency and overlap, situational and interpersonal flow, firm's marketing strategy, diffusion and adoption process, profile of consumer innovator, Case studies

06 Hours

UNIT – 5

Consumer Decision making and Beyond: Decision, levels, models of consumers, gifting behaviour, beyond the decision and relationship marketing, case studies **06 Hours**

TEXT BOOKS:

1. Consumer Behaviour, Leon G. Schiffman & Leslie Lazar Kanuk, Prentice Hall India, 8th Edition, 2003

2. Consumer Behaviour, Leon G. Schiffman, Joseph and S. Ramesh Kumar, 11th edition, Pearson Publications, 2015

REFERENCE BOOKS:

1. Case Studies in Consumer Behaviour, S. Ramesh Kumar, Pearson Publications, 1st edition, 2012

2. Consumer Behaviour: A Managerial Perspective, Dheeraj Sharma, Jagdish N. Sheth, Banwari Mittal, Cengage Learning India, 2015

MOOCS:

Consumer Behaviour offered by IIMB through edX

COURSE OUTCOMES:

At the end of the course the student is expected to:

CO 1	Apply knowledge of consumer behaviour principles, concepts and techniques to solve business problems
CO 2	Identify the consumer as an individual and their learning for understanding consumer diversity
CO 3	Distinguish the consumer in their social settings for various aspects of business
CO 4	Understand the consumer decision making process and beyond

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

To set one question from Units 1, 4 and 5 and set two questions from Unit 2 and 3.

Course		Credits : 03			Marks	
Name	**Finite Element Method of Analysis**	**L**	**T**	**P**	**CIE**	**SEE**
Code	**21ME7OEFEA**	**3**	**0**	**0**	**50**	**50**

*** -** Except Mechanical Engineering students

PRE-REQUISITES:

Engineering Mechanics

SYLLABUS:

UNIT – 1

Fundamental concepts: Principles of Elasticity: Concept of stress – Stress at a point – equilibrium equations. strain displacement relationships in matrix form – Constitutive relationships for plane stress, plane strain. **03 Hours**

Introduction to Finite Element Method (FEM), basic concept, historical background, engineering applications, Classification of elements, Banded matrix and node numbering, Steps for solving problems using FEM. Commercial packages – preprocessor, solver and post processor. **02 Hours**

Approximate method of structural analysis – Rayleigh-Ritz method, Galerkin's method, Finite element method etc. Rayleigh-Ritz method applied to simple problems on axially loaded members and beam. **05 Hours**

UNIT – 2

One dimensional problems: Finite Element Modeling using two noded bar element– Definition of generalized coordinates and identification of degrees of freedom. Polynomial based interpolation model, Convergence criteria, Shape functions, Stiffness matrix by minimum potential energy principle, Properties of stiffness matrix, Global stiffness matrix, Consistent load vectors for traction and body force and Temperature effects. Numerical problems on simple bars subjected to forces and temperature change for displacements, reactions and stresses. **06 Hours**

UNIT – 3

Analysis of Trusses and beams: Formulation of stiffness matrix for trusses. Hermite shape functions, Formulation of stiffness matrices for beams, Consistent load vectors for uniformly distributed load and triangular load. Numerical examples on beams and Trusses.**06 Hours**

UNIT – 4

Two dimensional problems: Nodal displacement parameters, PASCAL's triangle – geometric isotropy. Shape functions in Cartesian and Natural coordinates for three noded triangular (CST) and four noded quadrilateral elements. Concept of isoparametric elements, Development of strain-displacement matrix and stiffness matrix, Jacobian matrix, consistent nodal load vector.

06 Hours

Sub-parametric and Super-parametric elements and Numerical integration using gauss quadrature approach. Higher order elements – Serendipity and Lagrangian family of Finite elements. **04 Hours**

UNIT – 5

Structural dynamics: Steps in FEM applied to problems in Structural dynamics – Consistent and lumped mass matrices – evaluation of Eigen values and Eigen vectors for simple bars and beams.

07 Hours

TEXT BOOKS:

1. Krishnamoorthy C.S.**, "Finite Element Analysis**", 2nd ed., Tata-McGraw-Hill Education Pvt. Ltd., 2004.

2. Desai.Y.M., Eldho.T.I., and Shah. A.H., **"Finite Element Method with Applications in Engineering",** Pearson publication, 2011.

REFERENCE BOOKS:

1. Chandrupatla T.R., and Belegundu A.D., "Introduction to Finite Elements in Engineering", 2nd ed., Prentice Hall, India, 2003.
2. Zienkiewicz O.C., "The Finite Element Method – Basic & Fundamentals", 7th ed., Book-Aid International, 2013.
3. Reddy J.N., "An Introduction to the Finite Element Method", 3rd ed., McGraw-Hill, 2005.
4. Cook R.D., "Concepts and Applications of Finite Element Analysis", 4th ed., John Wiley & Sons, 2004.
5. Rajashekaran S., "Finite Element Analysis in Engineering Design", Wheeler Publishing, 2006.
6. Logan D.L., "First Course in the Finite Element Method", 4th ed., Cengage Learning, 2007.
7. Hughes T.J.R., The Finite Element Method: Linear Static and Dynamic Finite Element Analysis", 1st ed., Dover Publications, 2000

MOOCs

1. https://nptel.ac.in/courses/112/104/112104116/
2. https://nptel.ac.in/courses/105/105/105105041/
3. Finite Element Method (FEM) Analysis and Applications https://www.edx.org/course/finite-element-method-fem-analysis-tsinghuax-70120073x
4. A Hands-on Introduction to Engineering Simulations https://www.edx.org/course/hands-introduction-engineering-cornellx-engr2000x

Alternate assessment tool (AAT) for CIE: Utilization of finite element software to simulate practical problems – ABAQUS/ANSYS.

COURSE OUTCOMES:

At the end of the course the student is expected to:

CO1	**APPLY** basics of Theory of Elasticity to continuum problems.
CO2	**FORMULATE** finite elements like bar, truss and beam elements for linear static structural analysis.
CO3	**DEVELOP** finite element models for 2D elements
CO4	**COMPUTE** Mass matrices for bar and beam elements.
CO5	**SOLVE** problems of limited complexity in Linear static and Dynamics of structures
CO6	**UTILIZE** finite element software to simulate practical problems.

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.
To set one question each from Unit 2, 3 & 5 and Two questions each from Units 1 & 4.

Course		Credits : 03			Marks	
Name	**Operations Research***	**L**	**T**	**P**	**CIE**	**SEE**
Code	**21ME7OEOPR**	**3**	**0**	**0**	**50**	**50**

*** -** Except Mechanical Engineering students

PRE-REQUISITES:

Matrix computations, Statistics and Probability

SYLLABUS:

UNIT – 1

Introduction: Evolution, definition, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, Linear Programming Problems (LPP) - Formulation of LPP-Graphical solution. Use of slack, surplus and artificial variables, Canonical and Standard forms, Solution of LPPs using Simplex method, Big- M method. **07 Hours**

UNIT – 2

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner method, least cost method, Vogel approximation method, Degeneracy in transportation problems, optimal solutions by MODI method. **08 Hours**

UNIT – 3

Assignment Problem: Formulation, types, Hungarian method for assignment problem, Unbalanced assignment problem, application to maximization cases and travelling salesmen problem **08 Hours**

UNIT – 4

PERT-CPM Techniques: Introduction, network construction-AON & AOA diagrams, Fulkerson's rule for numbering the events, Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project. Predicting the completion time of project; crashing of simple projects. **09 Hours**

UNIT – 5

Game Theory: Formulation of games, types, solution of games with saddle point, Solution of games without saddle point, 2x2 games without saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games **08 Hours**

TEXT BOOKS:

1. **S.D. Sharma-Operations Research**, Kedarnath Ramanath & Co.2002
2. **Operations Research**, R. Panneer selvam-, 2nd Edition, PHI Learning Private Limited 2011
3. **Schaumn Outline series**, Richard Bronson, Govindasami Naadimuthu: -2nd Edition, Tata McGraw Hill Edition 2004, Eleventh reprint 2011.

REFERENCE BOOKS:

1. **Introduction to Operations Research**, Hiller and Liberman – 9th Edition Mc Graw Hill Publications
2. **Operations Research,** Hamdy A Taha H A- 8th Edition, Pearson Prentice Hall.
3. **Operations Research,** Kanti Swarup, P K Gupta, Man Mohan - Sultan Chand & Sons, 2010.

E-BOOKS:

1. https://books.google.co.in/books?isbn=8131711048, Taha – 2008. 2.
2. https://books.google.co.in/books?isbn=8121902819 – 3.
3. https://books.google.co.in/books?isbn=8131700003,A. M. Natara P. Balasubramani –

2006

COURSE OUTCOMES:

At the end of the course the student is expected to:

CO 1	Formulate a real-world problem as a mathematical programming model.
CO 2	Formulate and solve transportation models by applying cost cutting strategies.
CO 3	Formulate and solve assignment models and travelling salesmen problems.
CO 4	Construct a project network and apply program evaluation review technique and critical path management.
CO 5	Employ Game theory for strategic decision making.

Scheme of Examination (SEE):

Answer five full questions selecting one from each unit.

To set one question each from Units 2, 3 & 5 and two questions each from Units 1 & 4.

(OPEN ELECTIVE-II)

Course Title	**ELECTRICAL POWER AND ENERGY CONSERVATION				
Course Code	19EE7OE2EC	Credits	3	L-T-P	3-0-0

**** Except those EEE students who have taken Electrical Energy Conservation and Auditing - 19EE5PE1EA as Program Elective – I**

Prerequisites: Basic electrical engineering

Course Description: Objective: Energy studies and Energy management concerns the issues regarding optimal use of our present and future energy sources. This course is intended to address economic and environmental problems due to energy use, by considering the technical, economic and social factors that affect the demand for energy. On completing the course, one would have a good knowledge of how economic analysis can help understanding problems related to energy supply and use ; be able to analyze alternative energy policy options in terms of benefits and costs; have a good understanding of energy markets; be able to analyze the risks associated with energy options. Will also have acquired the skills needed to structure, analyse and evaluate energy related problems.

Course outcomes:

At the end of the course, the student will have the ability:

CO1	Ability to apply the knowledge and try to solve the problems of power crisis in India by analyzing different load availability with respect to requirements and demand.
CO2	Ability to select and apply different methods of tariffs used in practice so as to motivate and apply the energy conservation methods in various sectors of energy use.
CO3	Ability to analyze various energy auditing methods to conserve energy in various sectors
CO4	Ability to analyze different load curves of various energy sectors and apply load control methods for optimal use of electricity.

UNIT-I **07 Hrs**

Introduction: Electrical Energy demand, Electrical Energy growth in India, Growth of Electrical Energy consumption, Electrical Energy losses, Electrical Energy sources, conventional and nonconventional energy sources, power crisis in India, future Energy demand in India.

UNIT-II **08 Hrs**

Load and Load curves: Energy requirements, Maximum Demand, Group Diversity factor, Peak Diversity factor, type of load, load factor, capacity factor, utilization factor, base load and peak load plant. Numerical. Tariff: Objective, General Tariff forms, Types of Tariff, Numerical. Load plant. Numerical. Tariff: Objective, General Tariff forms, Types of Tariff, Numerical.

UNIT-III **08 Hrs**

Energy conservation: Introduction, motivation for Energy conservation, principles of Energy conservation, Energy conservation planning, Energy conservation in Industries, Energy conservation in Generation, Transmission and Distribution, Energy conservation in household and commercial sectors, Transport and Agriculture.

