SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
FACULTY OF CIVIL ENGINEERING								
DEPARTMENT OF CIVIL ENGINEERING								
B.E. Civil Engineering								
1.	CE5691	Lean Concepts, Tools And Practices	OE	3	3	0	0	3
2.	CE5692	Project Quality and Safety Management	OE	3	3	0	0	3
3.	AI5691	Basics of Integrated Water Resources Management	OE	3	3	0	0	3
4.	AI5692	Dairy Engineering	OE	3	3	0	0	3
B.E. Geoinformatics								
5.	GI5691	Photogrammetry	OE	3	3	0	0	3
6.	GI5692	Total Station and GPS Surveying	OE	3	3	0	0	3
FACULTY OF ELECTRICAL ENGINEERING								
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING								
B.E. Electrical and Electronics Engineering								
7.	EE5691	Introduction To Control Systems	OE	3	3	0	0	3
8.	EE5692	Electric Vehicle Technology	OE	3	3	0	0	3
FACULTY OF MECHANICAL ENGINEERING								
DEPARTMENT OF MECHANICAL ENGINEERING								
B.E. Mechanical Engineering								
9.	ME5691	Basic Automobile Engineering	OE	3	3	0	0	3
10.	ME5692	Product Design and Process Development	OE	3	3	0	0	3
11.	ME5693	Applications of 3D Printing Techniques	OE	3	3	0	0	3
12.	ME5694	Fuel Cells	OE	3	3	0	0	3
13.	ME5695	Sustainable Energy Technologies and Assessment	OE	3	3	0	0	3
14.	ME5696	Modern Healthcare Machines - I	OE	3	3	0	0	3
B.E. Materials Sciences and Engineering								
15.	ML5691	Materials Selection	OE	3	3	0	0	3
16.	ML5692	Electrical, Electronic and Magnetic Materials	OE	3	3	0	0	3
DEPARTMENT OF INDUSTRIAL ENGINEERING								
B.E. Industrial Engineering								
17.	IE5691	Introduction to Industrial Engineering	OE	3	3	0	0	3
18.	IE5692	Introduction to Applied Data Analytics	OE	3	3	0	0	3
19.	IE5693	Introduction to Sustainability Engineering	OE	3	3	0	0	3
DEPARTMENT OF MANUFACTURING ENGINEERING								
B.E. Manufacturing Engineering								
20.	MF5691	Manufacturing of Automotive Systems	OE	3	3	0	0	3
21.	MF5692	Sustainable Development and Manufacturing	OE	3	3	0	0	3

		DEPARTMENT OF PRINTING TECHNOLOGY						
B.E. Printing and Packaging Technology								
22.	PT5691	Design for Print Media	OE	3	3	0	0	3
23.	PT5692	Visual Communication for Digital Media	OE	3	3	0	0	3
		FACULTY OF INFORMATION AND COMMUNICATION ENGINEERING						
		DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING						
SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
B.E. Computer Science and Engineering								
24.	CS5691	Big Data Analytics	OE	3	3	0	0	3
25.	CS5692	Web Design and Management	OE	3	3	0	0	3
		DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING						
B.E. Electronics and Communication Engineering								
26.	EC5691	Automotive Electronics	OE	3	3	0	0	3
27.	EC5692	Electronics Engineering	OE	3	3	0	0	3
28.	EC5693	Wireless Technologies	OE	3	3	0	0	3
29.	EC5694	Microcontroller Programming	OE	3	3	0	0	3
B.E. Biomedical Engineering								
30.	BM5691	Management of Wastes in Hospitals	OE	3	3	0	0	3
31.	BM5692	Introduction to Biomaterials	OE	3	3	0	0	3
		DEPARTMENT OF INFORMATION SCIENCE AND TECHNOLOGY						
B.Tech. Information Technology								
32.	IT5691	Information Technology Essentials	OE	3	3	0	0	3
33.	IT5692	Internet of Things	OE	3	3	0	0	3
34.	IT5693	Blockchain Technologies	OE	3	3	0	0	3
35.	IT5694	Machine Learning Techniques	OE	3	3	0	0	3
		FACULTY OF TECHNOLOGY						
		DEPARTMENT OF LEATHER TECHNOLOGY						
B.Tech. Leather Technology								
36.	LT5691	Biotechnological Application in Leather Manufacture	OE	3	3	0	0	3
37.	LT5692	Leather Goods and Garments Manufacture	OE	3	3	0	0	3
		DEPARTMENT OF TEXTILE TECHNOLOGY						
B.Tech. Textile Technology and B.Tech. Apparel Technology								
38.	TT5691	Technical fibres	OE	3	3	0	0	3
39.	TT5692	Garment manufacturing machinery	OE	3	3	0	0	3
		DEPARTMENT OF CERAMIC TECHNOLOGY						
B.Tech. Ceramic Technology								
40.	CT5691	Ceramics Materials for Engineers	OE	3	3	0	0	3
41.	CT5692	Processing of Ceramics	OE	3	3	0	0	3
		DEPARTMENT OF BIO TECHNOLOGY						
B.Tech. Pharmaceutical Technology								
42.	PM5691	Introduction to Cancer Biology	OE	3	3	0	0	3

		B.Tech. Industrial Biotechnology						
43.	IB5691	Introduction of Biotechnology	OE	3	3	0	0	3
		B.Tech. Food Technology						
44.	FT5691	Biomolecules	OE	3	3	0	0	3
		DEPARTMENT OF CHEMICAL ENGINEERING						
		B.E. Chemical Engineering						
45.	CH5691	Environmental Pollution Pathways	OE	3	3	0	0	3
46.	CH5692	Introduction to Nanotechnology	OE	3	3	0	0	3
47.	CH5693	Introduction to Petroleum Streams	OE	3	3	0	0	3
		DEPARTMENT OF APPLIED SCIENCE AND TECHNOLOGY						
		B.Tech. Petroleum Engineering and Technology						
48.	AS5691	Petroleum Refining and Petrochemicals	OE	3	3	0	0	3
49.	AS5692	Lifestyle Modifications and Health In Unison	OE	3	3	0	0	3
50.	AS5693	Petroleum Operations	OE	3	3	0	0	3
		FACULTY OF SCIENCE AND HUMANITIES						
		B.E./B.Tech. students can take these electives.						
		DEPARTMENT OF PHYSICS						
51.	PH5691	Electromagnetic Theory	OE	3	3	0	0	3
52.	PH5692	Physics of Semiconductor Devices	OE	3	3	0	0	3
53.	PH5693	Nano-Scale Materials and Applications	OE	3	3	0	0	3
54.	PH5694	Quantum Physics for Engineers	OE	3	3	0	0	3
		DEPARTMENT OF ENGLISH						
55.	HS5691	English for Competitive Examinations	OE	3	3	0	0	3
56.	HS5692	Science Fiction	OE	3	3	0	0	3
57.	HS5693	Business Communication for Entrepreneurs	OE	3	3	0	0	3
		DEPARTMENT OF CHEMISTRY						
58.	CY5691	Nutritional and Medicinal Chemistry	OE	3	3	0	0	3
59.	CY5692	Chemistry in Everyday Life	OE	3	3	0	0	3
60.	CY5693	Chemistry for Forensic Studies	OE	3	3	0	0	3

CE5691 **LEAN CONCEPTS, TOOLS AND PRACTICES** **L T P C**

3 0 0 3

OBJECTIVE:
- To impart knowledge about the basics of lean principles, tools and techniques, and implementation in the construction industry.

UNIT I   INTRODUCTION   9
Introduction and overview of the construction project management - Review of Project Management & Productivity Measurement Systems - Productivity in Construction - Daily Progress Report-The state of the industry with respect to its management practices -construction project phases - The problems with current construction management techniques.

UNIT II   LEAN MANAGEMENT   9
Introduction to lean management - Toyota's management principle-Evolution of lean in construction industry - Production theories in construction –Lean construction value - Value in construction - Target value design - Lean project delivery system- Forms of waste in construction industry - Waste Elimination.

UNIT III   CORE CONCEPTS IN LEAN   9
Concepts in lean thinking – Principles of lean construction – Variability and its impact – Traditional construction and lean construction – Traditional project delivery - Lean construction and workflow reliability – Work structuring – Production control.

UNIT IV   LEAN TOOLS AND TECHNIQUES   9
Value Stream Mapping – Work sampling – Last planner system – Flow and pull based production – Last Planner System – Look ahead schedule – constraint analysis – weekly planning meeting-Daily Huddles – Root cause analysis – Continuous improvement – Just in time.

UNIT V   LEAN IMPLEMENTATION IN CONSTRUCTION INDUSTRY   9
Lean construction implementation- Enabling lean through information technology - Lean in design - Design Structure - BIM (Building Information Modelling) - IPD (Integrated Project Delivery) – Sustainability through lean construction approach.

TOTAL : 45 PERIODS

OUTCOME:
On completion of this course, the student is expected to be able to

- **CO1**   Explains the contemporary management techniques and the issues in present scenario.
- **CO2**   Apply the basics of lean management principles and their evolution from manufacturing industry to construction industry.
- **CO3**   Develops a better understanding of core concepts of lean construction tools and techniques and their importance in achieving better productivity.
- **CO4**   Apply lean techniques to achieve sustainability in construction projects.
- **CO5**   Apply lean construction techniques in design and modeling.

REFERENCES:
1. Corfe, C. and Clip, B., Implementing lean in construction: Lean and the sustainability agenda, CIRIA, 2013.
2. Shang Gao and Sui Pheng Low, Lean Construction Management: The Toyota Way, Springer, 2014.
3. Dave, B., Koskela, L., Kiviniemi, A., Owen, R., andTzortzopoulos, P.,Implementing lean in construction: Lean construction and BIM, CIRIA, 2013.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., Lean construction tools and techniques, 2002.
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., Site implementation and Assessment of Lean Construction Techniques, Lean Construction Journal, 2005.

CE5692   **PROJECT QUALITY AND SAFETY MANAGEMENT**   **L T P C**
                                                                      3 0 0 3

OBJECTIVES:
- To study and understand the various quality and safety concepts and requirements applied to construction projects.

UNIT I   QUALITY MANAGEMENT   9
Importance of quality; Elements of quality- quality characteristics- quality by design - quality conformance, contractor quality control- identification and traceability, Continuous Chain Management – brief concept and application. Importance of specifications - Incentives and penalties in specifications – Workmanship as a mark of quality – Final Inspection.

UNIT II   QUALITY ASSURANCE AND CONTROL   9
Quality assurance techniques – Inspection, testing, sampling. Documentation – Organization for quality control, Cost of quality. Introduction to TQM, Six Sigma Concept in construction industry.

UNIT IV   CONSTRUCTION ACCIDENTS   9
Accidents and their Causes – Human Factors in Construction Safety – Costs of Construction Injuries – Occupational and Safety Hazard Assessment –Problem Areas in Construction Safety.

UNIT II   SAFETY PROGRAMMES   9
Elements of an Effective Safety Programme – Job-Site Safety Assessment – Safety Meetings- Safety Culture – Safety Incentives - Safety Record Keeping - Workers Compensation.

UNIT V   DESIGNING FOR SAFETY   9
Safe Workers – Safety and First Line Supervisors – Safety and Middle Managers – Top Management Practices, Company Activities and Safety – Safety Personnel Substance Abuse – Sub contractual Obligation – Project Coordination and Safety Procedures.

                                                            TOTAL: 45 PERIODS

OUTCOMES:
On completion of the course, the student is expected to be able to
CO1   Apply the quality standards for preparing Quality system documents.
CO2   Select the techniques and tools for Quality Assurance and Control in construction.
CO3   Develop the knowledge on accidents and their causes
CO4   Develop the knowledge about safety programmes & job-site safety assessment
CO5   Apply knowledge while designing for safety and safety procedures

REFERENCES:
1. James, J.O' Brian, Construction Inspection Handbook – Total Quality Management, Van Nostrand, 1997
2. KB Rajoria, Deepak Naryan, Deepak Gupta, Practices in construction, CBS Publishers & Distributors Pvt. Ltd., ISBN:978-93-90709-33-5, 2021.
3. Juran Frank, J.M. and Gryna, F.M. Quality Planning and Analysis, McGraw Hill, 2001
4. Jimmy W. Hinze, Construction Safety, Prentice Hall Inc., 1997.
5. Bhattacharjee S.K. Safety Management in Construction (Principles and Practice), Khanna Publishers, New Delhi 2011

AI5691   BASICS OF INTEGRATED WATER RESOURCES MANAGEMENT   L T P C
                                                                          3 0 0 3
OBJECTIVES
- To introduce the interdisciplinary approach of water management.
- To develop knowledge base and capacity building on IWRM.

UNIT I   OVERVIEW OF IWRM   9
Facts about water - Definition – Key challenges - Paradigm shift - Water management Principles - Social equity - Ecological sustainability – Economic efficiency - SDGs - World Water Forums.

UNIT II   WATER USE SECTORS: IMPACTS AND SOLUTION   9
Water users: People, Agriculture, ecosystem and others - Impacts of the water use sectors on water resources - Securing water for people, food production, ecosystems and other uses - IWRM relevance in water resources management.

UNIT III   WATER ECONOMICS   9
Economic characteristics of water good and services – Economic instruments – Private sector involvement in water resources management - PPP experiences through case studies.