UNIT-IV **08 Hrs**

Energy Audit: Aim of Energy Audit, Energy flow diagram, Energy management team, Considerations in implementing Energy conservation programs, Periodic progress review, Instruments for Energy Audit, Energy Audit for illumination system, Energy Audit for heating, Ventilation, Air-condition systems, Energy Audit for compressed air systems and Energy Audit of Buildings.

UNIT-V **08 Hrs**

Concept of Demand Side Management (DSM), Load management as a DSM Strategy, Applications of Load control, End use Energy Conservation, Tariff options for DSM, DSM & Environment.

Unit Choice: Unit-II and Unit-IV

Text books:

1. Generation of Electrical Energy: B.R.Gupta, Chand & Company, 5th Edition
2. Energy Management: Umesh Rathore, S.K.Kataria & Sons, 2nd edition, 2004

Reference books:

1. Energy Management Handbook

E-Learning :

1. https://books.google.co.in/books?isbn=0881735434, Steve Doty – 2007
2. https://books.google.co.in/books?isbn=1315356619, D. Yogi Goswami – 201

Course Title	ELECTRIC AND HYBRID VEHICLES				
Course Code	19EE7OE2EV	Credits	3	L-T-P	3-0-0

Course outcomes:

At the end of the course, the student will have the ability:

CO1	Acquire in depth knowledge of the electric vehicle system and its components and various modes of operation.
CO2	Estimate and analyse the performance parameters including energy consumption, tractive effort etc. associated with an electric vehicle under different conditions of operation and also various types of electric drive systems suitable for electric vehicle operation.
CO3	Analyse various energy storage technologies used in electric vehicles
CO4	Demonstrate various configurations of Electric vehicles
CO5	Classify the configurations of Electric and Hybrid Electric Vehicles
CO6	Present a technical report on modelling and operation of Electric vehicles.

UNIT-I **04 Hrs**

Environmental impact and history of modern transportation: Air pollution, global warming, importance of different transportation, history of electric vehicles.

UNIT-II **08 Hrs**

Fundamentals of vehicle propulsion and brake: General description of vehicle movement, Vehicle resistance, dynamic equation, tire ground adhesion, and maximum tractive effort. Power train tractive effort and vehicle speed, vehicle power plant and transmission characteristics, vehicle performance, operating fuel economy, brake performance.

UNIT-III **08 Hrs**

Electric Vehicles and Hybrid Electric Vehicles: Configuration of EVs, performance of EVs, tractive effort in normal driving, energy consumption

Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains

UNIT-IV **08 Hrs**

Energy storages for electric vehicles: Electrochemical batteries, ultra capacitors, ultra high speed flywheels, hybridization of energy storage.

UNIT-V **08 Hrs**

Fundamentals of regenerative braking: Braking energy consumed in urban driving, Braking energy versus vehicle speed, braking energy versus braking power braking power versus vehicle speed, braking energy versus vehicle deceleration rate, brake system of EV.

Unit choice: **Unit 2 and Unit 3**

Text books:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles; Fundamentals Theory and Design", Second Edition, CRC Press.
2. Iqbal Husain, "Electric and Hybrid Vehicles; Design Fundamentals", CRC Press.

Reference books:

1. Chris Mi M. Abul Masrur, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Second Edition https://onlinelibrary.wiley.com/doi/book/10.1002/9781118970553
2. Tom Denton, Electric and Hybrid Vehicles, ISBN 9780367273231, Published June 10, 2020 by Routledge https://www.routledge.com/Electric-and-Hybrid-Vehicles/Denton/p/book/9780367273231
3. Amir Khajepour, M. Saber Fallah, Avesta Goodarzi, Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach, ISBN: 978-1-118-40310-5 https://www.wiley.com/en-us/Electric+and+Hybrid+Vehicles%3A+Technologies%2C+Modeling+and+Control+A+Mechatronic+Approach-p-9781118403105

E-Learning :

1. Introduction to Hybrid and Electric Vehicles: https://nptel.ac.in/courses/108/103/108103009/

BMS COLLEGE OF ENGINEERING, BANGALORE-19
(Autonomous College under VTU)
DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING
2018 Onwards

Course Title	**FUNDAMENTALS OF MOBILE COMMUNICATIONS**				
Course Code	**19EC7OE2MC**	**Credits**	**3**	**L-T-P**	**3:0:0**
CIE	**50 Marks(100% weightage)**	**SEE**		**100 Marks (50% weightage)**	

Course outcomes:
At the end of the course, the student will have the ability to

CO	Course Outcomes
1	**Acquire** the knowledge of mobile communications fundamentals and standards and apply in solving traffic problems
2	**Investigate** on m commerce life cycle, financial services, entertainment services, - content development and distribution and caching, through literature survey and use cases

Unit-I **07hrs**

Introduction to mobile communication, spectrum allocation, services and range of operation. Evolution of Mobile communication from 2G to 4G,WLAN, Bluetooth,Multiple Access Technologies: FDMA, TDMA, CDMA, organizational structure in mobile industry.

Unit-II **08 hrs**

Cellular Concepts , Frequency reuse, channel assignment strategies, call establishment, handoff mechanism, trunking concepts, Capacity expansion methods

Unit-III **08 hrs**

GSM architecture, frequency allocation, channels in GSM, frame structure, handoff mechanisms, power control mechanism, Call establishment, and security mechanism

Unit-IV **08 hrs**

EDGE architecture, UMTS architecture , LTE Architecture, Wireless LAN (Wi-Fi), Mobile IP architecture, Emerging Wireless systems: Adhoc Wireless networks, Sensor networks, Distributed control network, ultra wideband systems (UWB).

Unit-V **08 hrs**

Mcommece-framework, different players, lifecycle, Different Mobile commerce applications and services, content development and distribution, technologies, standard bodies

Choice: Unit-III and Unit-IV

Text Books:

1. Theodore Rappaport "wireless Communications , Principle and practise" Prentice hall 2005
2. Brian Mennecke, Troy J. Strader, "Mobile Commerce: Technology, Theory and Applications", IdeaGroupPublishing,

REFERENCE BOOKS:

1. Wireless Communication- Andreas F Molish, Wiley Student, Second Edition

Ebooks:

1. https://www.amazon.in/Wireless-Communications-Principles-Practice-2e/dp/8131731863

2. https:// www.amazon.com/Mobile-Commerce-Technology-Theory-Applications/dp/159140044 9

MOOCS:

1. Wireles communication for everybody
   https://www.coursera.org/learn/wireless-communications

2. Introduction to Wireless and Cellular Communications, By Prof. R. David Koilpillai | IIT Madras
   i. https://swayam.gov.in/nd1_noc20_ee61/preview

Course	HUMAN RESOURCE MANAGEMENT	Course Code	21IM7IEHRM
Credits	03	L-T-P	3-0-0

Prerequisites: Nil

UNIT – 1

INTRODUCTION: Evolution of HRM, Objectives, Functions and Policies.

HUMAN RESOURCE PLANNING: Uses and benefits, Man Power Inventory, Man Power Forecasting, Methods of Man Power Forecasting, job Description, Job Specification. **8Hrs**

UNIT - 2

RECRUITMENT: Sources of Man power, Advertisement, Short Listing of Candidates calling Candidates for selection Process.

SELECTION: Selection procedure – Written Test, Group Discussion. Interview – Different methods, advantages and Limitations, Psychological testing – Advantages and limitations, Induction procedure, transfers, promotion exit interview, (Tutorial on written test, Group discussion, Interviews).

11Hrs

UNIT - 3

TRAINING AND DEVELOPMENT: Identification of Training needs, Training Evaluation, Training Budget, Executive Development – Different Approaches, Non-executive development – Different methods.

PERFORMANCE APPRAISAL: Components (all round performance appraisal), Methods. Advantages and limitations of different methods, Personal Counseling based on Annual Confidential Reports.

11Hrs

UNIT - 4

COUNSELLING AND HUMAN RESOURCE ACCOUNTING: Characteristics, Need, Function, Types, Suggestions for personnel development, communication function, communication process, effective communication. Human resource records, Advantages of HR accounting, various methods of accounting. **5Hrs**

UNIT – 5

INDUSTRIAL RELATIONS: Indian trade union act, standing orders act, Indian factories act.

INDUSTRIAL DISPUTES AND SETTLEMENT: Indian Industrial Disputes act, Industrial disputes settlement machinery. Works committee, Board of Conciliation, Voluntary Arbitration, Compulsory arbitration, Court of inquiry, Industrial tribunal, Adjudication. **5Hrs**

TEXT BOOKS:

1. **Human Resources Management** – Dr. K Ashwathappa, Tata McGraw Hill, Edition 1999
2. **Management of Organisations Behaviour** – Hersey and Blanchard – Prentice Hall of India Edn – 1998

3. **Industrial Relations** – ArunMonappa – TMH, ISBN – 0-07-451710-8

REFERENCES BOOKS:

1. **Personnel / Human resource Management** – Decenoz and Robbins PHI, 2002
2. **Management of Human Resources** – CB Mamoria – Himalaya Publication House, 2003
3. **Industrial Acts** by Jain, 2004

ONLINE REFERENCE:www.shrm.org,

COURSE OUTCOMES

CO#	Course Outcomes	POs	Strength
CO1	Ability to understand and explain the concept of Human Resource Management	-	1
CO2	Ability to apply the processes related to Human Resource Management.	PO1	2
CO3	Ability to analyze the behaviour of individuals with respect to legal implication with respect to Industrial Relations	PO2	2
CO4	Ability to demonstrate and communicate effectively in oral and written forms about personnel interviews , selection placement induction, orientation, training and development.	PO9, PO10	3
CO5	Ability to evaluate- audit, account, record keeping and monitoring behaviours in organizations	PO5	2

SCHEME OF EXAMINATION:
One question to be set from units 1,4 & 5 and two questions from units2& 3

ASSESSMENT
Continuous Internal Evaluation (CIE) includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

Semester End Examination (SEE)-a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

Course	SUPPLY CHAIN AND LOGISTICS MANAGEMENT	Course Code	21IM7IESCM
Credits	03	L-T-P	3-0-0

Prerequisites: Nil

UNIT-1

INTRODUCTION TO SUPPLY CHAIN: Understanding Supply Chain - Objectives- importance Decision phases – Process view of a supply chain – Examples of supply chains – Supply chain performance - An overview: Competitive and supply chain strategies- Achieving strategic fit- Expanding strategic scope. Drivers of Supply Chain Performance: Framework for structuring drivers: Facilities, Inventory, Transportation, Information, Sourcing, Pricing, obstacles to achieving fit. **06 Hrs**

UNIT-2

DESIGNING THE SUPPLY CHAIN NETWORK: The Role of Distribution in the Supply Chains, Factors influencing distribution Network design, Design Options for a Distribution Network, e-Business and the Distribution network, Distribution Networks in practice. Factors influencing network design decisions, Framework for Network design decisions, Models for Facility location and Capacity allocation, The role of IT in Network design. The impact of uncertainty on network design, Discounted cash flow analysis, Representations of Uncertainty, Evaluating Network Design Decisions Using Decisions Trees, Risk Management and Network Design. Problems to be discussed. **06 Hrs**

UNIT-3

INVENTORY MANAGEMENT IN SUPPLY CHAIN: Definition of Inventory, inventory classification: P-System, Q-System, ABC system, VED, FSND and XYZ analysis. Classification of Inventory Models, Derivation and problems considering EOQ model for a single product with and without shortage. Economies of Scale to Exploit Quantity Discounts, Short-Term Discounting, Trade Promotions. The Role of Safety Inventory in a Supply Chain, Determining appropriate level of Safety inventory, Impact of supply Uncertainty on Safety inventory, Impact of aggregation on safety inventory, impact of replenishment policies on safety inventory. The Role of IT in inventory management. Problems to be discussed. **11 Hrs**

UNIT-4

DESIGNING AND PLANNING TRANSPORTATION NETWORKS: The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation, The role of IT in transportation. Problems to be discussed.

Managing Cross-Functional Drivers In A Supply Chain: The role of sourcing in a supply chain, in-house or outsource, Third-and Fourth-party logistics providers, Supplier scoring and assessment, Supplier selection-Auctions and Negotiations,Contracts and supply chain performance, Design Collaboration, The procurement process, sourcing planning and analysis, the role of IT in sourcing. **11 Hrs**

UNIT-5

CURRENT TRENDS IN SUPPLY CHAIN & LOGISTIC MANAGEMENT: Over view on e-SRM, e-LRM, e-SCM and block chain in SCM. Introduction to Supply Analytics: Descriptive Analytics, Prescriptive Analytics and Predictive Analytics. The role of sustainability in a Supply Chain, Key Metrics for sustainability and its drivers. Introduction to Reverse logistics, Closed Loop Supply Chains, Lean and Agile supply chains. **06 Hrs**

TEXT BOOKS:

1. **Supply Chain Management**, Chopra, S., Meindi, P. and Kalra, D.V., 7th Edition, Pearson, 2018.
2. **Designing And Managing the Supply Chain** David SimchiLevi , Edith Simchi Levi , Ravi Shankar and Philip Kaminsky, : Concepts, Strategies and Case studies, 3rd Edition, McGraw-Hill, 2019.
3. **Materials Management:** Procedures, Text and Cases, A K Datta, 2nd Edition, Prentice Hall India Learning Private Limited, 1998.
4. **Introduction to Materials Management** Chapman, Gatewood, Arnold and Clive, , 8th Edition, Pearson Education India, 2016.

REFERENCE BOOKS:

1. **Supply Chain Logistics Management** Bowersox, McGraw Hill Education, 4th Edition, 2018.
2. **Supply Chain Management: A Logistics Perspective,**John J. Coyle, Jr. C. John Langley, Robert A. Novack and Brian J. Gibson, 10th Edition, 2019
3. **Principles of Supply Chain Management (Resource Management)**Richard E. Crandall, William R. Crandall, Charlie C. Chen, , 2nd Edition, 2014.
4. **Introduction to Materials Management,** Stephen N. Chapman, Tony K. Arnold, Ann K. Gatewood, Lloyd Clive, 8th Edition, Pearson, 2016

ONLINE RESOURCE: www.nptel.ac.in

COURSE OUTCOME

CO#	Course Outcomes	POs	Strength
CO1	Understand supply chain basics, Role of SCM as systemic and strategic nature in dealing with global competitive environment	-	1
CO2	Evaluate supply chain alternatives and distribution network structures applying Operation Research models.	PO1, PO6	3
CO3	Develop optimum sourcing and inventory policies in the supply chain context.	PO2	3
CO4	Select and incorporate latest practices for managing supply chain processes	PO4	2

SCHEME OF EXAMINATION: One Question to be set from **unit 1,2 & 5** and Two Questions from **unit 3 &4.**

ASSESSMENT:

Continuous Internal Evaluation (CIE) includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

Semester End Examination (SEE)-a written examination for theory course.Both CIE and SEE have equal (50:50) weights. The student's performance in a course shallbe judged individually and together based on the results of CIE and SEE

Course	OPERATIONS RESEARCH	Course Code	21IM7IEOPR
Credits	03	L-T-P	3-0-0

Prerequisites: NIL

UNIT-1

INTRODUCTION: Evolution, definition, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, Linear Programming Problems (LPP) - Formulation of LPP-Graphical solution. Use of slack, surplus and artificial variables, Canonical and Standard forms, Solution of LPPs using Simplex method, Big- M method. **11 Hrs**

UNIT-2

TRANSPORTATION PROBLEM: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner method, least cost method, Vogel approximation method, Degeneracy in transportation problems, optimal solutions by MODI method. **06 Hrs**

UNIT-3

ASSIGNMENT PROBLEM- Formulation, types, Hungarian method for assignment problem, Unbalanced assignment problem, application to maximization cases and travelling salesmen problem **06 Hrs**

UNIT-4

PERT-CPM TECHNIQUES: Introduction, network construction-AON & AOA diagrams, Fulkerson's rule for numbering the events, Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project. Predicting the completion time of project; crashing of projects. **11 Hrs**

UNIT-5

GAME THEORY: Formulation of games, types, solution of games with saddle point, Solution of games without saddle point, 2x2 games without saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **06 Hrs**

TEXT BOOK:

1. S.D. Sharma-Operations Research, Kedarnath Ramanath & Co. 2002
2. R. Panneerselvam-Operations Research, second edition, PHI Learning Private Limited 2011.
3. Richard Bronson, Govindasami Naadimuthu:Schaumn Outline series-second edition, Tata McGraw Hill edition 2004, Eleventh reprint 2011.

REFERENCE BOOKS:

1. Hiller and Liberman -Introduction to Operations Research, Ninth edition McGraw Hill Publications.

2. Hamdy ATaha H A- Operations Research, eighth edition, Pearson Prentice Hall.
3. KantiSwarup, P K Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, 2010.

E-LEARNING:

1. **https://books.google.co.in/books?isbn=8131711048, Taha-2008**
2. **https://books.google.co.in/books?isbn=8121902819D S Hira-2008**
3. **https://books.google.co.in/books?isbn=8131700003, A. M. Natarajan, PBalasubramani-2006**

Question Paper Pattern:

1. Each unit consists of one full question.
2. Each full question consists of two, three or four subdivisions.
3. Five full questions to be answered.
4. Internal choice in Unit 1 and Unit 4.

COURSE OUTCOMES

CO#	Course Outcomes	POs	Strength
CO1	Ability to understand the concepts, approaches and optimization in Operation Research Techniques.	-	1
CO2	Ability to apply and develop the mathematical skills related to Operation Research Techniques.	PO2	3
CO3	Ability to analyze and solve network models arising from a wide range of applications	PO3	3
CO4	Ability to evaluate real world problems using Operation Research Techniques.	PO4	2

ASSESSMENT

Continuous Internal Evaluation (CIE) includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

Semester End Examination (SEE)-a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE

B. M. S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

DEPARTMENT OF CSE

Academic Year	Aug-Dec 2021/Jan-May-2022	**Sem**	7th
Course Title:	**Data Science**		
Course Code:	21CS7OEDAS		
L-T-P:	3-0-0	**Total Credits:**	3

A Syllabus

Unit No.	Topics	Hrs	Text book No. from which Unit topics are being covered
1	**Introduction to Data Science**: Data Analysis Life Cycle Overview. Data analysis Discovery, Framing Problem, Developing Initial Hypothesis, Sources of Data, Process for Making Sense of Data, Data Preparation, Performing ETLT, Data Conditioning, Survey and Visualize, Common tools for Data Preparation Phase, Data Exploration and Variable Selection, Common tools for the Model Planning and Building Phase, Communicate Results, Operationalize	6	**Book 2: Chapter 2**
2	**DESCRIBING DATA:** Observations and Variables, Types of Variables, Central Tendency, Distribution of the Data, Confidence Intervals, Hypothesis Tests, Student t-test	6	**Book 1: Chapter 2**
3	**PREPARING DATA TABLES:** Cleaning the Data, Removing Observations and Variables, Generating Consistent Scales Across Variables, New Frequency Distribution, Converting Text to Numbers, Converting Continuous Data to Categories, Combining Variables, Generating Groups, Preparing Unstructured Data.	7	**Book 1: Chapter 3**
4	**UNDERSTANDING RELATIONSHIPS:** Visualizing Relationships Between Variables, Calculating Metrics About Relationships. **IDENTIFYING AND UNDERSTANDING GROUPS:** Clustering, K-means, Association Rules, Apriori Algorithm and Applications of Association Rules	10	**Book 1 Chapter 4, 5 Book 2: Chapter 4,5**
5	**BUILDING MODELS FROM DATA:** Linear Regression, Logistic Regression, Bayes Theorem, Naive Bayes Classifier, *k*-Nearest Neighbours, Learning Decision Trees from Data.	10	**Book 1 Chapter 6 Book 2 : Chapter 7**

Prescribed Text Book					
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**
1.	Making sense of Data: A practical Guide to Exploratory Data Analysis and Data Mining	Glenn J. Myatt	2nd Edition	Wiley	2014
2	Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data	EMC Education services	---	EMC Education services	2015

Reference Text Book					
Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Python Data Science Handbook	Jake VanderPlas	1st Edition	O'Reilly	2017

E-Book						
Sl. No.	Book Title	Authors	Edition	Publisher	Year	URL
1.	Python Data Science Handbook	Jake VanderPlas	1st Edition	O'Reilly	2017	https://www.onlineprogrammingbooks.com/python-data-science-handbook/

MOOC Course				
Sl. No.	Course name	Course Offered By	Year	URL
1.	Data Science Methodology	Coursera	-	https://www.coursera.org/learn/data-science-methodology
2.	Foundations of Data Science	edX	-	https://www.edx.org/course/foundations-of-data-science

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DEPARTMENT OF CSE

B **Course Outcomes**

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

CO1	Apply the concept of Data Science to various applications.
CO2	Analyse the usage of appropriate Data analytics technique for a given application.
CO3	Design and develop a data analytics method for different applications.

C **CO-PO-PSO mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3			3											2	

Indicate strength of mapping (1/2/3) with justification

D **Assessment Plan (for 50 marks of CIE)**

Tool	Remarks	Marks
Internals	**TWO**	40
QUIZ	**TWO**	10
Lab Component	--	--
Alternate Assessment Tool	--	--
Total		**50**

E **Tutorial Plan** *(if applicable)*

F **Laboratory Plan** *(if applicable)*

G **Alternate Assessment ToolPlan** *(if applicable)*

H **SEE Exam Question paper format**

Unit-1	Mandatory	One Question to be asked for 20Marks
Unit-2	Mandatory	One Question to be asked for 20Marks
Unit-3	Mandatory	One Question to be asked for 20Marks

Unit-4	Internal Choice	Two Questions to be asked for 20 Marks each	
Unit-5	Internal Choice	One Question to be asked for 20Marks	

Bloom's Level	**Percentage of Questions to be Covered**
Remember / Understand	35%
Apply / Analyze	40%
Create / Evaluate	25%

B. M. S. COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

DEPARTMENT OF CSE

Academic Year	**Aug-Dec 2021/Jan-May-2022**	**Sem.**	**7**
Course Title:	**Python Programming**		
Course Code:	**21CS7OEPYP**		
L-T-P:	**3-0-0**	**Total Credits:**	**3**