UNIT IV   RECENT TREANDS IN WATER MANAGEMENT   9
River basin management - Ecosystem Regeneration – 5 Rs - WASH - Sustainable livelihood - Water management in the context of climate change.

UNIT V   IMPLEMENTATION OF IWRM   9
Barriers to implementing IWRM - Policy and legal framework - Bureaucratic reforms and inclusive development - Institutional Transformation - Capacity building - Case studies on conceptual framework of IWRM.

**   TOTAL: 45 PERIODS**

OUTCOMES
On completion of the course, the student will be able to apply appropriate management techniques towards managing the water resources.

CO1   Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management.
CO2   Discuss on the different water uses; how it is impacted and ways to tackle these impacts.
CO3   Explain the economic aspects of water and choose the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies.
CO4   Illustrate the recent trends in water management.
CO5   Understand the implementation hitches and the institutional frameworks.

TEXT BOOKS
1.   Cech Thomas V., Principles of water resources: history, development, management and policy. John Wiley and Sons Inc., New York. 2003.
2.   Mollinga P. *et al.* " Integrated Water Resources Management", Water in South Asia Volume I, Sage Publications, 2006.

REFERENCES
1.   Technical Advisory Committee, Background Papers No: 1, 4 and 7, Stockholm, Sweden. 2002.
2.   IWRM Guidelines at River Basin Level (UNESCO, 2008).
3.   Tutorial on Basic Principles of Integrated Water Resources Management ,CAP-NET. http://www.pacificwater.org/userfiles/file/IWRM/Toolboxes/introduction%20to%20iwrm/Tutorial_text.pdf
4.   Pramod R. Bhave, 2011, Water Resources Systems, Narosa Publishers.
5.   The 17 Goals, United Nations, https://sdgs.un.org/goals.

AI5692   **DAIRY ENGINEERING**   **L T P C**
                                                                                     3 0 0 3

OBJECTIVES:
At the end of the course the students would be exposed to fundamental knowledge in
- Properties of Milk
- Processing of Milk and Manufacture of dairy products
- Sanitation and effluent treatment in dairy industry

UNIT I   PROPERTIES AND HANDLING OF MILK   7
Milk-types-composition-Physical, Chemical and Thermal Properties of milk-Classification of milk - Market and Special Milk - toxicity of metals - milk reception – cooling - principles and methods – heat exchangers - transport and storage tanks - Can washers – types – construction, working principle and maintenance.

UNIT II   PROCESSING OF MILK   9
Processing of Milk - Pasteurization – principles and objectives – methods – batch / LTLT method -- equipment – HTST method – process and equipment – plate heat exchanger – regeneration efficiency - UHT pasteurization – principles and methods – vacreation - Homogenization – working principle of homogenizers – homogenization efficiency - cream separation – principles – gravity and centrifugal separation – clarifiers and separators – centrifugal separator – separation efficiency - fat loss in skim milk—bactofugation.

UNIT III   DAIRY PRODUCTS   11
Manufacture of dairy products-Butter - properties- Manufacture of butter-Market grades of butter-Cheese-Classification-Composition – manufacture of cheese - Methods and Equipment- Ghee processing-Methods and Equipment- Ice cream - ingredients – preparation of ice cream mix - freezing – ice cream freezers –batch and continuous freezers - Skim milk - Butter milk-Flavored Milk, Whey, Casein, Yogurt and Paneer.

UNIT IV   MILK POWDER PROCESSING   8
Condensed Milk-Composition-Properties-Methods and Equipment-Processing of Milk Powder-Properties-Composition-Types-Manufacture of Milk Powder - Drum and Spray driers-Types of atomizers and flow patterns-droplet trajectory of milk.

UNIT V   PACKAGING, SANITATION AND EFFLUENT TREATMENT   10
Packaging of Milk and Milk Products- bottle fillers and cappers- Flexible pouches – FFS - Milk-Storage Tanks-Storage of milk products - Transportation of Milk and milk products
Cleaning and Sanitation -Importance - Detergents - Properties - Cleaning procedures-CIP-Sanitation-Dairy effluent treatment and disposal.

                                                            TOTAL: 45 PERIODS

OUTCOMES
On completion of the course, the student will be able to
CO1   get an idea of milk, its properties and how it is handled
CO2   understand the concept and methods of processing and packaging of milk and milk products
CO3   appreciate the different products of milk and the variations available in market
CO4   possess the knowledge of maintaining the dairy plant clean and sanitary
CO5   apply the knowledge of different branches of Engineering in milk processing

TEXT BOOKS:
1. Ananthakrishnan, C.P., and Sinha, N.N., "Technology and Engineering of Dairy Plant Operations, Laxmi Publications, New Delhi, 1987.
2. Warner, J.N., "Principles of Dairy Processing", Wiley Eastern Pub. Co., New York, 1975.
3. De Sukumar . "Outlines of Dairy Technology", Oxford University press, New Delhi, 2002

REFERENCES:
1. Tufail Ahmed., "Dairy Plant Engineering and Management", Kitab Mahal Publishers, Allahabad, 1997.
2. Farrall,A.W. "Engineering for dairy and food products". John Wiley and Sons, New York, 1963.
3. Hall,C.W and T.J. Hedrick. "Drying of milk and milk products". AVI Publishing Co., West Port, Connecticut, 1971.
4. Robinson, R.K. "Modern dairy technology Vol.I Advances in Milk processing". Elsevier Applied Science Publishes, London, 1986.

GI5691	PHOTOGRAMMETRY	L T P C
		3 0 0 3

OBJECTIVE:
- To introduce basics and concepts of aerial photography, acquisition and mapping from aerial photographs using different types of stereo plotters

UNIT I INTRODUCTION 9
Principles - Stereoscopic depth perception – aerial photo-aerial camera -Scale – overlaps – stereoscopy – concepts – viewing and measuring system – principle of floating mark – methods of parallax measurement – vertical photographs – geometry, scale, parallax equations, planimetric mapping – Tilted photograph – Geometry, Coordinate system, Scale, Planimetric mapping

UNIT II TRANSFORMATIONS 9
Coordinate systems for Photogrammetry - Map projections, Datum and conversions- 2D and 3D Coordinate transformations: Affine, 7 Parameter Transformations - Collinearity and Space resection-Analytical stereomodel and relative orientation

UNIT III MAPPING 9
Concepts of interior, relative, absolute orientation – direct georeferencing – object, image relation collinearity and coplanarity conditions – effect of orientation elements - Elements and principles of Aerotriangulation – Independent Models-Simultaneous bundle adjustment - ortho mosaic

UNIT IV DIGITAL PHOTORGRAMMETRY 9
Concepts of Digital Photogrammetry- Digital cameras- CCD camera- full frame, frame transfer, interline CCD camera - Time delay integration- spectral sensitivity of CCD sensor – geometry and radiometry problem of CCD image Image Generation - Data Compression - formats – Softwares used for Digital Photogrammetric Mapping - Georeferencing - Stereo viewing-Display modes - image matching techniques - Image measurements

UNIT V APPLICATIONS 9
Review of space resection & intersection - Automatic tie point generation - Automatic Block triangulation, feature collection and plotting– DEM Generation - accuracy of DEMs, Orthorectification - regular & irregular data collection methods - contour generation – Applications in Hydrology, Highway (Cut and Fill Volume Calculations) - Satellite Photogrammetry principles – missions - stereo image products.

TOTAL: 45 PERIODS

OUTCOMES:
On completion of this course, the student shall
- Acquire knowledge about photogrammetry principles, methods and products generation strategies in both Analytical and digital photogrammetry system.
- Understand the problem related to generation of products and solving them.

REFERENCES:
1 Paul R.Wolf, Elements of Photogrammetry, McGraw-Hill Science, 2001, ISBN 0070713464, 9780070713468
2 Karl Kraus, Photogrammetry, Fundamentals and standard processes, Dümmler, 2000, ISBN 9783110190076

3   Micheal Kasser and Yves Egels, "Digital Photogrammetry", Taylor and Francis, 2002, ISBN 0 748409440
4   Francis h. Moffitt, Edward M. Mikhail, Photogrammetry, TBS The Book Service Ltd, 1968, ISBN 13: 9780700221370
5   Edward M. Mikhail, James S.Bethel, J.Chris McGlone, Introduction on "Modern Photogrammetry", John Wiley & Sons, Inc., 2001, ISBN 0-471 -30924-9
6   Wilfried Linder, "Digital Photogrammetry"-Theory and Applications, Springer-Verlag Berlin Heidelberg New York, 2003, ISBN 3-540-00810-1

GI5692	TOTAL STATION AND GPS SURVEYING	L T P C
		3 0 0 3

OBJECTIVES :

- To understand the working of Total Station and GPS equipment and solve the surveying problems.

UNIT I   FUNDAMENTALS   9
Methods of Measuring Distance, Basic Principles of Total Station, Historical Development, Classifications, applications and comparison with conventional surveying. Global Navigation System, Regional Navigation System and SBAS - Basic concepts of GNSS, Glonass,IRNSS Historical perspective and development - applications - Geoid and Ellipsoid- satellite orbital motion - Keplerian motion – Kepler"s Law - Perturbing forces - Geodetic satellite - Doppler effect-Different Coordinates and Time System.

UNIT II   ELECTROMAGNETIC WAVES   9
Classification - applications of Electromagnetic waves, Propagation properties, wave propagation at lower and higher frequencies- Refractive index (RI) - factors affecting RI-Computation of group for light and near infrared waves at standard and ambient conditions-Computation of RI for microwaves at ambient condition - Reference refractive index- Real time application of first velocity correction. Measurement of atmospheric parameters- Mean refractive index- Second velocity correction -Total atmospheric correction- Use of temperature - pressure transducers.

UNIT III   ELECTRO OPTICAL AND MICRO WAVE SYSTEM   9
Electro-optical system: Measuring principle, Working principle, Sources of Error, Infrared and Laser Total Station instruments. Microwave system: Measuring principle, working principle, Sources of Error, Microwave Total Station instruments. Comparison between Electro-optical and Microwave system. Care and maintenance of Total Station instruments– Applications of COGO functions -Traversing and Trilateration – Downloading and mapping - Recent trends.

UNIT IV   GPS SATELLITE SYSTEM   9
GPS - Different segments - space, control and user segments - satellite configuration - GPS signal structure - Orbit determination and representation - Anti Spoofing and Selective Availability – Task of control segment - GPS receivers- Single and Dual Frequency Receivers- Survey Grade GPS – GNSS Satellite Constellations

UNIT V   GPS DATA PROCESSING   9
GPS observables - code and carrier phase observation - linear combination and derived observables - concept of parameter estimation – downloading the data -data processing – software modules -solutions of cycle slips, ambiguities, RINEX format. Concepts of rapid, static methods with GPS - semi Kinematic, pure Kinematic and Real time kinematic methods –basic constellation of satellite geometry & accuracy measures - applications- Different GPS Data Processing and Mapping softwares.

TOTAL : 45 PERIODS

OUTCOMES:
On completion of this course students shall be able to

- Understanding the concepts of Electromagnetic waves and impact of Refractive Index.

- Work with Electro optical and microwave Total Station and understand error sources**.**
- Understand the advantages of electronic surveying over conventional surveying methods
- Understand the working principle of GNSS , it"s components, signal structure, and error sources
- Understand various GNSS surveying methods and processing techniques used in GNSS observations
- Familiarise various areas of GNSS applications and new developments.

REFERENCES:
1. Rueger, J.M. Electronic Distance Measurement, Springer-Verlag, Berlin, 4th edition, 2004
2. Satheesh Gopi, rasathishkumar, N.madhu, " Advanced Surveying, Total Station GPS and Remote Sensing " Pearson education , 2017
3. Laurila, S.H. Electronic Surveying in Practice, John Wiley and Sons Inc, 2007.
4. Guocheng Xu, GPS Theory, Algorithms and Applications, Springer - Verlag, Berlin, 2007.
5. Alfred Leick, GPS satellite surveying, John Wiley & Sons Inc., 3rd Edition, 2004.
6. Seeber G, Satellite Geodesy, Walter De Gruyter, Berlin, 2007

EE5691   **INTRODUCTION TO CONTROL SYSTEMS**   **L T P C**
3 0 0 3
OBJECTIVES
- To impart knowledge on various representations of systems.
- To familiarize time response analysis of LTI systems and steady state error.
- To analyze the frequency responses and stability of the systems
- To analyze the stability of linear systems in frequency domain and time domain
- To develop linear models mainly state variable model and transfer function model

UNIT I   MATHEMATICAL MODELS OF PHYSICALSYSTEMS   9
Definition & classification of system – terminology & structure of feedback control theory – Analogous systems - Physical system representation by Differential equations – Block diagram reduction–Signal flow graphs.

UNIT II   TIME RESPONSE ANALYSIS & ROOTLOCUSTECHNIQUE   9
 Standard test signals – Steady state error & error constants – Time Response of I and II order system–Root locus–Rules for sketching rootloci.

UNIT III   FREQUENCY RESPONSE ANALYSIS   9
Correlation between Time & Frequency response – Polar plots – Bode Plots – Determination of Transfer Function from Bode plot.

UNIT IV   STABILITY CONCEPTS & ANALYSIS   9
 Concept of stability – Necessary condition – RH criterion – Relative stability – Nyquist stability criterion — Stability from Bode plot — Relative stability from Nyquist & Bode — Closed loop frequency response.