A Syllabus

Unit No.	Topics	Hrs	Text book No. from which Unit topics are being covered
1	**Python Basics:** **Variables, expressions, and statements:** Values and types, Variables, Variable names and keywords, Statements, Operators and operands, Expressions, Order of operations, Modulus operator, String operations, Asking the user for input, Comments, Choosing mnemonic variable names, Debugging, Conditional execution, Boolean expressions, Logical operators, Conditional execution, Alternative execution, Chained conditionals, Nested conditionals, Catching exceptions using try and except, Short-circuit evaluation of logical expressions **Functions:** Function calls, Built-in functions, Type conversion functions, Random numbers, Math functions, Adding new functions, Definitions and uses, Flow of execution, Parameters and arguments, Fruitful functions and void functions, Why functions **Iteration:** Updating variables, The while statement, Infinite loops, break, Finishing iterations with continue, Definite loops using for, Loop patterns, Counting and summing loops, Maximum and minimum loops	**8**	**Text Book 1** **Chapter 1** **1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 1.10, 1.11** **Chapter 2** **2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13** **Chapter 3** **3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8, 3.9** **Chapter 4** **4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12** **Chapter 5** **5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7**
2	**Strings:** A string is a sequence, Getting the length of a string using len, Traversal through a string with a loop, String slices, Strings are immutable, Looping and counting, The in operator, String comparison, string methods, Parsing strings, Format operator **Lists:** A list is a sequence, Lists are mutable, Traversing a list, List operations , List slices, List methods, Deleting elements , Lists and functions, Lists and strings, Parsing lines, Objects and values, Aliasing, List arguments **Dictionaries:** Dictionary as a set of counters, Dictionaries and files, Looping and dictionaries, Advanced text parsing **Tuples**: Immutable, Comparing tuples, Tuple Assignment, Dictionaries and Tuples, Multiple Assignments with Dictionaries, Using Tuples as keys in Dictionary	**8**	**Text Book 1** **Chapter 6** **6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8, 6.9, 6.10, 6.11** **Chapter 8** **8.1, 8.2, 8.3, 8.4, 8.5, 8.6, 8.7, 8.8, 8.9, 8.10, 8.11, 8.12, 8.13** **Chapter 9** **9.1, 9.2, 9.3, 9.4** **Chapter 10** **10.1, 10.2, 10.3, 10.4, 10.5, 10.7**

3	**Object-Oriented Programming:** Managing Larger Programs, Getting Started, Using Objects, Starting with Programs, Subdividing a Problem – Encapsulation, Our First Python Object, Classes as Types, Object Lifecycle, Many Instances, Inheritance, Classes and Methods, Operator overloads **Exceptions:** Exception Class Hierarchy, User-Defined Exceptions	**8**	**Text Book 1** **Chapter 14** **14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8, 14.9, 14.10** **Text Book 2** **Chapter 14** **14.1, 14.2**
4	**Regular expressions**: Character matching in regular expressions, Extracting data using regular expressions, combining searching and extracting, Escape character **Files:** Persistence, Opening files, Text files and lines, Reading files, Searching through a file, Letting the user choose the file name, Using try, except, and open, Writing files	**7**	**Text Book 1** **Chapter 7** **7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8** **Chapter 11** **11.1, 11.2, 11.3, 11.4**
5	**Databases**: How to Use a Database, Working With a Database , Using SQL to Query a Database, Python and SQLite, Creating an SQLite DB, Pulling Data from a DB, SQLite Database Files. **Visualizing Data:** Building a OpenStreetMap from geocoded Data, Visualizing networks and interconnections, Visualizing mail data	**8**	**Text Book 2** **Chapter 17** **17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7** **Text Book 1** **Chapter 16** **16.1, 16.2, 16.3**

Prescribed Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Python for Everybody: Exploring Data Using Python 3	Charles R. Severance	First	University of Michigan	2016
2	Learning to Program using Python	Cody Jackson	Second	Packt Publishing	2018

Reference Text Book

Sl. No.	Book Title	Authors	Edition	Publisher	Year
1	Programming Python	Mark Lutz	Fourth	O'Reilly Media	2010
2	Python Essential Reference	David M. Beazley	Fourth	Pearson	2009
3	Core Python Applications Programming	Wesley J Chun	Third	Pearson	2015

E-Book						
Sl. No.	**Book Title**	**Authors**	**Edition**	**Publisher**	**Year**	**URL**
1	Think Python	Allen B. Downe	Second	Green Tea Press, Needham, Massachusetts	2014	https://greenteapress.com/thinkpython2/thinkpython2.pdf
2	Python Pocket Reference	Mark Lutz	Fifth	O'Reilly Media, Inc.	2014	https://github.com/MrAlex6204/Books/blob/master/python-pocket-reference-5th-edition.pdf

MOOC Course				
Sl. No.	**Course name**	**Course Offered By**	**Year**	**URL**
1	An Introduction to Interactive Programming in Python (Part 1)	Coursera	2021	https://www.coursera.org/course/interactivepython1
2	An Introduction to Interactive Programming in Python (Part 2)	Coursera	2021	https://www.coursera.org/course/interactivepython2
3	Introduction to Python Programming	edX	2021	https://www.edx.org/professional-certificate/introduction-to-python-programming

B Course Outcomes

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

CO1	Apply knowledge of Python constructs for developing programs/applications.
CO2	Analyse the given Python program to identify bugs and to write correct code.
CO3	Design Python programs/ applications for a given requirement.

C CO-PO-PSO mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**														
CO2		**3**													
CO3			**3**											**3**	

D Assessment Plan (for 50 marks of CIE)

Tool	Remarks	Marks
Internals	**TWO**	**40**
QUIZ	**TWO**	**10**
Lab Component	**-**	**--**
Alternate Assessment Tool	**--**	**--**
Total		**50**

E Tutorial Plan *(if applicable)*

F Laboratory Plan *(if applicable)*

G Alternate Assessment ToolPlan *(if applicable)*

H SEE Exam Question paper format

Unit-1	**Mandatory**	One Question to be asked for 20 Marks
Unit-2	**Internal Choice**	Two Questions to be asked for 20 Marks each
Unit-3	**Internal Choice**	Two Questions to be asked for 20 Marks each
Unit-4	**Mandatory**	One Question to be asked for 20 Marks
Unit-5	**Mandatory**	One Question to be asked for 20 Marks

Bloom's Level	**Percentage of Questions to be Covered**
Remember / Understand	25%
Apply / Analyze	50%
Create / Evaluate	25%

Course Title	ARTIFICIAL INTELLIGENCE & MACHINE LEARNING				
Course Code	20IS7OEAIM	Credits	3	L-T-P	3-0-0
CIE	50 Marks	SEE	100 Marks (50% Weightage)		
Contact Hours / Week	3	Total Lecture Hours			36

UNIT – 1	7 Hrs

Introduction: What is AI?
Intelligent Agents: How agent should act, Structure of Intelligent Agents, Environments
Problem Solving: Formulating problems, Example problems
Uniformed-search strategies: Breadth-First Search, Uniform Cost Search, Depth-First Search, Depth Limited Search, Iterative Deepening Search

UNIT – 2	7 Hrs

Heuristic Search Strategies: Generate-and-Test, Hill Climbing, Best-first Search, Problem Reduction, Constraint Satisfaction, Means-ends Analysis

UNIT – 3	7 Hrs

Learning: Well-posed learning problems, Designing a learning system, Perspectives and Issues in Machine Learning
Concept Learning: Find-S: Finding a maximally specific hypothesis, Version spaces and the candidate-elimination algorithm, Remarks.

UNIT – 4	7 Hrs

Decision Trees: Decision Tree Representation, Appropriate problems for decision tree learning, The Basic decision tree learning algorithm, Hypothesis space search, Inductive bias and Issues in Decision Tree learning.

UNIT - 5	8 Hrs

Artificial Neural Networks: Neural Network Representation, Appropriate problems for neural network learning, Perceptrons, Multilayer networks and Backpropagation algorithm
Machine Learning Project: Steps for End-to-End Machine Learning Project, Examples of Classification and Regression

Text Books:

1. Machine Learning by Tom M Mitchell, McGraw-Hill Education, Indian Edition, 2016.
2. Artificial Intelligence - A Modern Approach, Stuart Russell and Peter Norvig, Third edition, Pearson, 2014.
3. Hands-On Machine Learning with Scikit-Learn & Tensor Flow, Aurelian Geron, 2nd Edition, O'Reilly Media, 2019.

Reference Books:

1. Introduction to Machine Learning 3rd Edition by Ethem Alpaydin, PHI, 2015.
2. Machine Learning in Action by Peter Harrington, Manning Publications, 2012.

3. Artificial Intelligence, Elaine Rich, Kevin Knight and Shivashankar B Nair, Third edition, McGraw-Hill Education, 2015.

e-Books:

1. http://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/understanding-machine-learning-theory-algorithms.pdf
2. http://alex.smola.org/drafts/thebook.pdf
3. https://www.oreilly.com/library/view/hands-on-machine-learning/9781492032632/

MOOCS

1. https://www.coursera.org/learn/machine-learning
2. https://www.udacity.com/course/intro-to-machine-learning--ud120
3. https://swayam.gov.in/nd1_noc19_cs52/preview

Course Title	DATA SCIENCE FOR MACHINE LEARNING				
Course Code	19ET7OE2DM	Credits	3	L:T:P	3:0:0

UNIT I	[8 hours]
Introduction to Data Science. Functions (polynomial functions, exponential, sinusoidal); integration and differentiation of functions. To plot the functions, and perform integration/differentiation using Python	
UNIT II	**[8 hours]**
Probability: Dependence and Independence, Conditional Probability, Bayes's Theorem, Poisson Distribution, Binomial Distribution Random Variables, Continuous Distributions, The Normal Distribution, The Exponential distribution, The Uniform Distribution, The Central Limit Theorem To plot the given distribution, and compute the Mean, variance, standard deviation using Python	
UNIT III	**[8 hours]**
Introduction to Machine learning concepts – Bias/variance, over-fitting and train/test splits. Types of Machine learning – Supervised, Unsupervised, Semi-supervised, Classification and Regression algorithms, Linear Regression, Logistic Regression algorithms, the concept, and implementation using Python.	
UNIT IV	**[8 hours]**
The Naïve Bayes Classifier for Discrete and Continuous Input; Decision Trees (for Discrete and Continuous Input and Output); the concept, and implementation using Python.	
UNIT V	**[8 hours]**
Kmeans Clustering, Regularization (lasso, ridge). Support vector machines (SVM), Analysis of Time Series; Bagging and Boosting (to balance bias and variance) and random forest. Introduction to Neural Networks. Data Science Applications: To implement two or more relevant Machine Learning models on a given data set, and make a comparative study.	
Unit Choice: Unit III and Unit V	

Course Outcomes

CO1	Ability to understand the data science concepts	
CO2	Ability to apply the knowledge of Engineering mathematics and programming skills to develop efficient machine algorithms in data science	**PO1(3)**
CO3	Ability to 1nalyse the regression and classification models	**PO2(2)**
CO4	Ability to design a solution for data science application	**PO3(3)**
CO5	Ability to work as an individual and thereby conduct experiments using matlab/python for a given application/problem statement.	**PO5(3)** **PO9 (3)**
CO6	Develop, test, Analyse and demonstrate applications using python through a mini-project	**PO4(3)** **PO5(3)** **PO11(3)**

TEXT BOOKS:

Data science from scratch (first principles with python) by Joel Grus, Oreilly, April 2015, 1st edition.

REFERENCE BOOKS:

Doing data science (straight talk from the front line) by Rachel Schutt and Cathy O Neil, Oreily, October 2013, 1st edition.

MOOCs: Machine Learning by Andrew NG, Coursera,

https://www.coursera.org/learn/machine-learning

Course Title	SUSTAINABLE HEALTH WITH TECHNOLOGICAL ADVANCES				
Course Code	19ET7OE2SH	Credits	3	L:T:P	3:0:0

UNIT I	[8 hours]

Information Technology and Healthcare

Healthcare Informatics Developments, Different Definitions of Telemedicine, The Growth of E-health to M-health, Evolving from the Internet, Digital Health on the Move, Data as a Sequence of "Packets", Connected World Between Human and Devices

UNIT II	[8hours]

Communication Networks and Services

The Basics of Wireless Communications, Wired vs. Wireless, Types of Wireless Networks – Bluetooth, Infrared (IR) Wireless Local Area Network (WLAN) and Wi-Fi , ZigBee, Li-Fi, Cellular Networks, Broadband Wireless Access (BWA) ,M-health and Telemedicine Applications, RFID in Telemedicine, The Outdoor Operating Environment

UNIT III	[8 hours]

Information and Communications Technology in Health Monitoring

Body Area Networks, Emergency Rescue, Smart Ambulance, Network Backbone, Smart Hospital, Radiology Detects Cancer and Abnormality, Robot Assisted Telesurgery, Ward Management Using RFID , Electromagnetic Interference on Medical Instrument, Smart Wearable Integration, General Health Assessments, Case Studies

UNIT IV	[8 hours]

Data Analytics and Medical Information Processing- Introduction, Non-invasive Health Data Collection, Body Temperature, Heart Rate, Blood Pressure, Respiration Rate, Blood Oxygen Saturation, Blood Glucose Concentration, Biosignal Transmission and Processing, Medical Imaging, Magnetic Resonance Imaging, X-ray, Ultrasound, Medical Image Transmission and Analysis, Image Compression, Biopotential Electrode Sensing, Patient Records and Data Mining Applications, Artificial Intelligence (AI) in Digital Health, Deep Learning, AI in Mobile Health, Virtual Reality (VR) and Augmented Reality (AR)

UNIT V	[8 hours]

Digital Health for Community Care: Radiation Hazards from Cell phones, Safety standards for personnel, Telecare, Telecare for Senior Citizens, Telemedicine in Physiotherapy, Faster Wireless Communications for Supporting Virtual Reality (VR) in Telemedicine, The Future of Telemedicine and Information Technology for Everyone

Unit Choice: III and IV

Course Outcomes	
CO1: Ability to **explain** different heath parameters and concepts of ICT in Healthcare	--
CO2: Ability to **apply** the knowledge of ICT in Telecare, Telemedicine and health monitoring	PO1 (3) PO6 (3)
CO3: Ability to a**nalyse** the role of data analytics, AR, VR, AI and digital health for community care	PO2 (3) PO6 (3)

Text book:

Telemedicine Technologies: Information Technologies in Medicine and Digital Health, Bernard Fong, A.C.M. Fong,C.K. Li, Wiley 2nd edition, 2020

Reference Textbook

Wearable Technology in Medicine and Health Care, Raymond K Y Tong, Elsevier Inc, 2018

Department of Chemical Engineering

Course Title	ADVANCES IN ENERGY TECHNOLOGY													
Course Code	1	9	C	H	7	O	E	A	E	T	Credits	03	L – T – P	3 – 0 – 0
CIE	100 marks (50% weightage)										SEE		100 marks (50% weightage)	

SYLLABUS:

UNIT I

INTRODUCTION: Man, and energy, worlds and India's production and reserves of energy, present and future power position, need for alternate energy, energy alternatives.

06 Hrs

UNIT II

SOLAR ENERGY: Introduction: Extra-terrestrial solar radiation, radiation at ground level, collectors. Solar cells, applications of solar energy

06 Hrs

UNIT III

BIOMASS & GEOTHERMAL: Biomass energy, introduction, biomass conversion, biogas production, ethanol production, pyrolysis and gasification, direct combustion, applications of biomass energy.

RECOVERY OF THERMAL CONVERSION PRODUCTS: Combustion of waste materials & related calculations, waste incineration with heat recovery and use of refused derived fuels (RDF).

GEOTHERMAL ENERGY: Introduction, resource types, resource base, applications for heating and electricity generation.

10 Hrs

UNIT IV

WIND ENERGY SOURCES: Introduction: Basic theory, types of turbines, applications.

HYDROPOWER ENERGY SOURCES: Introduction, basic concepts, site selection, types of turbines, small scale hydropower.

10 Hrs

UNIT V

FUEL CELLS: Introduction Principle and operation of fuel cells, classification and types of fuel cells and application of fuel cells.

07 Hrs

TEXTBOOKS:

1. G. D. Rai, Non-conventional energy resources, 1st Edition, Khanna Publishers, New Delhi, 2011.

2. B. H Khan, Non-conventional energy resources, Tata McGraw Hill, New Delhi.

REFERENCE BOOKS:

1. Harker and Back Hurst, Fuel and energy science and engineering, Academic press, London 1981.

2. Howard S. Peavy, Donald R Rowe & George Tchobanoglous, Environmental Engineering, MeG Engineering Thermodynamics raw Hill International Editions

E BOOKS

1. Non-Conventional Energy Resources (Second Edition) by B.H. Khan, https://www.abebooks.com/Non-Conventional-Energy-Resources-Second-Edition-B.H/4877611079/bd

MOOC's &ONLINE COURSES:

1) http://nptel.ac.in/courses/Webcourse-contents/

QUESTION PAPER PATTERN:

1. Overall question paper pattern to have seven questions from five units.
2. Five questions to be answered.
3. One question from each unit.
4. One question each from Unit I, II, and V and two questions each from Unit III and IV.

COURSE OUTCOMES (COs):

COURSE OUTCOMES		PROGRAMME OUTCOMES
CO1	Acquaint with the various forms of available and alternative energy resources	PO2
CO2	Demonstrate the global scenario of energy recourses and its need for sustainable development.	PO7
CO3	Comprehend the principles behind different non-conventional energy systems.	PO2
CO4	Analyse economic and environmental aspects to establish non-conventional energy harvesting units.	PO6
CO5	Design and Develop the energy generating devices using renewable energy sources.	PO3
CO6	Understand the applications of various non -conventional energy systems.	PO2

ASSESSMENT:

Continuous Internal Assessments		**Marks 100 (Weightage 50%)**	**Assessment**
Theory Component	Three Internals (Best of Two)	40%	Course Instructor
	Quiz (Two Quizzes)	10%	Course Instructor
Semester End Examination (Written Examination for Three Hours)			

ASSESSMENT PATTERN:

Component	**Test 1**	**Test 2**	**Quiz 1/AAT**	**Quiz 2 /AAT**	**Total Marks**
Max. Marks	40	40	10	10	100
Reduced CIE	20	20	5	5	50

Course Title	ECOLOGY AND ENVIRONMENTAL MANAGEMENT										Credits	3
Course Code	1	9	B	T	7	I	E	E	E	M	L-T-P	3-0-0

Course Pre-requisites: Very basic knowledge about life forms, environment and ecology.

Course Description: The course covers various aspects of an ecosystem and its components, community characteristics and biogeochemical cycles. This course also includes general population attributes, their distribution and interaction of living components with each other and with environment. This course covers importance of the biodiversity, its protection and environmental issues, policies and regulations.

Course Objectives: To enable the students to gain knowledge on the various environmental issues and the application of biotechnological concepts in the management and sustainability of environment and the various policies and regulations involved.

UNIT1

Introduction to Ecology, Community and Ecosystem: [8 hrs]

Interrelationship between the living world and environment. Biosphere and its components, Environmental concepts (theory of tolerance and limiting factors), Community characteristics, organization and succession in different habitats, Bioenergetics and biogeochemical cycles, Concepts of habitat and niche.

UNIT2

Population and Community Ecology: [12 hrs]

Population Attributes: Density, nasality, mortality, age ratio, sex ratio, Dispersion of population, Exponential and logistic growth, Population interactions, Predation types, Simpsons index, R and K selected species, Host parasite interactions, Social parasitism, Symbiosis with examples

UNIT3

Biogeography: [7 hrs]

Phytogeography: Phytogeographic regions in the world, Major plant communities, Vegetation of India, zoogeography

UNIT4

Biotechnology in environmental management: [13 hrs]

Biodiversity and conservation strategies, success stories conservation, Sustainable utilization, Endangered and threatened species, Germ plasm banks, Sustainable utilization of wastes, Biofertilizers, Microbes as saprophytes, Ecofriendly biopesticides, Bioremediation, bio indicators.

UNIT5

Pollution, environmental impact and protection [8 hrs]

Impact of urbanization and industrialization, Environmental impact assessment, Environmental Pollution, Global climatic changes, National and international guide lines, climate summits(Paris summit), Wild life act of India.

COs:

1. Understand key ecological concepts and the ecological interactions which effect environment
2. Analyze and predict the effects of ecological interactions amongst populations.
3. Understand the phytogeographical and zoogeographical distribution of the world.
4. Understand the principles and concepts related to environmental management.
5. Analyze and evaluate the applicability of various biotechnological principles for maintenance of ecological sustainability.
6. Understand the guidelines and regulatory policies involved in environmental management.

Primary references:

1. Environmental studies: Anubha kaushik, CP KAushik, New age international, 3rd edition

Secondary references:

1. Environmental studies selective and scientific books: Mishra A, New delhi, 2005
2. Basics of environmental science: Allaby. M , Routledge, 2002
3. Elements of Ecology: Smith, TM, Simth RC Istedn. Pearson publications, 2006
4. Environmental science: Miller GT, 11th edition Brooks/cole, 2006.

E-Books:

1. Environmental studies: Erach Bharucha, Univeristy Grants Commission

MOOCs:

1. http://nptel.ac.in/courses/122102006/
2. Biodiversity and Global Change: Science & Action (Coursera): https://www.mooc-list.com/course/biodiversity-and-global-change-science-action-coursera
3. Environmental Challenges: Justice in Natural Resource Management (FutureLearn) https://www.mooc-list.com/course/environmental-challenges-justice-natural-resource-management-futurelearn
4. Environmental Studies: A Global Perspective (edX) https://www.mooc-list.com/course/environmental-studies-global-perspective-edx

DEPARTMENT OF BIOTECHNOLOGY

Course Title	INSTRUMENTAL METHODS OF ANALYSIS (OTHER THAN BT STUDENTS)										**Credits**	**3**		
Course Code to check & change	1	9	B	T	7	I	E	I	M	A	**L-T-P**	**3**	**0**	**0**

Pre-requisites:
Knowledge of basic Physics, Mathematics, Chemistry, Basics of Biomolecules

UNIT 1

ADVANCED MICROSCOPIC TECHNIQUES **[9 hrs]**

Electron Microscopy: Scanning electron microscope, Transmission Electron microsope. Scanning probe microscopy: Atomic force microscope,Scanning tunnelling microscope . Applications

UNIT 2

[9 hrs]

SPECTROSCOPIC TECHNIQUES

Introduction, Modern approaches in Bioanalysis and Bioassays. UV-Visible spectroscopy, Fluorescence spectroscopy, NIR spectroscopy, CD spectroscopy, and Mass spectroscopy, NMR, Xray, Atomic absorption and Flame emission spectroscopic techniques, colorimetry
(Only principle, Instrumentation and applications and no derivation required).

UNIT 3

[7hrs]

ELECTROPHORETIC TECHNIQUES

Electrophoresis; Principle, Design of horizontal and vertical gel electrophoresis apparatus, performing electrophoresis techniques, application of electrophoresis in analysing macromolecules.

UNIT 4

[8hrs]

CHROMATOGRAPHIC TECHNIQUES

Chromatographic techniques; General principles, Paper chromatography, TLC, Column chromatography: Ion exchange, Gel filtration, Affinity and Gas and High performance liquid chromatography techniques and FPLC

UNIT 5

CENTRIFUGATION TECHNIQUES

[6hrs]

Basic principles, Different types of centrifuges, Analytical and Preparative Ultracentrifugationmethods.(Only principle, Instrumentation and applications and no derivation required).