UNITV   STATE VARIABLE ANALYSIS   9
Concept of state – State Variable & State Model – State models for linear & continuous time systems–Solution of state & output equation–controllability & observability.

TOTAL:45 PERIODS
OUTCOMES:
Ability to
CO1: Design the basic mathematical model of physical System.
CO2: Analyze the time response analysis and techniques.
CO3: Analyze the transfer function from different plots.

CO4: Apply the stability concept in various criterion.
CO5: Assess the state models for linear and continuous Systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2							2
CO2	3	3	2	3	1							
CO3	3	3	3	2	2							
CO4	3	3	3	2	2							2
CO5	3	3	3	1	1							1

TEXT BOOKS
1. Farid Golnarghi , Benjamin C. Kuo, Automatic Control Systems Paper back, McGraw Hill Education, 2018.
2. Katsuhiko Ogata, 'Modern Control Engineering', Pearson, 5th Edition2015.
3. J. Nagrath and M. Gopal, Control Systems Engineering (Multi Colour Edition), New Age International, 2018.

REFERENCES
1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, Pearson Education, 2010.
2. Control System Dynamics" by Robert Clark, Cambridge University Press, 1996 USA.
3. John J. D'Azzo, Constantine H. Houpis and Stuart N. Sheldon, Linear Control System AnalysisandDesign, 5th Edition, CRC PRESS, 2003.
4. S. Palani, Control System Engineering, McGraw-Hill Education Private Limited, 2009.
5. Yaduvir Singh and S.Janardhanan, Modern Control, Cengage Learning, First Impression 2010.

EE5692	**ELECTRIC VEHICLE TECHNOLOGY**	**L T P C**
		3 0 0 3

COURSE OBJECTIVES
- To provide knowledge about electric machines and special machine
- To understand the basics of power converters
- To know the concepts of controlling DC and AC drive systems
- To understand the architecture and power train components.
- To impart knowledge on vehicle control for standard drive cycles of hybrid electrical vehicles (HEVs)

UNIT I   ROTATING POWER CONVERTERS   9
Magnetic circuits- DC machine and AC machine –Working principle of Generator and Motor-DC and AC - Voltage and torque equations – Characteristics and applications. Working principle of special machines like: Brushless DC motor, Switched reluctance motor and PMSM.

UNIT II   STATIC POWER CONVERTERS   9
Working and Characteristics   of Power Diodes, MOSFET and IGBT. Working of uncontrolled rectifiers, controlled rectifiers (Single phase and Three phase), DC choppers, single and three phase inverters, Multilevel inverters and Matrix Converters.

UNIT III   CONTROL OF DC AND AC MOTOR DRIVES   9
Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, Transformation theory, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives

**UNIT IV   HYBRID ELECTRIC VEHICLE ARCHITECTURE AND POWER TRAIN
                   COMPONENTS   9**

History of evolution of Electric Vehicles - Comparison of Electric Vehicles with Internal Combustion
Engines - Architecture of Electric Vehicles (EV) and Hybrid Electric Vehicles (HEV) – Plug-in
Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches,
Transmission and Brakes.

**UNIT V   MECHANICS OF HYBRID ELECTRIC VEHICLES AND CONTROL OF
                   VEHICLES   9**

Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard
drive cycles of HEV's - motor torque and power rating and battery capacity. HEV supervisory
control - Selection of modes - power spilt mode - parallel mode - engine brake mode -
regeneration mode - series parallel mode

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Able to understand the principles of conventional and special electrical machines.
CO2: Acquired the concepts of power devices and power converters
CO3: Able to understand the control for DC and AC drive systems.
CO4: Learned the electric vehicle architecture and power train components.
CO5: Acquired the knowledge of mechanics of electric vehicles and control of electric vehicles.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			3							
CO2	3	2	2			3			3			
CO3	3			3		2	2					
CO4	3	2	2		3							
CO5	3		2								2	

REFERENCES:
1 Stephen D. Umans, "Fitzgerald & Kingsley's Electric Machinery", Tata McGraw Hill, 7th Edition,
   2020.
2 Bogdan M. Wilamowski, J. David Irwin, The Industrial Electronics Handbook, Second Edition,
   Power Electronics and Motor Drives, CRC Press, 2011
3 Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven D. Pekarek "Analysis of Electric
   Machinery and Drive Systems", 3rd Edition, Wiley-IEEE Press, 2013.
4 Rashid M.H., "Power Electronics Circuits, Devices and Applications ", Pearson, fourth Edition,
   10th Impression 2021.
5 Iqbal Husain, 'Electric and Hybrid Electric Vehicles', CRC Press, 2021.
6 Wei Liu, 'Hybrid Electric Vehicle System Modeling and Control', Second Edition, WILEY, 2017
7 James Larminie and John Lowry, 'Electric Vehicle Technology Explained', Second Edition,
   Wiley, 2012

**ME5691   BASIC AUTOMOBILE ENGINEERING   L T P C
                                                                        3 0 0 3**

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Classifying the types of chassis and identify different class of automobiles
2. Outline the hybrid vehicle system architecture and their merits and demerits.

3. Illustrating the functions of various transmission systems.
4. Imparting the working of different braking and steering systems.
5. Understanding the working of electrical and electronic components

UNIT I   INTRODUCTON   9
Types of automobiles, vehicle construction and different layouts, chassis, frame and body, Aerodynamic Drag, Specifications, Performance Parameters, Bharat New Vehicle Safety Assessment Program (BNVSAP) – Crash Test norms.

UNIT II   HYBRID ELECTRIC VEHICLES   9
History and need for electric and hybrid vehicles, Concept of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles, comparison of diesel, petrol, electric and hybrid vehicles based on performance and emissions, limitations of electric vehicles and technical challenges

UNIT III   TRANSMISSION SYSTEMS   9
Clutch-types and construction, gear boxes, manual and automatic, propeller shaft, slip joints, universal joints, Differential, and rear axle.

UNIT IV   STEERING, BRAKES AND SUSPENSION SYSTEMS   9
Types of steering, Power Assisted Steering., Pneumatic and Hydraulic Braking Systems, Suspension Systems – Need & types.

UNIT V   SAFETY AND COMFORT SYSTEMS   9
Passive Safety Systems – Airbags, Seatbelts, Crumple Zones, Active Safety Systems – Automatic Driver Assist Systems (ADAS), Antilock Braking System, Reverse parking system, Anti-collision system, Traction control system, Comfort Systems – Cruise control system, Heating, ventilation and Air-conditioning system (HVAC), Autonomous Driving Cars – Level of Driving Automation.

TOTAL:45 PERIODS

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
   1. Distinguish the different types of automobiles and chassis.
   2. Interpret the various types of engines and their emission control.
   3. Select the appropriate transmission systems.
   4. Compare the braking and steering systems.
   5. Infer the functions of different electrical and electronic components.

TEXT BOOKS:
   1. William H. Crouse and Donald L. Anglin, "Automotive Mechanics",Tata McGraw Hill, 2004,10[th]Ed
   2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition CRC Press, 2011

REFERENCES:
 1. Ganesan V, "Internal Combustion Engines", Tata McGraw Hill Book Co., 2003.
 2. Ehsani, M, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", CRC Press, 2005
 3. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and   Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
 4. Bosch "Automotive Handbook", Robert Bosch GmbH, Germany, 2008, Eighthth Edition.

ME5692   **PRODUCT DESIGN AND PROCESS**   **L   T   P   C**
                    DEVELOPMENT

                                                            3   0   0   3

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identifying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and screening the concepts for new product design and development.
5. Testing and prototyping the concepts to design and develop new products.

UNIT I   INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT   9
Introduction – Characteristics of Successful Product Development – People involved in Product Design and Development - Duration and Cost of Product Development - The Challenges of Product Development - The Product Development Process - Concept Development: The Front-End Process - Adapting the Generic Product Development Process - Product Development Process Flows - Product Development Organizations.

UNIT II   OPPORTUNITY DENTIFICATION & PRODUCT PLANNING   9
Opportunity Identification: Definition - Types of Opportunities - Tournament Structure of Opportunity Identification - Effective Opportunity Tournaments – Opportunity dentification Process - Product Planning: Four Types of Product Development Projects - The Process of Product Planning

UNIT III   IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS   9
Identifying Customer Needs: The Importance of Latent Needs - The Process of Identifying Customer Needs. Product Specifications: Definition - Time of Specifications Establishment - Establishing Target Specifications - Setting the Final Specifications

UNIT IV   CONCEPT GENERATION & SELECTION   9
Concept Generation: Activity of Concept Generation - Structured Approach - Five step method of Concept Generation. Concept Selection: Methodology - Concept Screening and Concepts Scoring.

UNIT V   CONCEPT TESTING & PROTOTYPING   9
Concept Testing: Seven Step activities of concept testing. Prototyping – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

                                                            TOTAL: 45 PERIODS
COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply the principles of generic development process; and understand the organization structure for new p1roduct design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and screen the concepts for new product design and development.
5. Test and prototype the concepts to design and develop new products.

TEXT BOOK:
1. Ulrich K.T., Eppinger S. D. and Anita Goyal, "Product Design and Development"McGraw-Hill Education; 7 edition,2020.

REFERENCES:
1. Belz A., 36-Hour Course: "Product Development" McGraw-Hill,2010.
2. Rosenthal S., "Effective Product Design and Development", Business One Orwin, Home

wood, 1992, ISBN 1-55623-603-4.
3.   Stuart Pugh., "Total Design –Integrated Methods for Successful Product Engineering" Addison Wesley Publishing, 1991, ISBN 0-202-41639-5.
4.   Chitale, A. K. and Gupta, R. C., Product Design and Manufacturing, PHI Learning, 2013.
5.   Jamnia, A., Introduction to Product Design and Development for Engineers, CRC Press 2018.

ME5693   **APPLICATIONS OF 3D PRINTING TECHNIQUES**   **L   T   P   C**
                                                                        3   0   0   3

OBJECTIVES:
1.   To understand about concept of 3D printing
2.   To appreciate the role of 3D printing in food technology
3.   To appreciate the role of 3D printing in fashion technology
4.   To appreciate the role of 3D printing in construction technology
5.   To appreciate the role of 3D printing in healthcare Industry

UNIT I   3D PRINTING   9
History-Rapid Prototyping –ISO/ASTM 52915/21/- Additive Manufacturing- Process Steps in 3D printing-Classification of AM techniques- Advantages, Limitations.

UNIT II   3D PRINTING IN FOOD TECHNOLOGY   9
Printable food materials and properties, food product design- advantages & limitations, FOOD SAFETY LAWS AND REGULATION- Ethics- Software's, Advantages, Limitations, Future Aspects, case studies.

UNIT III   3D PRINTING IN FASHION TECHNOLOGY   9
Printable materials and properties, Fashion & Apparel design, N-topology, Conductive textiles, Smart Wearable electronics, printed garments, Sportswear, software's, Advantages, Limitations, Future Aspects, case studies.

UNIT IV   3D PRINTING IN CONSTRUCTION TECHNOLOGY   9
Printable materials and properties, Bio inspired designs, Advantages, Limitations, Future Aspects case studies.

UNIT V   3D PRINTING IN HEALTHCARE TECHNOLOGY   9
Printable materials and properties, Bio-printing, Modelling, pharmacology, forensic, Future Aspects

OUTCOMES:
The students will able to
1.   Remember the role modern healthcare machines
2.   Apply the concept of 3D printing in food technology
3.   Apply the concept of 3D printing in fashion technology
4.   Apply the concept of 3D printing in construction technology
5.   Apply the concept of 3D printing in healthcare technology

REFERENCES
1.   Muralidhara HB, Soumitra Banarjee, 3D PRINTING TECHNOLOGY AND ITS DIVERSE APPLICATIONS, CRC Press, AAP, 2022, ISBN 9781771889780
2.   Ben Redwood, Filemon Schöffer, Brian Garret, The 3D Printing Handbook: Technologies, design and applications [1st ed.], 3D Hubs, 2017, ISBN 9789082748505.
3.   Godoi, Fernanda C, Fundamentals of 3D food printing and applications, Elsevier Ltd. Academic Press, 2012, ISBN 9780128145647.
4.   Carlos BAÑÓN, Félix RASPALL, 3D Printing Architecture: Workflows, Applications, and Trends [1st ed.], Springer Singapore, 2021, ISBN 9789811583872
5.   Georgios Tsoulfas, Petros I. Bangeas, Jasjit S. Suri, 3D Printing: Applications in Medicine and Surgery [1 ed.], Elsevier, ISBN 9780323661645.

ML5691   **MATERIALS SELECTION**   **L T P C**
                                                                         3 0 0 3

UNIT – I   INTRODUCTION TO MATERIALS   9

Significance of Materials in Design, Evolution of engineering Materials, traditional Materials - Futuristic materials, Classification of Materials-Ferrous and Non-Ferrous materials, Polymers, Ceramics, Composites and other advanced materials.