TEXT BOOKS

1. Biophysical Chemistry by Cantor R., and Schimmel P.R
2. Physical Biochemistry by David Freifelder (N H Freeman and Company)
3. Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman

Course Title	Imaging Modalities	Course Code	19ML7OE2IM
Credits	03	L-T-P	3-0-0

Course outcomes:

CO1: Recognise the need for different imaging modalities

CO2: Compare the basic principles of various imaging modality

CO3: Select the most suitable modality for a given clinical case

CO4: Provide basic advice on imaging modalities to your peers

Unit 1: X-Rays **8 Hours**

Introduction to imaging, myth busting of imaging, need of multimodality. **X-Rays:** Basic scientific principles of X-rays, X-ray technology, contrast, clinical applications, case study, Advanced X-ray: digital subtraction angiography (DSA), dual energy Xray absorptiometry (DXA), Orthopantomography.

Unit 2: Computer Tomography (CT): **8 Hours**

Basic scientific principles of CT, CT Technology, Contrast, clinical applications, case study, Advanced section on CT: Back projection, maximum intensity projection reconstruction.

Unit 3: Ultrasound **7Hours**

Basic scientific principles of ultrasound, Ultrasound technology, clinical applications, case study, Advanced section on Ultrasound: 3D reconstruction

Unit 4: Magnetic Resonance Imaging (MRI) **8 Hours**

Basic scientific principles of MRI - The Nuclear Spin, The MR Signal, Relaxation, Spatial Encoding, Contrast, MRI technology, Clinical Applications, case study, Advanced section on MRI: Fourier Transformation, MRI registration.

Unit 5: Diagnostic Nuclear Medicine **8 Hours**

Basic Principles of Diagnostic Nuclear Medicine, SPECT, PET, Quality Control, case study, Advanced section on Diagnostic Nuclear Medicine: PET image reconstruction, attenuation correction.

Textbook:

1. Introduction to Biomedical Imaging by Andrew G. Webb Wiley-IEEE Press, Nov 2017.
2. Guy, Chris, and Dominic Ffytche. An introduction to the principles of medical imaging. London:: Imperial College Press, 2005.

Reference book:

1. Smith, Nadine Barrie, and Andrew Webb. Introduction to medical imaging: physics, engineering and clinical applications. Cambridge university press, 2010.

MOOC:

- https://www.edx.org/course/introduction-to-biomedical-imaging
- https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r
- https://onlinecourses.nptel.ac.in/noc20_ee40/preview

e-books

- Burbridge, Brent, and Evan Mah. Undergraduate diagnostic imaging fundamentals. University of Saskatchewan, 2017. (https://undergradimaging.pressbooks.com/)
- Maier, Andreas, Stefan Steidl, Vincent Christlein, and Joachim Hornegger, eds. "Medical imaging systems: An introductory guide.", 2018. https://link.springer.com/book/10.1007%2F978-3-319-96520-8

UNIT Choice: Unit 1 and Unit 4

Course Title	Instrumentation for Food Processing and Agriculture				
Course Code	19EI7OE2 IA	Credits	3	L-T-P	3:0:0
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)		

UNIT-I	8 Hours

Introduction to food Processing

Introduction, Process control, Definition of the Elements in a control loop, Process facility consideration, Fundamentals of Food Manufacturing: Goals, Food Spoilage and Foodborne Diseases, Food Spoilage and Biological Factors, Food Spoilage and Chemical (Including Biochemical) Factors, Food Spoilage and Physical Factors, Prevention and Retardation of Food Spoilage, Sources of Information, Product Formulations and Flow Charts

UNIT-II	8 Hours

Product Developments, and Recent Advances in food processing:

Product Development, Flavor Creation and New Product Development, Generation of New Product Ideas, Isolation, Identification, and Synthesis of Flavour Compounds, Isolation and Concentration of Volatiles, Identification of Compounds, Synthesis of Flavour Compounds, Formulation and Compounding of Synthetic Flavourings, Sensory Analysis of Flavourings, Compounding of Imitation Flavouring, Trial Use of Synthetic Flavourings, Marketing of the New Product

UNIT-III	8 Hours

Sensors and Instrumentation for Food processing:

Food quality and Food safety. Flow diagram of Fruit & vegetable processing industry and instrumentation setup. Food Industry Instrumentation: Instrumentation in canning, baking, dairy industries. Introduction to baking; Bakery ingredients and their functions; Machines and equipment

for batch and continuous processing of bakery products. Objectives and techniques of food preservation Canning: Preservation principle of canning of food items, thermal process time calculations for canned foods, spoilage in canned foods

UNIT-IV	8 Hours

Dairy Processing Instrumentation:

Building blocks of dairy processing, Heat exchangers, Centrifugal separators and milk standardisation, Homogenisers, Membrane filters, Evaporators, Deaerators, Pumps, Pipes valves and fittings, tanks, Process control and service systems

UNIT-V	7 Hours

Agriculture Instrumentation: An integrated view on precision smart farming from a multidisciplinary perspective, Internet of things architectures and paradigms, open source internet of things platforms, solenoid valves, relay, Moisture sensor, rainfall sensor, state of art smart object, cognitive techniques, platform, smart object interoperability, IoT applications	
Text books:	
1	Fundamentals of Industrial Instrumentation and Process Control by William C. Dunn, McGraw-Hill (Chapter 1)
2	Handbook of Food products and Manufacturing by YH Hui, Wiley publishers (Chapter 2 and 3)
3	Dairy Processing Handbook by Tetra Pak Processing Systems AB (Chapter 4)
4	Agricultural Internet of Things and Decision Support for Precision Smart Farming (Chapter 5)
Reference books:	
1	Instrumentation and Sensors for the Food Industry by E Kress-Rogers, C J B Brimelow Woodhead Publishing, CRC, 2001
2	Introduction to Food Engineering by R Paul Singh and Dennis R. Heldman,Elsevier publication, Fourth Edition
3	Sensor in Agriculture by MDP books
Internal choice: Unit – III & V	
Course outcomes At the end of the course, the student will have the ability	
CO1: To understand possible technological solutions of food processing industries.	
CO2: To familiarize with current literature, research in agricultural instrumentation	
CO3: To analyze and design of automation system by evaluating agricultural parameter constraint.	

Course Title	Building Automation				
Course Code	19EI7OE2BA	Credits	3	L-T-P	3:0:0
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)		

UNIT-I	8 Hours

Automation System Structure:

Introduction, Needs and benefits of automation, Subsystems, Input Instrumentation Subsystem, Output Instrumentation Subsystem, Human Interface Subsystem- Direct Monitoring, Direct Control, Control Subsystem- Data Acquisition, Data Analysis and Decision Making, Control Execution, Communication. Basic strategies, Open and closed loop, Discrete, Continuous and Hybrid

UNIT-II	8 Hours

Building Automation

Introduction, Difference Between Building Automation and Building Control, Benefits, Structure of Building Automation and Control Networks, Typical architecture of building automation systems and control stations, Programming platform and environment.

Building Management Functions: Installation- management and control functions,, Risk-management functions, Information- processing functions, Facility- management functions, Performance monitoring and diagnosis, Maintenance management, Energy Management Functions, Comfort, Convenience, and Energy Management Functions in Room Automation, Standardized Bus Systems and Networks in Building Automation

UNIT-III	7 Hours

Sensors and Actuators:

Role of Sensors and Actuators- Importance of Estimation in Sensing, Innovative Sensor Technologies. Application Scenarios. Analog and Digital Sensors- Selection and its Applications, Digital and Innovative Sensing : Innovative Sensor Technologies, Continuous-Drive Actuators: Requirements and Applications, Overview of Temperature sensors and thermal actuators, Optical sensors and actuators, Electric and magnetic sensors and actuators, Mechanical sensors and actuators, Acoustic sensors and actuators, Chemical and biological sensors and actuators, Radiation, MEMS and smart sensors

UNIT-IV	8 Hours

Basics of Industrial Communication Technology :

Industrial Communication, Digital Data Transfer: Important Terms and Definitions, Field Bus

and Network: Important Terms and Definitions

BAS communication standards and architecture: Background and problems, BACnet and its features, Konnex and its features, LonWorks and its features, Modbus and its features, PROFIBUS and its features, EIB and its features, Compatibility of different open protocol standards, Integration at management level. Examples.

Internet technologies and their applications in BASs:

An overview of applications of Internet technologies in BAS, Use of Internet technologies at automation level, Use of Internet technologies at management level, Convergence networks and total integration.

UNIT-V	**8 Hours**

Control and Optimization of Air-Conditioning Systems: Typical control loops of the air-conditioning process, Control of CAV systems, Control of VAV systems

Lighting-Control Systems: Purpose of lighting- control system, Basic components of lighting and lighting- control systems, Systems based on standard lighting- control protocols

Security and Safety Control Systems: CCTV systems, Access- control systems, Burglar alarm systems, Fire alarm systems, System integration and convergence.

Case Studies : Controlling the Internet of Things – from Energy Saving to Fast Evacuation in Smart Buildings

Text books:

1.	Hermann Merz, Thomas Hansemann, Christof Hübner - Building Automation-Springer International Publishing (2018)
2.	Shengwei Wang, Intelligent Buildings and Building Automation, Spon Press (2009)

Reference books:

1.	Hermann Merz, Thomas Hansemann, Christof Hübner - Building Automation_ Communication systems with EIB_KNX, LON und BACnet-Springer-Verlag Berlin Heidelbe (2009)
2.	KLS Sharma, Overview of Industrial Process Automation, Second edition, Elsevier (2017)
3.	John T. Wen, Sandipan Mishra -Intelligent Building Control Systems A Survey of Modern Building Control and Sensing Strategies, Springer Publications
4.	Nathan Ida- Sensors, Actuators, and Their Interfaces: A multidisciplinary introduction, The Institution of Engineering and Technology; 2nd edition (2020)
5.	Clarence W. de Silva, Sensors and Actuators Engineering System Instrumentation, Second

	Edition, CRC Press(2016)
E- References:	
1.	https://digital.library.ryerson.ca/islandora/object/RULA%3A6887/datastream/OBJ/view
2.	https://link.springer.com/book/10.1007/978-3-319-68462-8
3.	e-Learning: https://www.udemy.com/topic/building-management-system/ https://www.tpctraining.com/blogs/news/introduction-to-building-automation-systems-1
Internal choice: Unit – IV & V	
Course outcomes At the end of the course, the student will have the ability	
CO1: Identify and describe the major components in a BAS: ATC, Lighting, Security, Fire and Safety, Surveillance	
CO2: Identify and describe the basic mechanical components and controls in an HVAC control system	
CO3: Describe networking as used in BAS systems	
CO4: Apply the knowledge of implementing BAS	
CO5: Apply the knowledge of Energy Conservation Strategies	

DYNAMICS OF ATMOSPHERIC AEROSOLS

Syllabus for the UG Students - Year 2017-2018

Course Code: 16PY7IEDAA L-T-P-S: 3-0-0-0

Credits: 03 Hours/Week: 03

Unit-1 : Basics of atmospheric aerosols 7 Hours

Introduction: Origin of aerosols, natural means, anthropogenic means, chemical means of aerosol formation, gas-to-particle conversion, and climate. Atmospheric aerosols bulk-to-particle conversion. Classification of aerosols, effects of aerosols on health, nature and water vapour. Influence of meteorological parameters on aerosol growth and scavenging.

Unit-2 : Transmission of solar radiation through the Earth's atmosphere 7 Hours

Introduction: Earth's atmosphere, troposhpere, stratosphere, mesosphere, thermosphere. Attenuation of solar radiation. Bouguer-Lambert-Beer law, Aerosol Optical Thickness (AOT), Langley plot, Solar Zenith Angle (SZA), zero air mass solar flux, extinction due to molecular scattering, molecular absorption, O_3 absorption and H_2O absorption.

Unit-3 : Wavelength dependence of AOT 5 Hours

Introduction: Mie scattering of water vapour and dust particles. Angstrom's turbidity formula for all aerosols. Reported work on wavelength dependence of AOT. Power law features for a given location. Time scale characteristics of AOT, Aerosol year.

Unit-4 : Atmospheric Turbidity 8 Hours

Introduction: Procedure for determining the values of Alpha and Beta, the Angstrom turbidity parameters. Monthly characteristics of Alpha and Beta. Seasonal variations of Alpha and Beta. Average seasonal trends of Alpha and Beta through three years. Inter-annual trends in Alpha and Beta. An empirical relationship between Alpha and Beta. Atmospheric visibility. Problems.

Unit-5 : Influence of Atmospheric water vapour on AOT 11 Hours

Introduction: Water vapour and aerosol. Estimation of water vapour in the atmosphere. Methodology of determining the influence of atmospheric water vapour on aerosol optical thickness. Growth rate features of AOT at 500 nm, growth rate features of AOT at 1020 nm. Reported work on atmospheric water vapour and its influence on AOT.

Text book:

Iqbal, M. (1983). *An Introduction to Solar Radiation*, Academic Press. Ontario, Canada

Reference Book:

John H. Seinfeld (Author), Spyros N. Pandis (Author) (2006). *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change.*

E- Resource /Book:

http://danida.vnu.edu.vn/cpis/files/Books/Atmospheric%20Aerosol%20Properties.pdf

Course Outcomes:

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

CO1: Interpret the importance of knowledge of atmospheric aerosols and understands various mechanisms involved in aerosol generation.

CO2: Apply the mathematical skills in quantifying solar extinction due to aerosols

CO3: Predict the influence of water vapour on the dynamics of atmospheric aerosols.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**					**3**					
CO2	**3**	**2**					**3**					
CO3	**3**	**2**					**3**					

B.M.S. COLLEGE OF ENGINEERING, BENGALURU
Autonomous Institute, Affiliated to VTU

INSTITUTIONAL ELECTIVE OFFERED BY THE DEPARTMENT OF CHEMISTRY

Course Name	Nanomaterials - Synthesis, Characterization And Applications	**Course Code**	**17CY7IENMA**
Credits	**03**	**L-T-P-S**	**3- 0 -0-0**
Contact hours	**36**	**Faculty Handling**	**Dr. M. S. DHARMAPRAKASH**

Course Objectives: The basic objectives course is to make students aware of Nano scale materials and structures, their properties and size effects. To make students learn some methods of synthesis of Nano materials their characterization by XRD, SEM and TEM. Some important Industrial applications of Nano materials is also dealt with.

UNIT-I

INTRODUCTION: **6 Hrs**

Definition, History, background scope and interdisciplinary nature of nanoscience and nanotechnology, scientific revolutions. Definition of Nanometer, Nanomaterials and Nanotechnology. Concepts of nanotechnology - size dependent properties, surface to volume ratio, atomic structure and phases, energy at the nanoscale molecular and atomic size. Classification of Nanostructures – Zero-, one-and two-dimensional nanostructure materials- Nano Particles, Nano crystalline Materials, Nanocrystalline Ceramics, Semiconductor Nanoparticles, Metal Nanoparticles, Nanotubes and Nano -Scale Architectures.

Unit-II

SYNTHESIS: **8 Hrs**

Top down approaches and bottom up approaches.

Chemical methods: sol-gel synthesis, Co-precipitation, CVD, CVS, and combustion synthesis. Microwave Synthesis of Metallic nano Particles (Ag, Au, pt) and Nanoparticles of Metal Oxides (ZrO_2, ZnO, Al_2O_3 and TiO_2). Carbon Nanotubes -Synthesis Multi-Walled Nanotubes Aligned Carbon Nanotube Bundles Single-Walled Carbon Nanotubes.

Physical methods: Vapor deposition techniques- pulsed laser deposition, Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining).

Unit-III

PROPERTIES: **6 Hrs**

Effects of nanometer length scale on Physical and Chemical Properties of Materials. Size Effects – Fraction of Surface Atoms – Specific Surface Energy and Surface Stress – Effect on the Lattice Parameter – Phonon Density of States. Thermal, Magnetic and Chemical properties - Catalysis.

Unit-IV

CHARACTERIZATION: **8 Hrs**

XRD-X-ray powder diffraction – Bragg's law - Instrumentation. Determination of lattice parameters - particle size analysis using Scherer formula.

SEM-Working Principle of Specimen Preparation – Modes of operation– Backscattered electrons (EDAX) – secondary electrons- X-rays – typical forms of contrast– Resolution and contrast – enhancement –Analyses of SEM images.

TEM-Basic principles - Modes of operation – Specimen preparation – Diffraction in imperfect crystals and dislocations – Structure of Grain boundaries and interfaces- HRTEM.

Unit-V

APPLICATIONS **6 Hrs**

Renewable energy, solar energy, fuel cells. Materials manufacturing and automobile industry. Biomedical Science, Medicine, Diagnostics. Biotechnology. Computers, Electronics and communication. Chemical analysis, Pharmacy Environmental sciences, Sport sector, Printing, Optics. Agriculture, Food, Textile, Cosmetics. Defense, Aerospace and Marine Nanotechnology.

Text book:

1. C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, *The Chemistry of Nanomaterials :Synthesis, Properties and Applications*, Volume 1, Wiley-VCH, Verlag GmbH, Germany (2004).

References:

1. G.A. Ozin and A.C. Arsenault, "Nanochemistry : A chemical approach to nanomaterials", Royal Society of Chemistry, 2005.
2. Charles P.Poole Jr. "*Introduction to Nanotechnology*", John Willey & Sons , 2003. T. Pradeep
3. "*NANO The Essential , understanding Nanoscience and Nanotechnology"*. Tata McGraw-Hill
4. Nano scale Science and Technology Robert Kelsall, Ian Hamley, and Mark Geoghegan (Editors) John-Wiley

Scheme of Evaluation:

Component	Type of assessment	Max. Marks		Weightage	Total	Total Marks
CIE - Theory	Quiz 1	10		10	50*	50 (CIE)
	Quiz 2	10				
	Test 1	40	Best of Two test	40		
	Test 2	40				
	Test 3	40				
SEE	End Exam	100		50		50 (SEE)
Grand Total Marks						**100**
*** minimum CIE marks (Theory) ≥ 10.0 to gain eligibility to write the SEE**						

BMS COLLEGE OF ENGINEERING, BENGALURU-19

Autonomous Institute, Affiliated to VTU

INSTITUTIONAL ELECTIVE OFFERED BY THE DEPARTMENT OF CHEMISTRY

Course Name	**Functional Materials For Engineering Applications**	**Course Code**	**21CY7IEFME**
Credits	**03**	**L-T-P-S**	**3-0-0-0**
Contact hours	**38**	**Faculty Handling**	**Dr Srinidhi Raghavan M**

Course Objectives:

The fundamental of the course is to:

- Provide a basic knowledge of Materials sciences and Functional Materials to Engineers for their applications aspects
- Demonstrate the significance of new class of materials in Engineering applications
- Brief about the preparation of some Functional materials in various techniques
- Instruct significance of materials excellence and its applications in modern aspects

A	**Course Outcomes: At the end of the course the student must learned by**	**POS mapped**	**Strength of mapping**
CO1	Ability to understand the significance of materials in applications aspects		
CO2	To put on the erudite knowledge and select a right material for explicit to the current applications.		
CO3	Progress the skill to resolve the material associated glitches in Research and Industrial aspects.		

Course object:

The objective of this course is to provide a deeper insight and a platform for learning and development in the following thrust areas of "Functional Materials" through well designed subject to upcoming Engineers. These courses will update the knowledge of Engineering students on the recent developments in the field of materials science. This course is highly interdisciplinary by nature, encompassing aspects of basics of materials and its applications in the field of energy storage, sensors, biomedical applications, etc.

Unit-I

Overview of Functional Materials: General introduction and significance of Novel materials: Carbon nanotubes and Graphene, fullerene, Oxide Superconductors, Hybrid materials (MOF), Nanocomposites, semiconductors and ceramic materials and Biomaterials.

Carbon Nanotube: Classifications-properties – physical and chemical properties-preparation through various methods (Plasma arcing of carbonaceous materials, laser ablation, and CVD Method) – Modifications (functionalization using gold nanoparticles)-and their potential Applications (Energy storage, Biomedical applications, etc.)

(8 hours)

Unit-II

Graphene: Types of graphene – properties (mechanical, electrical, optical, thermal)-production of graphene (Using Hummer's Method)- potential applications. **Fullerene:** Classification – properties and applications. **Oxide superconductors:** Properties- physical and chemical properties- Types of superconductors with few examples-simple preparation and potential applications with few examples-simple preparation and potential applications. **(8 hours)**

Unit-III

Metal organic Frame works: Structures – properties – preparation of Metal acetylacetonate complexes for MOF architecture– characterizations and their potential applications. **Nanocomposites**: Classifications (Three types)– properties of composites materials – preparation of nanocomposites- Engineering applications. **(6 hours)**

Unit-IV

Semiconductor Materials: Types of semiconductor materials – properties of semiconductor materials-some examples with bandgap measurement-preparation and their applications (Sensors and optoelectronics applications). **Perovskite materials**: Classifications (few examples)-Properties – PV cell constructions and Energy harvesting process - Halide based perovskites for PV Cell applications and their challenges (Halide ion replacement) **(8hours)**

Unit-V

Ceramic Materials: Classification (Three types) – properties of ceramics (Mechanical, Electrical, Thermal and optical)- simple methods of preparation of ceramics (suitable examples" Barium titanate, Ferrites, PZT)–characterization and potential applications. **Biomaterials:** Introduction – Bioactivity- Self-assembly - Structural hierarchy- Biocompatible Plastics-Preparation and properties and their applications.

(6 hours)

Text Books:

1. Materials Sciences and Engineering – A First course – Sixth edition- By V. Raghavan

2. Solid state chemistry and Application – Anthony. R. West

Reference Books:

1. Novel Materials – by M. R. Islam.

2. Nanomaterials and Their Applications- By Zishan Husain Khan

NPTEL Course : https://nptel.ac.in/courses/118/102/118102003/

Scheme and evaluation:

Component	Type of assessment	Max. Marks		Weightage	Total	Total Marks
CIE - Theory	Quiz-1	10		2.5	25*	50 (CIE)
	Quiz-2	10		2.5		
	Test 1	40	Best of Two test	20		
	Test 2	40				
	Test 3	40				
SEE	End Exam	100		50		50 (SEE)
Grand Total Marks						100
* minimum CIE marks (Theory as well as Lab) ≥ 10.0 to gain eligibility to write the SEE						

The choice questions have to be provided in Unit I and Unit IV

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BMS COLLEGE OF ENGINEERING, BENGALURU-19
Autonomous Institute, Affiliated to VTU

INSTITUTIONAL ELECTIVE OFFERED BY THE DEPARTMENT OF CHEMISTRY

Course Name	INDUSTRIAL ELECTROCHEMICAL ENGINEERING	Course Code	21CY7IEIEE
Credits	03	L-T-P-S	3- 0 -0-0
Contact hours	38	Faculty Handling	Dr.K L Nagashree

Course Objectives

- To impart basic knowledge of electrochemical aspects behind manufacturing processes and industrial effluent treatment
- To give an overview of various electrochemical manufacturing processes adopted in the industry and role of electrochemistry in treatment of waste water from dye and metallurgical industry.