UNIT – II   MATERIAL PROPERTIES   9

Significance for material design, Economic aspects, Mechanical properties-Density, Modulus, Damping, Yield Strength, Tensile Strength, Hardness, Fracture Toughness, Fatigue Strength, Thermal Fatigue Resistance, Creep Strength; Surface properties-Hardness, Modulus of Rupture, Surface Roughness and Friction Coefficient, Wear and Corrosion Rate and other functional properties, Ease of Manufacture, Joining and Aesthetic Properties

UNIT-III   MATERIALS SELECTION FOR ENGINEERING APPLICATIONS – I   9

Materials for Automotive applications, Aircraft applications, Case studies in materials selection for various applications – oar, table leg, flywheel, kiln walls, passive solar heating, heat exchangers, bearings, springs, pressure vessel, passive solar heating, ceramic valves.

UNIT – IV   MATERIALS SELECTION FOR ENGINEERING APPLICATIONS – II   9

Materials for Marine applications, Electrical and electronic industries, Case studies in materials selection for High temperature and cryogenic applications.

UNIT – V   MATERIAL DESIGN   9

Material attributes, Ashby process of Materials Selection, Performance Index, Material Index, Case study for Material selection using Ashby method, Constraints in Materials selection, Selection of materials against multiple constraints, Role of materials in shaping the product character. New frontiers in systems design of materials: Integrated Computational Materials Engineering

TEXT BOOKS:
1. M. F. Ashby, Materials Selection in Mechanical Design, Elsevier Publication, 2005
2. William D.Callister, Jr, Materials Science and Engineeering, Second Edition, Wiley publications, 2017.

REFERENCES:
1. J. G. Gerdeen, H. W. Lord and R. A. L. Rorrer, Engineering Design with Polymers and Composites, Taylor & Francis, 2005
2. M. F. Ashby and K. Johnson, Materials and Design, Butterworth Publication, 2002
3. D.R. Askeland and P.P. Phule, The Science and Engineering of Materials, Thomson Brooks/Cole Publication, 4th edition, 2006
4. ASM Handbook – 'Materials Selection and Design' – 1997

IE5691   **INTRODUCTION TO INDUSTRIAL ENGINEERING**   **L T P C**
                                                                        3 0 0 3

OBJECTIVES:

The objective of this course is to provide foundation in Industrial Engineering in order to enable the students to make significant contributions for improvements in diverse organizations.
   - Explain the concepts productivity and productivity measurement approaches.
   - Explain the basic principles in facilities planning and plant location.
   - Apply work study and ergonomic principles to design workplaces for the improvement of human performance
   - Impart knowledge to design and implement Statistical Process control in any industry.
   - Recognize the concept of Production and Operations Management in creating and enhancing a firm's competitive advantages

UNIT I   INTRODUCTION   9
Concepts of Industrial Engineering – History and development of Industrial Engineering –Roles of Industrial Engineer – Applications of Industrial Engineering – Production Management Vs Industrial Engineering – Production System – Input Output Model – Productivity – Factors affecting Productivity – Increasing Productivity of resources – Kinds of Productivity measures.

UNIT II   PLANT LOCATION AND LAYOUT   9
Factors affecting Plant location – Objectives of Plant Layout – Principles of Plant Layout – Types of Plant Layout – Methods of Plant and Facility Layout – Storage Space requirements – Plant Layout procedure – Line Balancing methods.

UNIT III   WORK SYSTEM DESIGN   & ERGONOMICS   9
Need – Objectives – Method Study procedure – Principles of Motion Economy – Work Measurement procedures – Time Study –Work sampling- Ergonomics and its areas of application in the work system - Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing.

UNIT IV   STATISTICAL QUALITY CONTROL   9
Definition and Concepts – Fundamentals – Control Charts for variables – Control Charts for attributes – Acceptance Sampling- O.C curve –Single sampling plan- Double sampling plan.

UNIT V   PRODUCTION PLANNING AND CONTROL   9
Forecasting –Techniques – Types of production – Process planning – Economic Batch Quantity– Loading – Scheduling and control of production.

TOTAL: 45 PERIODS

OUTCOMES:
CO1: To understand the concepts of productivity and productivity measurement approaches.
CO2: Evaluate appropriate location models for various facility types and design various facility layouts
CO3: To conduct a method study and time study to improve the efficiency of the system.
CO4: Control the quality of processes using control charts in manufacturing/service industries.
    CO5: The students will obtain sufficient knowledge and skill for Planning strategies and Material Requirement Plan.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											1
CO2	2	2	3									
CO3	2	2	2	1	1			2			1	
CO4	2	2	3	1	1							
CO5	1	2	2									1

TEXT BOOKS:
1. O.P.Khanna, 2010, Industrial Engineering and Management, Dhanpat Rai Publications.
2. Martand Telsang,2006, Industrial Engineering and Production Management, S. Chand and Company

REFERENCES:
1. Ravi Shankar, 2009, Industrial Engineering and Management, Galgotia Publications & Private Limited.

MF5691 **MANUFACTURING OF AUTOMOTIVE SYSTEMS** **L T P C**
                                                    3 0 0 3

COURSE OBJECTIVES:
- To introduce the various automotive vehicle systems
- To impart knowledge on the various materials used for automotive components
- To study the production processes of automotive engine system.
- To production processes of automobile auxiliary systems
- To learn the advancements in automotive production

UNIT I   INTRODUCTION TO AUTOMOTIVE SYSTEMS   9
Introduction - Engine systems - Transmissions and driveline – suspensions and steering - Tyres and wheels- Braking systems –Chassis system - Electrical system –HVAC system - Engine control and Vehicle control systems - Emissions control system

UNIT II   MATERIALS FOR AUTOMOTIVE SYSTEMS   9
Selection of automotive materials – types of materials – Ferrous –Low, medium and high carbon steels, Cast Irons– Nonferrous – Aluminum, Magnesium, Titanium, Copper and Nickel alloys, Composites , Non-metallic materials –Polymers--Smart materials.

UNIT III   MANUFACTURING OF ENGINE SYSTEM   9
Manufacturing of Cylinder Block, Cylinder Head, Piston Assembly, Connecting Rod, Crankshaft, Camshaft, Manifolds, and Valve Train- Fuel system – cooling system – ignition system – Bearing and lubrication system

UNIT IV   MANUFACTURING OF AUXILIARY SYSTEMS   9
Manufacturing of Gear box, Clutch, propeller shaft - Suspensions and steering system - Tyres and wheels - Braking systems –Chassis system - Electrical system - Emissions control system

UNIT V   ADVANCES IN AUTOMOTIVE SYSTEM   9
Manufacturing of Hybrid Vehicle, Electric vehicle, Traction batteries, Fuel-cell, Sensors and actuators, intelligent vehicle systems - Automation and equipment technologies
                                                        TOTAL : 45 PERIODS

TEXT BOOKS:
1. Hiroshi yamagata, "The Science and Technology of materials in Automotive Engines", CRC Press Word head publishing Limited, Cambridge, England, 2005.
2. Heldt. P.M., "High Speed Combustion Engines ", Oxford Publishing Co., New York, 1990.
3. Heinz Hesiler, Advanced Vehicle technology. Elsevier publications, 2nd edition, 2011.

REFERENCES
1. Kirpal Singh, "Automobile Engineering. Vol. I and II", Standard Publishers, New Delhi, 13th edition,2012.
2. Serope Kalpakjian and Steven R. Schmid, "Manufacturing Processes for Engineering Materials", Fourth Edition – Pearson Education publications, 2003.
3. Richard D. Atkins, An Introduction to Engine Testing and Development, SAE International,USA,2009.
4. Bosch Automotive Handbook, (8th Edition), Robert Bosch GmbH, Germany, 2011.
5. James D. Halderman and Chase D. Mitchell Jr. Automotive Engines: Theory and Servicing, Pearson Education Inc., 2005.
6. Christopher Hadfield, Automotive Engineering: Engine Repair and Rebuilding, Delmar Learning (Cengage Learning India Private Ltd.), 2010.

COURSE OUTCOMES:
At the end of the course, students will be able to:
  CO1: Identify different automotive system and its functions
  CO2: Select suitable materials and production process for automotive components
  CO3: Acquire complete knowledge on the production processes of automotive engine system.

CO4: Understand the production process of automotive auxiliary systems.
CO5: Develop knowledge in the advancements in automotive production

	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	0.9	0.9	0.9										0.9	0.3	
CO2	0.9	0.9	0.9										0.9	0.3	
CO3	0.9	0.9	0.9										0.9	0.3	
CO4	0.9	0.9	0.9										0.9	0.3	
CO5	0.9	0.9	0.9	0.9	0.9								0.9	0.3	

PT5691   **DESIGN FOR PRINT MEDIA**   **L T P C**
                                                                      3 0 0 3

OBJECTIVES
The students should be made to:
  ◦ Learn the basics of graphic design for printing.
  ◦ Understand the design requirements for various printed product
  ◦ Learn the prepress workflow
  ◦ Be familiar with various printing processes
  ◦ Comprehend the print finishing processes

UNIT I   PRINCIPLES OF DESIGN   9
Design concept; Typography; Design elements; Design consideration; Layout – purpose & advantages; layout styles; layout components; stages in preparing a layout; marking- up; Software; Dummy, Case studies.

UNIT II   DESIGNING FOR PRINT PRODUCTS   9
Standard sizes of printed products; Designing for Visiting Cards, Invitations, Books, Magazines, Business publications, Banners & Posters, Advertising, Packages; Case studies; Print buying - Specifications, cost estimation.

UNIT III   PREPRESS   9
Additive and Subtractive colour theory; Continuous and halftone; Originals - text, image, graphics; Vector and Raster images; Image resolution, File formats and software; File submission requirements; Preflighting, Trapping, Proofing; Prepress workflow.

UNIT IV   PRINTING PROCESSES   9
Types of process – Letterpress, Offset, Gravure, Flexography, Screen printing, Digital Printing Processes; Variable data printing, Print on Demand, Web to print, Security printing, Selection criteria; Applications.

UNIT V   PRINT FINISHING   9
Standard Paper sizes; Value additions to printed products; Types of finishing process - cutting, folding, binding, coating, hot foil stamping, die-cutting, embossing, pouching; Digital print finishing; Selection criteria, Applications.
                                                          TOTAL: 45 PERIODS
OUTCOMES:
Upon completion of the course, the student should be able to:
  ◦ Apply principles of design in the ideation of print products
  ◦ Classify the print products
  ◦ Summarize requirements for preparing print ready file
  ◦ Interpret the print specifications and select suitable printing process.
  ◦ Utilize relevant print finishing methods to enhance value of printed product

TEXT BOOKS:
1. David A. Lauer, Stephen Pentak, "Design Basics", 6th Edition, Wadsworth, 2011
2. Helmut Kipphan, "Handbook of Print Media", Springer, Heidelberg, 2000

REFERENCES:
1. Poppy Evans, Aaris Sherin, "The Graphic Design Reference and Specification Book", Rockport Publishers, 2013
2. Kaj Johansson, Peter Lundberg, Robert Ryberg, "A Guide to Graphic Print Production", 3rd edition, Wiley Publishers, 2012.
3. Franziska Morlok, Till Beckmann, "Extra Encyclopaedia of Experimental Print Finishing", Walter de Gruyter GmbH, 2013

PT5692	VISUAL COMMUNICATION FOR DIGITAL MEDIA	L	T	P	C
		3	0	0	3

OBJECTIVES
- To understand the nature and purpose of visual analysis.
- To explore how to blend different types of approaches and useful tools with visual content.
- To understand different types of visual breakdown and theories related to it.
- To study the models for analysis.
- To understand different types of visual analysis and evaluations.

UNIT I   INTRODUCTION TO VISUAL ANALYSIS   9
Design and communication – visual communication design-Visual analysis: Definition and different perceptions – Methods and Scope of visual communication – Unit of analysis – Image analysis – Text, context, form, colour, social practice in media.

UNIT II   TYPES OF DIGITAL MEDIA   9
Elements of design- principles of design -Typography – design semiotics- syntax- semantics – pragmetics; visual perception- visual language. Visual design methodology- generic , graphic - web design.

UNIT III   QUANTITATIVE APPROACH   9
Content analysis – definition – variables, values – result approaches – Reliability and Validity – Limitations and extension – Visual Rhetoric and Metaphor – Research Questions – Symbolism – Iconography.

UNIT IV   COMMUNICATION AS A PROCESS   9
Communication – types problems-semiotics- polysemy -Perception and meaning- design methods – design process- types- contemporary – modern design principles.

UNIT V   VISUAL AESTHETICS   9
Aesthetic theory – Perception theory – Representation theory, Theory of Visual Rhetoric – Cognitive theory – Visual Semiotic theory – Reception theory – Narrative theory – Visual Ethics theory – Visual Literacy theory - Sensual Theories – Gestalt and Constructivism.

TOTAL: 45 PERIODS

OUTCOMES
At the end of the course, the student will be able to:
- Understand the scope and limitations of visual media.
- Identify the range of approaches to visual analysis.
- Learn the different visual representation techniques and its applications.
- Understand the theories of visual analysis.
- Learn to analyze and evaluate visual content.

REFERENCES
1. Kenneth L. Smith, Sandra Moriarty, Keith Kenney, Gretchen Barbatsis: Handbook of Visual Communication: Theory, Methods, and Media, Routledge, London, 2005.
2. David Machin, Andrea Mayr, How to Do Critical Discourse Analysis: A Multimodal Introduction, Sage, 2012.
3. Per Ledin, David Machin, Doing Visual Analysis: From Theory to Practice, Sage,2018.
4. Giorgia Aiello, Katy Parry, Visual Communication: Understanding Images in Media Culture 1st Edition, Sage, 2020.
5. Jonathan Baldwin, Lucienne Roberts, Visual Communication From Theory to Practice , Bloomsbury Publishing· 2019.

CS5691	BIG DATA ANALYTICS	L T P C
		3 0 0 3

OBJECTIVES
- To know the fundamental concepts of big data and analytics.
- To explore tools and practices for working with big data
- To familiarize with different Recommendation system
- To learn about stream computing.
- To know about the research that requires the integration of large amounts of data.

UNIT I   INTRODUCTION TO BIG DATA   9

Evolution of Big data – Best Practices for Big data Analytics – Big data characteristics – Validating – The Promotion of the Value of Big Data – Big Data Use Cases- Characteristics of Big Data Applications – Perception and Quantification of Value –Understanding Big Data Storage – A General Overview of High-Performance Architecture – HDFS

UNIT II   CLUSTERING AND CLASSIFICATION   9

Advanced Analytical Theory and Methods: Overview of Clustering – K-means – Use Cases – Overview of the Method – Determining the Number of Clusters – Diagnostics – Reasons to Choose and Cautions .- Classification: Decision Trees – Overview of a Decision Tree – The General Algorithm – Decision Tree Algorithms – Evaluating a Decision Tree – Decision Trees in R – Naïve Bayes – Bayes' Theorem – Naïve Bayes Classifier.

UNIT III   RECOMMENDATION SYSTEM   9

Recommendation System: Collaborative Recommendation- Content Based Recommendation – Knowledge Based Recommendation- Hybrid Recommendation Approaches.

UNIT IV   GRAPH MEMORY AND STREAM MEMORY   9

Using Graph Analytics for Big Data: Graph Analytics – The Graph Model – Representation as Triples – Graphs and Network Organization – Choosing Graph Analytics – Graph Analytics Use Cases – Graph Analytics Algorithms and Solution Approaches – Technical Complexity of Analyzing Graphs- Features of a Graph Analytics Platform – Considerations: Dedicated Appliances for Graph – Introduction to Streams Concepts – Stream Data Model and Architecture – Stream Computing, Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating moments – Counting oneness in a Window – Decaying Window

UNIT V   NOSQL DATA MANAGEMENT FOR BIG DATA AND VISUALIZATION   9

NoSQL Databases : Schema-less Models": Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores – Tabular Stores – Object Data Stores – Graph Databases Hive – Sharding –- Hbase.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, the students will be able to:
- Work with big data tools and its analysis techniques
- Design efficient algorithms for mining the data from large volumes
- Design an efficient recommendation system
- Design the tools for visualization
- Learn NoSQL databases and management

TEXT BOOKS:

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.
2. Umesh R Hodeghatta, Umesha Nayak, "Business Analytics Using R – A Practical Approach", Apress, 2017
3. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.

REFERENCES:

1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers, 2015.
2. Seema Acharya, ' Data Analytics using R', McGraw-Hill, 2018
3. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers, 2015.
4. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press, 2010.
5. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers " CRC Press, 2015.
6. Jimmy Lin and Chris Dyer, "Data-Intensive Text Processing with MapReduce", Synthesis Lectures on Human Language Technologies, Vol. 3, No. 1, Pages 1-177, Morgan Claypool publishers, 2010.
7. U. Dinesh Kumar, "Business Analytics: The Science of Data-Driven Decision Making", Wiley, 2017

CS5692	WEB DESIGN AND MANAGEMENT	L T P C
		3 0 0 3

OBJECTIVES:
- To learn the concepts of Web design and its types.
- To understand the basic concepts of HTML
- To understand and learn the scripting languages with design of web Applications.
- To understand the concepts of web hosting and SEO.
- To learn the SQL queries to retrieve/store data from/to database.

UNIT I INTRODUCTION 9
Basic principles involved in developing a web site, Planning process, Domains and Hosting, Responsive Web Designing, Types of Websites (Static and Dynamic Websites), Introduction to HTML: What is HTML, HTML Documents, Basic structure of an HTML document, Creating an HTML document, Mark up Tags, Heading-Paragraphs, Line Breaks, HTML Tags., Working with Text, Working with Lists, Tables and Frames, Working with Hyperlinks, Images and Multimedia, Working with Forms and controls

UNIT II CONCEPT OF CSS 9
Creating Style Sheet, CSS Properties, CSS Styling (Background, Text Format, Controlling Fonts), Working with block elements and objects, Working with Lists and Tables, CSS Id and Class, Box Model (Introduction, Border properties, Padding Properties, Margin properties) CSS Advanced (Grouping, Dimension, Display, Positioning, Floating, Align, Pseudo class, Navigation Bar, Image Sprites, Attribute sector), CSS Color, Creating page Layout and Site Designs.

UNIT III   SCRIPTING LANGUAGES   9
Introduction to Client Side Scripting, Introduction to Java Script, Javascript Types, Variables in JS, Operators in JS, Conditions Statements, Java Script Loops, JS Popup Boxes, JS Events, JS Arrays, Working with Arrays, JS Objects, JS Functions, Using Java Script in Real time, Validation of Forms, Related Examples

UNIT IV   WEB HOSTING   9
Web Hosting Basics, Types of Hosting Packages, Registering domains, Defining Name Servers, Using Control Panel, Creating Emails in Cpanel , Using FTP Client, Maintaining a Website Concepts of SEO : Basics of SEO, Importance of SEO, Onpage Optimization Basics.

UNIT V   DATABASE: SQL, ADO.NET 2.0 AND JAVA DB   9
Introduction to Relational Databases – Basics of SQL – CRUD Operations – Basics of MySQL – Instructions for Installing MySQL – Instructions for Setting Up a MySQL User Account - Creating a Database in MySQL - ADO.NET Object Model – Java DB/Apache Derby.

TOTAL: 45 PERIODS

OUTCOMES:
Upon completion of the course, the students will be able to
- Visualize and Recognize the basic concept of HTML and application in web designing.
- Recognize and apply the elements of Creating Style Sheet (CSS).
- Understanding the basic concept of Java Script and its application.
- Introduce basics concept of Web Hosting and apply the concept of SEO
- Retrieve data from/to data from the database using SQL.

REFERENCES:
1. Harvey M. Deitel,Paul J,,Abbey Deitel.,"Internet & World Wide Web How to Program", fifth edition , Pearson Education, 2020
2. Scobey, Pawan Lingras, "Web Programming and Internet Technologies An ECommerce Approach", Second Edition, Jones & Bartlett Publishers, 2016.
3. Jennifer Niederst Robbins, "Learning Web Design", OREILLY 4th Edition, 2018
4. Steven M. Schafer, "HTML, XHTML, and CSS Bible, 5ed", Wiley India, 2010
5. Ian Pouncey, Richard York, "Beginning CSS: Cascading Style Sheets for Web Design", Wiley India, 2011

EC5691	AUTOMOTIVE ELECTRONICS	L T P C
		3 0 0 3

OBJECTIVES:
- To make the students to understand the concepts of electronics components, and the design of various combinational circuits.
- To introduce the Microcomputer Instrumentation and Electronics engine control
- Ability to understand sensor based electronics applications.
- To introduce the motion control, Instrumentation and Telematics.
- To impart knowledge on future automotive systems.

UNIT I   AUTOMOTIVE ANDELECTRONICSFUNDAMENTALS   9
Introduction to Automobile Engineering, Automotive Engines and Control Systems, Electronic Engine Management Systems. Introduction to Basic Electronics- Semiconductor Devices. Diodes, Rectifiers, Transistors. Logic Gates, Combinational Circuits and Microprocessors.

UNIT II   MICROCOMPUTER INSTRUMENTATIONAND
ELECTRONICSENGINECONTROL   9
Microcomputer Fundamentals - Digital Vs Analog Computers, Microcomputers Vs Mainframe Computers   and   basic   computer   programming.   Instrumentation   Examples   of Microcomputer. Electronic Engine Control- Motivation. Engine Performance Terms, Electronic Fuel Control systems, Catalytic Converters, Idle Speed Control, Electronic Ignition Systems

UNIT III   SENSORSANDACTUATORS   9

Basic Measurement System, Sensory- Airflow Sensor, Pressure Sensor, Magnetic and hall Effect Sensors, Optical Positioning Sensors. Exhaust and Knock Sensors. Automotive Engine Control Actuators- Fuel Control Actuators, Exhaust Recirculation Actuators, Electrical Motors – Brushless DC and Stepper Motors. IgnitionSystem

UNIT IV   MOTIONCONTROL, INSTRUMENTATION ANDTELEMATICS   9

Digital Engine Control and Features, Control Modes- Fuel Control, Engine Start, Engine Crank and Warm-Up, Speed Control Acceleration / Deceleration, EGR Control and Hybrid Electric Vehicle Power train Control, Electronic Steering Control and Electronic Suspension Systems. Advantages of Computer-Based Instrumentation, Digital Consoles – High-Speed Digital Communications CAN, Display Devices LED, LCD, Flat Panel Display, Trip Information Computer, Telematics, GPS Navigation and Structure.

UNIT V   DIAGNOSIS AND FUTUREAUTOMOTIVESYSTEMS   9

Electronic Control System Diagnostics, Service Bay Diagnostic Tool, Onboard Diagnostics, Model-Based Sensor Failure Detection, Diagnostic Fault Codes, Onboard Diagnosis (OBD II), Model-Based Misfire Detection System, Expert Systems in Automotive Diagnosis, Occupant Protection Systems. Future Automotive Systems- Alternative Engine, Advanced Travel and Safety Control- Collision Avoidance Radar Warning System. Low Tire Pressure Warning System. Sensor Multiplexing and Automatic DrivingControl.

TOTAL : 45 PERIODS

TEXTBOOKS:
1. William B. Ribbens. "Understanding Automotive Electronics – 7ᵗʰEdition, Butterworth. Heinemann Woburn.2017
2. Tom Weather Jr and Cland C Hunter "Automotive Computers and Control System" – Prentice Hall Inc, New Jersey. July2016

REFERENCES:
1. Tom Denton, "Automobile Electrical and Electronic System", Fourth edition, routledge,2017
2. Ribbens William, " Understanding Automotive Electronics , Elsevier – Health Sciences Division, 2020
3. V.A.W Hillier Fundamentals of Automotive Electronics: Second Edition OUP Oxford publisher, 1996.

COURSE OUTCOMES:
CO1: Recognize electronics components required for automotive electronic based systems.
CO2: Ability to design microcomputer Instrumentation and Electronics Engine Control.
CO3: Gain knowledge to design sensor based electronic applications.
CO4: Comprehend vehicular communication and motor control concepts in automotive engineering.
CO5: Exposure to future automotive systems.

PO-CO Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	1	1	1	1								
CO2		2	3	1								
CO3		3	2	1								
CO4		3	1	2								
CO5		1	1	2							1	1

EC5692   **ELECTRONICS ENGINEERING**   **L T P C**
                                                                        3 0 0 3

COURSE OBJECTIVES:
- To understand the basic concepts of electronics components.
- To learn about construction and working of basic electronic devices.
- To impart knowledge on Boolean algebra and design various combinational and sequential circuits.
- To introduce the Integrated circuits design and fabrications and related technology.
- To design sensor based electronics applications.

UNIT I   ELECTRONIC COMPONENTS   9
History, Evolution and Inventors of Electronic Components - Resistors, Capacitors and Inductors - Types, Construction and Functions, Cables – Construction, Characteristics, Types- High Impedance, Low Impedance, Ribbon, High Temperature, Flat Twin, RF, Telephone, Optical Fiber, Connectors, Switches, Relays, Displays (construction an working) –LED, LCD, LASER, Application- Alphanumeric display.

UNIT II   BASIC ELECTRONIC DEVICES AND ITS WORKING: 9
History, Evolution and Inventors of Electronics Devices- PN Junction Diodes, Zener, Bipolar Junction Transistors, Field Effect Transistors- JFET & MOSFET, Uni Junction Transistors, Silicon Controlled Rectifier.

UNIT III: **DIGITAL ELECTRONICS   9**
Boolean algebra, Logic Gates, Half and Full adders, Decoder, Encoder, Multiplexer, Demultiplexer, Flip flops- JK, RS, T, D- construction, Truth table, Characteristic equation, Digital to Analog converters, Analog to Digital converters.

UNIT IV   INTEGRATED CIRCUITS   9
Evolution and Inventors of Integrated Circuits – Structure, Scale/Level, Classification, Surface Mount Devices and Surface Mount Technology, Printed Circuit Boards, Semiconductor Manufacturing Case Study.

UNIT V: **ELECTRONICS SYSTEMS   9**
Tsunami Warning System – Detection (Seismometer), Data processing and Management, Alert Signal & Messaging, E Nose - Detection (Chemical Sensors), Data processing and Classification, Agriculture Robots – Detection (Navigation, Soil and Crop Sensors), Processing, and Actuation. Automotive electronics – Engine Control, Braking, Driver Assistance, Navigation, Safety and Communication Systems- Video Illustrations.