CO. NO	On completion of the course the student will have ability to	**POs Mapped**	**Strength of mapping**
CO 1	Describe the fundamental concepts behind electrochemical processes, electrochemical synthesis of commercially important materials, metal finishing and use of electrochemistry for waste water treatment		
CO 2	Apply the principles of electrochemistry for manufacturing of materials of technological importance and environmental monitoring		
CO 3	Analyse electrochemical manufacturing of materials, treatment of waste water and safety aspects in electrochemical industry		

SYLLABUS:

Unit I

Introduction to industrial electrochemistry: Introduction and overview of electrode processes-electrochemical reactions, cell potential, overpotential, decomposition potential, polarization and cell resistance. Electrochemical cells-primary and secondary cells.

Electrolysis: Fundamental considerations-costing of an electrolytic process eg: chlor-alkali process, electrolysis parameters-electrode potential, electrode materials and structure, concentration of electroactive species, electrolysis medium, temperature and pressure, mass transport regime and cell design. Typical cell designs-general rules, tank cells, parallel plate flow cells and thin film cells. Electrochemical reactors-batch, plug flow, back mix. Multielectrode reactor-monopolar and bipolar cells. Porous and packed bed electrodes. Laboratory data and scale up. (8 hrs)

Unit 2

Thermodynamics and kinetics of electrochemical processes: Basic terms of chemical kinetics and thermodynamics-enthalpy, entropy, equilibrium constant, rate and order of a reaction. Electrochemical thermodynamics – emf of a cell, relationship between free energy and cell potential, Nernst equation, formal potentials, electrochemical potential, electrochemical series, liquid junction potentials, conductance, mobility, junction of two immiscible liquids.

Electrode kinetics-kinetics of electron transfer, electrocatalysis-Butler Volmer equation, Tafel equation, types of electrocatalysis-homo and hetero (bulk and nano). Mass transport-diffusion, convection, migration.

(6 hrs)

Unit 3

Industrial electrosynthesis and electrophoresis: Chlor-alkali process by membrane cell process, sodium chlorate production, Aluminium production by Hall-Heroult process, Production of Fluorine by Moissan's method.

Electroorganic synthesis: Monsanto process, hydrodimerization of acrylonitrile.

Hydrogen and oxygen production from water electrolysis.

Electrophoresis: General principle, factors affecting electrophoresis, Gel electrophoresis: Types of gels: electrophoresis unit, preparation of gel, SDS-PAGE - Principle, apparatus and methods, gradient gels, Two dimensional gels, isoelectric focusing. Industrial and clinical applications. (8 hrs)

Unit 4

Metal finishing: Technological importance of metal finishing. Electroplating-definition, plating variables-effect on electrodeposition. Overview of electroplating of –metals, 3D printed objects, medical devices, composites, automobile parts, defence equipments. Electroplating of Au and Cr.

Electroforming, electrochemical machining and electrochemical etching.

Electrorefining, electrowinning, and cementation.

Electroless deposition-definition, differences between electro and electroless plating, electroless plating of copper-through hole connection, electroless Ni and electroless composites. (8 hrs)

Unit 5

Electrochemistry for waste water treatment and challenges of electrochemical industry:

Electrochemical oxidation of phenol and electrochemical reduction pf chromium, electrocoagulation, electroflotation, electrochemical advanced oxidation process for dye removal and reclamation of waste water.

Challenges of electrochemical industry: Cost of electricity to drive an electrochemical process, cost of producing electricity, cost of operating device, durability of materials, change in infrastructure, process integration, sludge formation and waste disposal. Safety issues-use of-hazardous electrolytes, toxic, flammable and corrosive solvents, environmentally unfriendly additives.

(8 hrs)

Text Books:

1. ELECTROCHEMISTRY Principles, Methods, and Applications, Christopher M. A. Brett and Ana Maria Oliveira Brett, Oxford University Press
2. ELECTROCHEMICAL METHODS Fundamentals and Applications, Allen J. Bard and Larry R. Faulkner, John Wiley & Sons, Inc.

Reference Books:

1. Industrial Electrochemistry, Derek Pletcher and Frank C. Walsh, Springer Science + Business Media, LLC

MOOCs:

1. https://nptel.ac.in/courses/103/108/103108162/

Scheme and evaluation:

Component	Type of assessment	Max. Marks		Weightage	Total	Total Marks
CIE - Theory	Quiz 1	10		10	50*	50 (CIE)
	Quiz 2	10				
	Test 1	40	Best Two	40		
	Test 2	40				
	Test 3	40				
SEE	End Exam	100		50		50 (SEE)
Grand Total Marks						**100**
*** minimum CIE marks (Theory) ≥ 10.0 to gain eligibility to write the SEE**						

B.M.S. COLLEGE OF ENGINEERING, BENGALURU-19

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DEPARTMENT OF MATHEMATICS

SYLLABUS (2021 - 2022)

SEVENTH SEMESTER – INSTITUTIONAL ELECTIVE

Course Title	NUMBER THEORY	Course Code	21MA7IENMT
Credits	03	L – T – P	3 – 0 – 0
Contact hours	39 hours		

Course Objectives:

The course is a graduate level introduction to Number Theory in which fundamentals of the subject will be covered. It contributes to many practical problems such as Coding Theory and Cryptography in modern information technology.

UNIT-1

CONGRUENCES: [09 hours]

Introduction, Congruences and Equivalence Relations, Linear Congruences, Linear Diophantine Equations and the Chinese Remainder Theorem, Modular Arithmetic: Fermat's Theorem, Wilson's Theorem and Fermat Numbers. Polynomial congruences, Pythagorean equations.

UNIT-2

ARITHMETIC FUNCTIONS: [07 hours]

Introduction, Sigma Function, Tau Function, Dirichlet Product, Dirichlet Inverse, Moebius Function, Euler's Function, Euler's Theorem.

UNIT-3

PRIMITIVE ROOTS AND INDICES: [07 hours]

The order of a positive integer, primality tests, primitive roots for primes, the algebra of indices.

UNIT-4

QUADRATIC CONGRUENCE AND CONTINUED FRACTION: [09 hours]

Legendre symbol, quadratic reciprocity, the Jacobi symbol, finite continued fractions, infinite continued fractions.

UNIT-5

NON LINEAR DIOPHANTINE EQUATIONS: [07 hours]

Pythagorean triangles, Fermat's last theorem, Sum of Squares, Pell's equation, Mordell's equation.

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On completion of the course, student will have the ability to:

CO No	Course Outcomes	PO
1	Apply the concept of congruence to compute system of equations (algebraic equations) and non-linear Diophantine equation	**1**
2	Demonstrate an understanding towards the nature of different functions, primitive roots and indices	**1**
3	Apply concept of quadratic congruence to evaluate quadratic residues and understand continued fractions	**1**

Text Books

1. Thomas Koshy, Elementary number theory with Applications, 2nd Edition, Elsevier, 2009.
2. Neville Robbins, Beginning Number Theory, 2nd Edition, Jones and Barlett, 2006.
3. Ivan Niven, Herbert S. Zukerman and Hugh L. Montgomery, Introduction to theory of Numbers, 7th edition, Wiley, 2000.

Reference Books

1. David M. Burton, Elementary Number Theory, 6th Edition, Tata McGraw Hill Publ., 2006.
2. Gareth A. Jones and Josephine Mary Jones, Elementary Number Theory, Springer, 1998.

Question Paper Pattern

- Five full question to be answered.
- Each unit consists of one full question.
- Each full question consists of two, three or four subdivisions.
- Internal choice in Unit 1 and Unit 4.

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SYLLABUS (2021 - 2022)

SEVENTH SEMESTER – INSTITUTIONAL ELECTIVE

Course Name	**Computational Graph Theory**	**Course Code**	**21MA7IECGT**
Credits	**03**	**L – T - P**	**3 - 0 - 0**
Contact hours	**39 hours**		

Course Objectives: The objective of the course is to introduce the concepts in graph Theory, with a sense of algorithms and some modern applications. They will be able to use these methods in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.

UNIT-1

GRAPHS AND DIGRAPHS **[8 hours]**

Fundamentals of graphs and digraphs, modelling using graphs and digraphs, graph search – BFS, DFS. The shortest path algorithms: Dijkstra algorithm, Bellman algorithm. Minimum weight spanning tree: Kruskal's algorithm and Prim's algorithms. Applications: Job sequencing problems, designing an efficient computer drum, making a road system one-way.

UNIT-2

EULERIAN AND HAMILTONIAN GRAPHS **[7 hours]**

Transportation Problems: Eulerian graphs, Fleury's algorithm, Chinese Postman Problem, Hamiltonian cycles, Travelling Salesman Problem, applications.

UNIT-3

CONNECTIVITY **[8 hours]**

Vertex and edge connectivity, separable graphs, block graphs, k-connected graphs, maximum flow Problem, Ford-Fulkerson algorithm, Min Cut - Max Flow theorem, Maximum Flow of Minimum Cost, feasible flows. Construction of reliable communication networks-The minimum connector problem, enumeration of chemical molecules and electrical networks.

UNIT-4

COVERING AND MATCHING **[8 hours]**

Vertex and edge covering, vertex and edge independence, matchings, perfect matchings, maximum matching, Hall's theorem, augmenting path, Edmond's algorithm, maximal independent sets, König's Min-Max theorem, Gale-Shapley Algorithm, Minimum path cover**,** Friend's strangers problem.

UNIT-5

COLORABILITY **[8 hours]**

Vertex colouring, Chromatic Number, Bi-chromatic, Edge coloring and its applications to timetabling and sport scheduling, Vizing's theorem, Sequential coloring algorithm, map coloring, Four Color problem, chromatic polynomial. König's theorem, Applications: Scheduling examinations, Frequency assignments, Index registers.

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Text Books

1. Narsing Deo, Graph Theory, PHI, 2014.
2. Geir Agnarsson & Raymond Greenlaw Pearson, Graph Theory, modelling, applications and algorithms, Prentice Hall, 2007.

Reference Books

1. Frank Harary, Graph Theory, Addison Wesley, Reading, Massachussets, 1969.
2. Jonathan L. Gross, Jay Yellen, Graph Theory and its Applications, 2nd Edition, CRC Press LLC, Florida, 2000.
3. Gary Chartrand and Ping Zhang, Introduction to Graph Theory, McGraw Hill, 2005.

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

CO	Course Outcomes	PO's
CO-1	Demonstrate an understanding of the fundamental concepts of graph theory, digraphs, trees, finding Paths and cycles, weighted graphs matching and graph coloring.	**1,2**
CO-2	Apply appropriate graph algorithms to solve problems involving transportation, connection, social networking and scheduling.	**1,2**
CO-3	Analyse the algorithms to find the shortest path, maximum flow of minimum cost, maximum matching and minimum path cover.	**2**
CO-4	Use of MATLAB to find the shortest path, minimum weighted spanning tree, maximum flow.	**5**

Question Paper Pattern

- Each unit consists of one full question.
- Five full question to be answered.
- Internal choice in Unit 3 and Unit 5.