                                           TOTAL:45 PERIODS

TEXT BOOK:
1. Malvino, 'Electronic Principles', McGraw Book Co., 1993.
2. Robert L.Boylestad, Louis Nashelsky, " Electronic devices and circuit theory" , Pearson education, Eleventh edition, 2015

REFERENCES:
1. Grob. B and Schultz. M.E. 'Basic Electronics', Tata Mcgraw Hill, 2003.
2. Thomas L. Floyd, 'Electronics Devices', Pearson Education, 2002.
3. Thomas L. Floyd, 'Digital Fundamentals', Pearson Education, 2003.
4. Millman, Halkias Jacob, Jit Christos and Satyabrata, 'Electronic devices and Circuits', Tata McGraw Hill, 4th Edition, 2015
5. V. R. Deo, Electronic Components and Applications, Ane Books Pvt. Ltd. 2012
6. www.semiconductors.org/main/resources
7. www. technav.ieee.org/tag/5783/electronic-noses
8. www.tsunami.noaa.gov
9. Make Electronics – Learning by Discovery by Charles Platt, 3rd edition,2021.

Course Outcomes:
CO1: Acquire knowledge on electronics components required for electronic based systems.
CO2: Comprehend basic electronic devices working.
CO3: Explore to design digital electronic systems.
CO4: Gain knowledge on design and fabricate PCB's
CO5: Analyze and design sensor based electronics applications.

PO-CO Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	3	1	1	1								
CO2		2	3	2								
CO3		3	2	2								
CO4		3	1	2								
CO5		2	3	2						1		

EC5693   **WIRELESS TECHNOLOGIES**   **L T P C**
                                                                            3 0 0 3

OBJECTIVES:
- To provide basic understanding about wired and wireless communication.
- To have an exposure to Internet of Things and applications.
- To know the basic wireless network security.
- To get exposed to antenna systems.
- To understand various satellite communication.

UNIT I   FUNDAMENTALS OF COMMUNICATION   9
Basics of Communication, Spectrum - FCC, Transceiver design and its Components, Wired and wireless communication. Modulation techniques, OSI Layers, TCP/IP Protocols 1G to 5G developments; 3G, 4G and 5G cell architecture.

UNIT II   INTERNET OF THINGS   9
Introduction, IoT- Architecture, IEEE 802.15.4, M2M and IoT Protocols, SCADA and RFID Protocols, Architecture and Applications - Bluetooth, Zigbee, LORA, 6LOWPAN, Wi-Fi, WIMAX.

UNIT III   WIRELESS NETWORK SECURITY   9
Cryptography, Integrity, Authentication and Key management, Wireless Threats – Hacking 802.11, Eavesdropping, Jamming, Cyber-crimes and awareness – countermeasures, Wireless Security.

UNIT IV   ANTENNA SYSTEMS   9
Introduction, Types of Antennas, Radiation Mechanisms and Measurements, Dipole, Monopole, Mobile Phone Antenna, Smart Antennas, RFID antennas, Automotive Antenna, Reconfigurable Antennas, SAR measurements.

UNIT V   SATELLITE COMMUNICATION   9
Basic principles, Kepler's law, Types of satellites – LEO, MEO and GEO. Launch Vehicles, Satellite Subsystems and Satellite links, Applications – GPS, Mobile communication and TV broadcast, Navigation systems, Modern Navigation systems.

TOTAL:45 PERIODS

TEXT BOOK:
1. John G Proakis, MasoudSalehi, "Communication Systems Engineering" Prentice Hall, 1994.

2. Oliver Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things- Key applications and Protocols", Wiley 2012.

REFERENCES:
1. Dennis Roddy, "Satellite Communication", 4th Edition, Tata McGraw-Hill, 2009.
2. Behrou A. Forouan, "Data Communication and Networking" 5th Edition, Tata McGraw Hill, 2013.
3. Vijay Madisetti and ArshdeepBahga, "Internet of Things (A Hands-onApproach)", VPT, 1 st Edition, 2014.
4. AfifOsseiran, Jose.F.Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.
5. KasunMaduranga Silva Thotahewa(Author), Jean-Michel Redoute(Author), Mehmet RasitYuce, "Ultra Wideband Wireless Body Area Networks", Springer, 2016.
6. Timothy Pratt and Charles W.Bostain, "Satellite Communications", John Wiley and Sons, 2nd Edition, 2012.
7. M. Richharia, "Satellite Systems for Personal Applications", John Wiley, 2010
8. Balanis. A, "Antenna Theory Analysis and Design", 3rd edition, John Wiley and sons, New York, 1982.
9. William Stallings, "Cryptography & Network Security - Principles and Practices" Pearson Education, 4th Edition, 2006.

Course outcomes:
- To be able to analyze the wired and wireless communication and networks.
- To be able to develop Internet of Things for various applications.
- To be able to apply security protocols in Wireless Networks.
- To be able to acquire the antenna systems for Wireless Technologies.
- To be able to explain the Satellite Communication technologies.

PO-CO Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PO12
CO1	2											
CO2	3	2	3	3		1						
CO3	1	3				3						
CO4	1	1	3	2		1						1
CO5	2	2	2	2		2						1

EC5694   **MICROCONTROLLER PROGRAMMING**   **L T P C**
                                                                3 0 0 3

COURSE OBJECTIVES
- To study different microcontroller internal architectures.
- To learn the assembly language and C programming - microcontrollers.
- To learn the interfacing concepts in microcontrollers.
- To design a microcontroller system with different basic hardware.
- To program the microcontroller for real time applications – case study.

UNIT I   INTRODUCTION TO 8051 MICRO CONTROLLER   9
Overview of 8051 Micro Controller, Architecture, I/O ports and Memory Organization, Interrupts, Timer/Counter and Serial Communication, Programming in Assembly language.

UNIT II   INTRODUCTION TO PIC MICROCONTROLLER   9
PIC microcontroller Architecture - Memory - Parallel ports - Interrupts - Timers/Counters - UART- A/D converter – PW, Programming in Assembly language.

UNIT III   PROGRAMMING WITH C   9

Introduction to C - Microchip MPLAB IDE - CCS PCM C compiler - Proteus VSM - Microchip PICDEM Mechatronics board, case study.

UNIT IV   APPLICATIONS OF 8051   9

Human interface from switches to keypads - LED displays - LCD - interfacing to the physical world-simple sensors: micro switch, Light-dependent resistors, Optical object sensing, opto-sensor applied as a shaft encoder, Ultrasonic object sensor - Actuators: DC and stepper motors - Interfacing to actuators, case study.

UNIT V   APPLICATIONS OF PIC MICROCONTROLLERS   9

LED Chasing circuit - Four digit LED Display interface, Interrupt driven event counter with 4-digit LED display - Simple Buzzer interface, Speaker interface - Electronic Siren - Interfacing Digital temperature sensor - Analog temperature sensor IC with A/D converter, case study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- Know the internal architecture of the microcontrollers.
- Program in assembly and C with microcontrollers.
- Understand the basic hardware interfacing with microcontroller system.
- Find effective solutions to a wide range of real-world microcontroller applications.
- Design a case study using microcontroller.

TEXT BOOKS:

1. Muhammad Ali Mazidi and Janice GilliMazidi, The 8051 Micro Controller and Embedded Systems', Pearson Education, 5th Indian reprint, 2003.
2. Martin P.Bates, Programming 8-bit PIC Microcontrollers in C with interactive hardware simulation, Newnes Press, 2008.

REFERENCES:

1. Tim Wilmshurst, Designing Embedded Systems with PIC Microcontrollers Principles and applications, Newnes, Elsevier, 2007.
2. Milan Verle, PIC Microcontrollers – Programming In C, MikroElektronika, 2009.
3. Lambert M. Surhone, Miriam T. Timpledon, Susan F. Marseken, Proteus (Design Software), VDM Publishing, 2010
4. Hubert Henry Ward, C Programming for the PIC Microcontroller: Demystify Coding with Embedded Programming,Apress; 1st ed. Edition, December 2019.
5. 5.Dogan Ibrahim, Microcontroller Projects in C for the 8051, Newnes, 2000.

PO- CO matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PO12
CO1	2			1								
CO2	3	2		2		1						
CO3	1	1		2								
CO4	1	1	3	2		1						2
CO5	2	2	2	2		2						2

BM5691   MANAGEMENT OF WASTES IN HOSPITALS   L T P C
3 0 0 3

OBJECTIVES:

The student should be made :

- To understand the importance of handling wastes and proper disposal.
- To teach the students about regulatory requirements of waste management.
- To study the concept of sterilization and challenges behind infectious wastes.
- To create Knowledge about hospital wastes disposal methods.
- To understand the techniques involved in hazard identification and Risk management.

UNIT I   INTRODUCTION TO WASTES   9
Hospital waste, types of medical waste, hazardous waste, infectious waste, Microbial and pathological wastes, Elements of waste management, hospital waste categorization.

UNIT II   WASTE REGULATION IN INDIA   9
Environment protection Act and rules, Regulation and control rules, Management, handling and transboundary movements.

UNIT III   STERILIZATION TECHNIQUES   9
Transmission of disease, related pathogens, infections and disinfectants, steam sterilization, microwave sterilization, EtO/EO sterilization and dry heat techniques.

UNIT IV   WASTE DISPOSAL METHODS   9
Solid waste disposal, liquid waste disposal, hazardous and radioactive wastes destruction, waste reduction methods, incinerator, crematories.

UNIT IV   SAFETY AND RISK ASSESSMENT   9
Risk management in hospitals, hazard identification and risk assessment, Environmental issues in hospitals and safety issues, Risk analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, the student should be able to:
CO1: Describe the importance of handling wastes and proper disposal.
CO2: Explain about regulatory requirements of waste management
CO3: Comprehend the Challenges against the infectious waste.
CO4: Apply various waste disposal methods.
CO5:Describe the importance of safety and risk assessment techniques.

TEXT BOOKS:
1. C.R.BRUNNER, Medical Waste Disposable Handbook, Incentrated, Consultant in Corporated, Virginia, 2000
2. Tarannum Dana, Medical Waste Management , July 2012.

REFERENCES:
1. Madhurisharma, Hospital waste Management and its Monitoring, Jaypee Brothers Medical publishers, second Edition February 2017.
2. D.B. Acharya, Meet singh, The book of Hospital Management, Minerva Press, 2007.
3. Dr. Shahnawaz Hamid, A Handbook on Biomedical Waste: National and International Overview, Notion Press; 1st edition, 2019.
4. Mohammad Mohsin, Hospital waste management, VDM Publishing, 2013
5. Mohd. Faisal Khan, Hospital waste Management : Principles and Guidelines, Kanishka Publishers, 2010.

PO- CO matrix :

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							3					
CO2						2						
CO3							2					
CO4							2					
CO5			3									

BM5692   **INTRODUCTION TO BIOMATERIALS**   **L T P C**
                                                                                    3 0 0 3

OBJECTIVES:
The student should be made to:
- Learn the classification and characteristics of Biomaterials.
- Understand different types of materials used as biomaterials.
- Comprehend the response of the living system towards the biomaterials.
- Introduce various applications of biomaterials and identify areas of research opportunities.
- Learn the standards and rules involved in developing biomaterials.

UNIT I   DEFINITIONS AND PROPERTIES   9
Definition for biomaterials- biocompatibility-biodegradation- criteria for choosing a biomaterial- use of biomaterials in medicine-physical and chemical properties, surface properties and surface characterization.

UNIT II   CLASS OF MATERIALS   9
Metals - polymers- ceramics- bioactive glasses-hydrogels- natural polymers-pyrolytic carbon composites-smart polymers.

UNIT III   RESPONSE TO MATERIALS   9
Adsorption- role of adsorbed protein in tissue response-cell adhesion- extracellular matrix-cell injury-healing process-host response to biomaterial.

UNIT IV   APPLICATIONS OF BIOMATERIALS   9
Cardiac assist device- non thrombogenic treatments- dental implants- orthopedic applications-dermal treatments- ocular and extracorporeal implants.

UNIT V   STANDARDS AND NEW PRODUCTS   9
Rules and regulations for developing medical products- standards-material evaluation- legal aspects of biomaterials- ethical issues in developing biomaterials.

                                                              TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, the student should be able to:
CO1: Understand the important concepts of biomaterials and their contribution towards
        Biomedical Engineering.
CO2: Perform combinations of materials that could be used as implants.
CO3: Evaluate response of biomaterials in living system.
CO4: Analyze different applications of biomaterials in biomedical field.
CO5:Assimilate information on the standards and rules involved in developing biomaterials.

TEXT BOOKS:
1. BD Ratner, AS Hoffmann,FJ Schoen, JE LemmonsBiomaterials Science: An Introduction to Materials in Medicine. Netherlands, Elsevier Science, 3rd Edition, 2013.
2. Sujata V. Bhatt, Biomaterials Second Edition, Narosa Publishing House,2005.

REFERENCES:
1. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.
2. Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGraw-Hill, 2003
3. Introduction to Biomedical Engineering – John Enderle, Joseph D. Bronzino, Susan M. Blanchard, Elsevier, 2005.
4. Medical Textiles and Biomaterials for Healthcare- Edited by AC Anand, J F Kennedy, M.Miraftab, S.Rajendran, Woodhead Publishing Limited 2006
5. Materials Science and Technology: Volume 14, Medical and Dental Materials: A comprehensive Treatment Volume Editor D F Williams, VCH Publishers 1992
6. An introduction to Materials in Medicine:BD Ratner, AS Hoffmann,FJ Schoen, JE Lemmons, Academic Press 1996.

7. Kiran, A Sandeep Kranthi, and Ramakrishna, Seeram. An Introduction To Biomaterials Science And Engineering. Singapore, World Scientific Publishing Company, 1st Edition, 2021.
8. Handbook of Biomaterials Biocompatibility. United Kingdom, Elsevier Science, 1st Edition, 2020.
9. Joon B, Park Joseph D. Bronzino, Biomaterials - Principles and Applications – CRC Press, 2003.
10. H.H.Willard, D.L.Merrit,Instrumental Methods of Analysis, CBS Publishers 1992.

PO-CO matrix:

COURSE OUTCOMES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	2						2	1		
CO2	2	2	3						2	2		
CO3	2	2				1		1	2			
CO4	1	2	2			1			2	3		
CO5			2			2		2				

IT5691   **INFORMATION TECHNOLOGY ESSENTIALS**   **L   T   P   C**
                                                             3   0   0   3

OBJECTIVES:

- To provide a basic knowledge of computer hardware and software.
- To familiarize with the basic taxonomy and terminology of computer networking.
- To design and develop web pages using HTML and CSS.
- To understand the general concepts of PHP scripting language and MySQL functionalities for the development of simple data-centric applications.
- To understand fundamental concepts of mobile communication and various types of information systems and their complexities.

UNIT I   HARDWARE AND NETWORK ESSENTIALS   **9**

Basics of Computer System - Motherboard – Networking Cards – Graphics Card – Processors – Hard Drive – USB Port – Monitor Ports – Servers – Types of Servers – Web Server – Database Server – Data Transmission Fundamentals – Communication Medium – Fundamentals of Computer Networking – Types of Computer Networks – Network Topologies – Network Standards: OSI Model, TCP/IP Model - Network Components.

Suggested Activities:

- Explore the web to know more about the networking concepts and recent technologies. Students may present their findings orally or by a written report or through discussion forums.
- Explore the networking devices used in laboratories and homes, and their configurations.

Suggested Evaluation Methods:

- Quizzes on network transmission and communication.
- Report evaluation by peers.
- Discussion on network devices.

UNIT II   WEB ESSENTIALS   **7**

Internet Basics – Browser Fundamentals – Introduction to HTML5 – HTML5 Tags – HTML5 Forms – Cascading Style Sheets (CSS3) Fundamentals**.**

Suggested Activities:

- Browse the internet on special topics given by instructor.
- Learn HTML basic tags for web page design.
- Practical - Design of a small simple website, interlinking set of web pages created using the HTML tags and CSS.

Suggested Evaluation Methods:

- Quizzes on all the topics.
- Peer evaluation of the simple websites created.

UNIT III   CLIENT-SIDE SCRIPTING ESSENTIALS   **8**

Need for Scripting Languages – Introduction to JavaScript - Variables and Assignments - Writing Functions –   Built-in functions and methods - Object Oriented JavaScript - JavaScript Loops – Events – JavaScript Forms - JavaScript Cookies and AJAX.

Suggested Activities:

- Implementing simple JavaScript programs.
- Identify different types of form validations in the websites that are commonly used.
- Creation of Dynamic Web Pages.

Suggested Evaluation Methods:

- Demonstration of the implementations.
- Discussion on form validation.

UNIT IV   SERVER-SIDE SCRIPTING ESSENTIALS   12

Introduction to PHP – PHP Variables – Constants – Operators – Flow Control and Looping – Arrays – Strings – Functions – File Handling – Exception Handling – PHP and HTML – Database Management – Introduction to MySQL – MySQL Commands – MySQL Database Creation – Connecting MySQL and PHP – Querying MySQL Database with PHP – Session and Cookies.

Suggested Activities:
- Implementing simple programs using PHP.
- Designing dynamic web pages using PHP.
- Database creation using MySQL and linking with the PHP scripts.
- Incorporating of session and cookies.

Suggested Evaluation Methods:
- Demonstration of the implementations.
- Assignment problems
- Quizzes

UNIT V   MOBILE AND APPLICATION ESSENTIALS   9

Introduction to Mobile Communication – Generations of Cellular Networks – GSM - Creation of Simple Interactive Applications – Simple Database Applications – Introduction to Information Systems – Personal Information System – Information Retrieval System – Social Networking Applications.

Suggested Activities:
- Flipped classroom on generations of cellular networks.
- Explore the web to know more about the concepts and technologies used for the design of Information Systems. Students may present their findings orally or by a written report.
- Design a simple web or mobile application.
- Explore and analyse some of the visual analytics software.
- Flipped classroom on social networking applications.

Suggested Evaluation Methods:
- Quizzes on features of social networking applications.
- Presentations on various information systems.
- Demonstration of application.

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of this course, the student will be able to:
- understand the basic concepts of hardware, data communications and networking.
- create dynamic websites that meet specified needs and interests using HTML5, and CSS.
- understand the basic concepts and analyse their impact on problem solving and demonstrate concepts by building web pages generated by JavaScript programming.
- create responsive web sites using the PHP, and MYSQL databases.
- identify the fundamental concepts of mobile communications and key issues in the design of commonly used applications.
- create web-based applications using HTML5, PHP, and MYSQL database.

TEXTBOOKS
1. James Kurose and Keith Ross, "Computer Networking: A Top-Down Approach", Seventh Edition, 2017.
2. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5: A Step-by-Step Guide to Creating Dynamic Websites", O'Reilly Media, Inc, 2014.

REFERENCES
1. Douglas E. Comer, "Computer Networks and Internets", Sixth Edition, Prentice Hall, 2015.
2. Steven Holzner, "PHP: The Complete Reference", Fifth Edition, Mc Graw Hill, 2017.
3. Niederst Robbins, Jennifer, "Learning Web Design: A Beginner's Guide to HTML, CSS, Javascript, and Web Graphics", Fifth Edition, O'Reilly Media, 2018.
4. Laura Lemay, Rafe Colburn, Jennifer Kyrnin, "Mastering HTML, CSS & JavaScript, Web Publishing", BPB Publications, 2016.
5. Jochen Schiller, "Mobile Communications", Pearson Education, 2012.

6. R. Kelly Rainer, Casey G. Cegielski, Brad Prince, "Introduction to Information Systems", Fifth Edition, Wiley Publication, 2014.

IT5692	INTERNET OF THINGS	L T P C 3 0 0 3

OBJECTIVES:

- To understand the fundamentals of Internet of Things.
- To build a small low-cost embedded system using Arduino / Raspberry Pi or equivalent boards.
- To learn communication protocols that is frequently used in IoT ecosystems.
- To explore the ways of processing enormous amount of data generated in IoT based systems.
- To understand the importance of visualization in IoT analytics.

UNIT I ENABLING TECHNOLOGIES AND REFERENCE MODELS 7

Definition and Characteristics of IoT, Sensors, Actuators, - Centralized Sensing vs Distributed Sensing – Making Physical Objects as Smart Objects - Physical Design of IoT – IoT Protocols, IoT communication models, IoT Communication APIs, IoT enabled Technologies – Wireless Sensor Networks, Cloud Computing and Data Analytics – IoT vs M2M – Possible IoT Reference Models – Domain Specific IoTs – Levels of IoT Based Systems.

Suggested Activities:
- Flipped classroom on enabling technologies.
- External learning – Exploring proprietary protocols used in IoT and M2M.
- Analysing the required level of design for different IoT based ecosystems.

Suggested Evaluation Methods:
- Quiz and discussion on enabling technologies (WSN, Cloud and Big Data).
- Assignments on proprietary protocols used in IoT and M2M.
- Deciding the level and designing the IoT framework for case studies

UNIT II DESIGN OF END DEVICES 10

Microprocessors vs. Microcontrollers – Open-Source Movement in Hardware – Engineering vs Prototyping – Software Development Lifecycle for Embedded Systems – Arduino IDE – Programming and Developing Sketches – Arduino Rest APIs – Raspberry Pi – Interfaces – Python Packages of Interests for IoT.

Suggested Activities:
- Flipped classroom on open-source movement in hardware and SDLC for embedded systems.
- Explore the variants of Arduino Boards, Atmel Microcontrollers, Cypress Pioneer and NXP Freedom.
- Learning to write Arduino Sketches and Python programs.

Suggested Evaluation Methods:
- Quiz and discussion on open-source movement in hardware and SDLC for embedded systems.
- Assignments on Arduino boards, Atmel Microcontrollers, Cypress Pioneer and NXP Freedom.
- Practical – Developing Arduino Scripts and Python programs

UNIT III IoT PROTOCOLS 10

MAC Layer Protocols – IEEE 802.15.4 – G and E Variants of IEEE 802.15.4 – IEEE 802.11ah – IEEE 1901.2a – LoRaWAN – 6LoWPAN – From 6LoWPAN to 6Lo – NBIoT – REST Based Protocols – CoAP and MQTT.

Suggested Activities:
- External learning – Explore various software tools that support CoAP and MQTT.

- Flipped classroom on role of Ipv6 in designing IoT based systems.
- Analyse Cisco Reference Model and IBM Reference Models.

Suggested Evaluation Methods:
- Assignments on software tools that support Coap and MQTT.
- Quiz and discussion on role of Ipv6 in IoT based systems.
- Assignments on the IoT policy of Meity (Government of India).

UNIT IV   IoT ANALYTICS   9

Structured vs. Unstructured Data – Data in Motion vs. Transit - IoT Analytics - Definition, Challenges, Devices, Connectivity protocols - IoT Data Analytics – Elastics Analytics Concepts, Scaling - Visualization and Dashboard – Designing visual analysis for IoT data- creating dashboard – creating and visualizing alerts – Case Studies.

Suggested Activities:
- Flipped classroom on software and management tools for IoT analytics.
- External learning – Visualization tools.

Suggested Evaluation Methods:
- Quiz and discussion on different visualization methods.
- Demonstration on various visualization tools

UNIT V   INDUSTRIAL IoT AND CASE STUDIES   9

Industrial IoT adoption – IIoT Challenges, Drivers and Taxonomies – Industry 4.0 - Areas of IIoT Adoption –Tools and Technologies assisting IIoT – Case studies, Retail Industry, Home automation, Energy management, Health care and Workflow Management.

Suggested Activities:
- External learning – Industry 5.0 (Exploring scalability, security, and customization).
- Flipped classroom on IIoT business Models.
- Learning and Imbibing Green IoT.

Suggested Evaluation Methods:

- Assignments on emerging areas of Industry 5.0.
- Quiz and group discussion on technologies for IIoT business Models.
- Practicing green framework for IoT application (expeditionary learning- project based)

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of this course, the student will:
- Understand the enabling technologies and reference models of IoT.
- Design portable IoT devices using Arduino IDE/ Raspberry Pi with Python.
- Apply appropriate protocols in various parts of IoT based systems.
- Understand the importance of visualization in analytics part of IoT systems.
- Understand Big Data tools and technologies and apply them in IoT based systems.
- Design IoT systems for various real time applications.

TEXTBOOKS
1. RMD Sundaram Shriram K Vasudevan, and Abhishek S Nagarajan, "Internet of Things", Wiley, 2019
2. David Hanes, Gonzalo Salguerio, Patrick Grossetete, Rob Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for Internet of Things", Cisco Press, 2017.

REFERENCES
1. Perry Lea, "Internet of Things for Architects", PACKT, 2018.
2. Ravi Ramakrishnan, Lovleen Gaur, "Internet of Things: Approach and Applicability in Manufacturing", CRC press, Taylor, and Francis First Edition, 2019.
3. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A Hands-On Approach", Universities Press, 2015.

IT 5693   **BLOCKCHAIN TECHNOLOGIES**   **L T P C**

                   3 0 0 3

OBJECTIVES:
- To provide an introduction to the basic principles of cryptography
- To explore the working mechanism of Blockchain technology
- To learn bitcoin related methodologies.
- To understand distribution consensus related techniques
- To explore the emerging technologies in Blockchain networks
- To develop decentralized applications using various tools

UNIT I   **INTRODUCTION TO BLOCKCHAIN and CRYPTOGRAPHY**   **9**

Blockchain Mechanism – Centralization Vs Decentralization – P2P Systems - Transactions and Blocks - Consensus - Cryptographic Hash functions - SHA 256 - Proof of membership - Digital Signatures - Public Key Cryptosystems - Types of Blockchains.

Suggested Activities:

- Flipped classroom on studying cryptographic functions
- Implementation of hashing algorithms.
- Verifying message authentication using digital signatures
- Exploring Blockchain
- Developing application to issue transaction

Suggested Evaluation Methods:
- Assignment to be given on public crypto systems and Digital signatures

UNIT II   **BITCOIN MECHANICS**   **9**

Bitcoin transactions - Bitcoin script - Wallet - Ledger - Bitcoin Blocks - Bitcoin Network - Mining - Proof -of- Work Consensus - Cryptocurrency .

Suggested Activities:

- Creating Bitcoin wallet
- Creating Bitcoin raw transaction and adding to blockchain
- Creating and validating Bitcoin transaction
- Exploring Proof of Work(PoW)
- Flipped classroom on Cryptocurrency.

Suggested Evaluation Methods:
- Practical exercises to be given for creating Bitcoin scripts

UNIT III   **ETHEREUM**   **9**

The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain- EVM - Smart Contract -Solidity .

Suggested Activities:

- ✓ External learning - Exploring Ethereum tools like Ganache and GO. Practical - Setup the Ethereum development environment.

Suggested Evaluation Methods:

- ✓ Evaluation of developed smart contract on private Blockchain

UNIT IV   BLOCKCHAIN DEVELOPMENT FRAMEWORKS   9

Ethereum Development framework - Geth - Mist/Metamask-Web3 -HyperLedger as a Protocol - Reference Architecture - Hyperledger Fabric.

Suggested Activities:

- ✓ External learning - Developing Ethereum applications
- ✓ Practical - Setup the Dapps development environment

Suggested Evaluation Methods:

- ✓ Evaluation of decentralized application using Web3.0

UNIT V   APPLICATIONS AND EMERGING TRENDS   9

Distributed applications - Blockchain interoperability - Non-Fungible Tokens (NFTs)- Scalability -Alt coins- Case studies.

Suggested Activities:

- ✓ Assignments on emerging Blockchain tools.
- ✓ Exploring NFTs.
- ✓ Presentation on Altcoins.

Suggested Evaluation Methods:

- ✓ Practical assessment for developing Blockchain applications in respective domains.

COURSE OUTCOME

On completion of course the students will be able to
1. Explain the technology components of Blockchain and decentralized applications
2. Analyze the choices in Bitcoin and identify its pros and cons
3. Develop smart contracts using Ethereum with an understanding of the components of Ethereum.
4. Demonstrate usage of different Blockchain development frameworks
5. Evaluate recent developments in Blockchain Tools and Altcoins.
6. Develop Blockchain applications for different domains.

TEXTBOOKS
1. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.

REFERENCES:
1. Antonopoulos, 'Mastering Bitcoin'. Second Edition , O'Reilly Publishers .2017.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction. Princeton University Press ,2016.
3. D. Drescher, 'Blockchain Basics' First Edition , Apress, 2017.
4. Antonopoulos and G. Wood, Mastering Ethereum, First Edition, 2018.
5. Jared Tate and Andrew Knapp "Blockchain 2035: The Digital DNA of Internet 3.0 ",BlueShed LLC publisher , 1st edition (31 October 2019).

	L	**T**	**P**	**C**

IT5694   **MACHINE LEARNING TECHNIQUES**

L	**T**	**P**	**C**
3	**0**	**0**	**3**

OBJECTIVES:
- To understand the concepts of machine learning.
- To appreciate Classification and Regression algorithms.
- To understand SVM and ANN algorithms
- To understand the clustering algorithms.
- To appreciate the concepts and algorithms of reinforcement learning.
- To know about probabilistic graphic models.

UNIT I   INTRODUCTION TO MACHINE LEARNING   9

Machine Learning – Basic Concepts in Machine Learning – Types of Machine Learning – Examples of Machine Learning – Applications –The Bias-Variance - Data Pre-processing - Noise removal – Normalization - Principal Component Analysis – Independent Components Analysis.

Suggested Activities:
- Install python and explore the packages required for machine learning including numpy, scikit-learn, and matplotlib.

Suggested Evaluation Methods:
- Quiz on different applications of machine learning.

UNIT II   SUPERVISED LEARNING - I   9

Linear Models for Regression – Multiple Regression – Logistic regression - KNN Algorithms - Neural Networks – Feed-Forward Network Functions – Error Back Propagation – Decision Tree – Evaluation of Classification Algorithms.

Suggested Activities:
- Practical – Collection of data from different recourses and summarize the data.
- Practical – Build linear, multi-linear, logistic Regression model to predict the data.

Suggested Evaluation Methods:
- Evaluation of the practical implementations using the T-test set.
- Group discussion on basics of classification and regression.

UNIT III   SUPERVISED LEARNING II   9

SVM Classifier – Soft and Hard Margin - Kernel Methods – Ensemble Methods – Bagging – Boosting – Reinforcement Learning – Model based Reinforcement Algorithms – Model-free Reinforcement Algorithms - Q-Learning and SARSA algorithms.

Suggested Activities:
- Practical – Develop SVM model for a two-class problem, whose training points are distributed in a 2D plane and improve the performance of the model by applying kernel methods.
- Practical – Implement bagging approach for credit card analysis.

Suggested Evaluation Methods:
- Tutorial – Kernel methods.
- Evaluation of the practical implementations using appropriate test set.
- Group discussion on back propagation.

UNIT IV   UNSUPERVISED LEARNING   8

Clustering – K-means – Hierarchical Clustering – EM Algorithm in General – Model Selection for Latent Variable Models.

Suggested Activities:
- Implement k-means algorithm to cluster the traffic data set based on accident type.

Suggested Evaluation Methods:
 - ✓ Tutorial on model selection and validation.
 - ✓ Evaluation of the practical implementation using appropriate test set.

UNIT V   PROBABILISTIC GRAPHICAL MODELS   10

Directed Graphical Models – Bayes Theorem – Naïve Bayesian Classifier – Laplacian approximation - Bayesian Networks – Markov Models – Hidden Markov Models – Inference – Learning-Generalization.
Suggested Activities:
 - ✓ Assignment on solving numerical problem using HMM.
Suggested Evaluation Methods:
 - ✓ Group discussion on graphical models.

TOTAL: 45 PERIODS

OUTCOMES

Upon completion of this course, the student will:
 - ✓ Implement a neural network for an application of your choice using an available tool.
 - ✓ Implement probabilistic discriminative and generative algorithms for an application of your choice and analyze the results.
 - ✓ Use a tool to implement typical clustering algorithms for different types of applications.
 - ✓ Design and implement an HMM for a sequence model type of application
 - ✓ Implement a PGM for any real time application using an open-source tool.
 - ✓ Identify applications suitable for different types of machine learning with suitable justification.

TEXTBOOKS
1. Sridhar S and Vijayalakshmi M, "Machine Learning", Oxford University Press, 2021.
REFERENCES
1. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997.

LT5691	BIOTECHNOLOGICAL APPLICATION IN LEATHER MANUFACTURE	L T P C 3 0 0 3

UNIT I   NUCLEIC ACID, PROTEINS & ENZYMOLOGY   9
Chemistry of DNA and RNA: Structure, Conformation and function Proteins - Chemistry, structure and Function. Separation Principles in proteins. Proteins - classification, assay, characterization. Enzymes – mechanism of action, enzyme kinetics, immobilization of enzymes.

UNIT II   GENETIC ENGINEERING (RECOMBINANT DNA TECHNOLOGY)   9
Principles and methods, Essentials of biotechnology-products of biotechnology, Restriction enzymes, vectors, DNA cloning strategies.

UNIT III   BIOTECHNOLOGY FOR HIDES/SKINS IMPROVEMENT   9
Applications in Animal nutrition and animal production: embryo transfer, gene transfer, transgenic animals. Cleaner Leather Processing: Use of enzyme options in beam house operations - Soaking, unhairing, bating, degreasing, offal treatment: Types of enzymes - proteases, lipases - properties, assay systems and production. Types of fermentation, Preparation of media, preparation of inoculum, separation and purification of products.

UNIT IV   WASTE MANAGEMENT   9
General features of the organic and inorganic pollutants of tannery. Stabilisation and disposal of organic and chemical wastes and their biological treatment. Possible energy generation from wastes.

UNIT V   UTILISATION OF COLLAGENOUS BIOPRODUCTS   9

Purification of collagen; Preparation of collagenous biomaterials; Gelatin extraction; Use of Collagen/gelatin in food and beverages; Collagen use in cosmetic and medical fields
.   **TOTAL: 45 PERIODS**

OUTCOMES

At the end of the course, the student will understand basic biotechnology concepts and its relevance for
application in leather processing.

CO-1   Have a basic understanding about DNA, Proteins and Enzymes.
CO-2   Able to understand the principles of genetic engineering
CO-3   Have knowledge in enzyme for leather processing.
CO-4   Gain knowledge on biotechnological aspects in tannery waste management
CO-5   Gain knowledge on various application of collagen

Course Articulation Matrix: BIOTECHNOLOGICAL APPLICATION IN LEATHER MANUFACTURE

CO	Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO-1	Have a basic understanding about DNA, Proteins and Enzymes	3	1	1	1	3	1	3	3	1	1	-	1	2	3	1
CO-2	Able to understand the principles of genetic engineering	3	-	1	1	1	1	3	1	1	1	-	1	-	3	3
CO-3	Have knowledge in enzyme for leather processing	3	2	1	1	2	1	3	2	1	1	-	1	1	3	2
CO-4	Gain knowledge on biotechnological aspects in tannery waste management	3	1	1	1	2	1	3	2	1	1	-	1	1	3	2
CO-5	Gain knowledge on various application of collagen	3	1	1	1	2	1	3	2	1	1	-	1	1	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and

Substantial (High) respectively

TEXT BOOK AND REFERENCES

1.   Rohm,   H.J. and Reed, G. "A Comprehensive treatise on Biotechnology", Verlag   Chemie, lecinheim,1983.
2.   Pelczar, J., Reid, R. D.and Chan, F.C.S.,"Microbiology", Tata McGraw Hill, 1977.
3.   Old, R.W. and Primrose,S.B.,   "Principles of Gene manipulation" 3/e Cambridge, 1985.
4.   Stryer, L."Biochemistry" 3/e W.H. Freeman and Co. 1989.
5.   Lehninger, A.L., Nelson, D.L., Gx M.M "Principles of Biochemistry", CBS Publications, 1993

6.   Puvanakrishnan, R and Dhar, S.C."Enzyme Technology in Beamhouse practices"' CLRI Publication.
7.   Wrinter, N.A., "Biological treatment of waste water",   1982.
8.   Schroeder, E.D., "Waste and Waste water treatment" McGraw - Hill Inc.1983.

LT5692   LEATHER GOODS AND GARMENTS MANUFACTURE   L T P C
**   3 0 0 3**

OBJECTIVE
To impart knowledge on making leather goods and garments

UNIT I   OVERVIEW ON LEATHER PRODUCTS   9
Different life style products from leather; Classification of Leather Goods and Garments; Selection of Materials, grading and assorting of leathers for leather goods and garments; Property requirements for leather and other materials; Accessories for Leather goods and garments - Various types of fasteners, fittings and other accessories. Alternative materials and their adaptability for goods and garments. Operational sequences in leather goods and garments production.

UNIT II   OPERATIONS IN LEATHER GOODS/GARMENTS   11
i)   **Production planning -** Nomenclature used for component identification in various leather garments skirts, jackets, trousers etc and various leather goods – Wallet, hand bags, Executive bags etc. Process scheduling and line balancing.
ii)   **Cutting and clicking** - Hand and machine cutting, Knives and tools – Preparation and handling. Pattern interlocking/nesting for material optimization. Factors influencing cutting value. Dieless cutting.
iii)   **Assembling**- Pre assembly and assembly operations – skiving, splitting, folding, sewing etc. Various types of assembly techniques for leather goods and garments.
iv)   **Quality** - Quality control measures in leather products manufacture.

UNIT III   LEATHER PRODUCTS MACHINERY   9
Machinery needs for leather goods and garments manufacture. Various types of sewing machines – flat bed, cylinder bed, post bed and other special sewing machines
– different feed mechanisms. Clicking, splitting, skiving, folding, embossing, creasing machines – their working principles operation and maintenance.

UNIT IV   DESIGN AND DEVELOPMENT   9
Pattern design and development – measurement/ sizing for various types of garments, pattern design of leather goods and garments, pattern grading for leather garments. CAD applications for leather goods and garments. Fashion and material trends.

UNIT V   ORGANISATION AND MANAGEMENT   7
Project Feasibility reports, plant layout, costing and pricing for leather goods and garments. Analysis of International market trends for goods and garments – EU, USA and other markets. Social auditing of leather goods and garment units - occupational Health and Safety, ISO 9000 and 14000.
**   TOTAL: 45 PERIODS**

OUTCOMES:
On the completion of the course students are expected to
CO1.To gain orientation on various products made from leather; various materials and
      components for the manufacture of leather goods and garments.
CO2.To understand various operations involved in making of leather good and garments.
CO3.To understand the working principle, operation and maintenance of different
      machineries used for making leather goods and garments
CO4.To gain fundamental knowledge on design and development of leather goods and
      garments
CO5.To understand organisation and management of leather goods and garments
       manufacturing unit.

Course Articulation Matrix: LEATHER GOODS AND GARMENTS MANUFACTURE

CO	Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO-1	To know various materials and components for the manufacture of leather goods and garments.	3	2	1	-	-	-	1	1	-	1	2	2	3	-	-
CO-2	To understand various operations involved in making of leather good and garments.	3	3	2	2	2	1	1	1	2	2	2	2	3	-	--
CO-3	To understand the working principle, operation and maintenance of different machineries used for making leather goods and garments	3	2	2	1	2	1	1	1	-	1	1	2	3	-	-
CO-4	To gain fundamental knowledge on design and development of leather goods and garments	3	2	2	2	2	1	1	1	-	2	1	2	3	-	-
CO-5	To understand Organisation and management of leather goods and garments manufacturing unit.	3	3	2	1	1	2	2	1	2	1	3	2	3	-	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

TEXT BOOK AND REFERENCES:
1.   Pattern Making Manual - Womens Garments, ESMOD, Paris, 1991.
2.   Fashion Drawing Method, ESMOD, Paris, 1992.
3.   Metric Pattern cutting for Menswear, Winifred   Aldrich, BSP Professional Books, London, 1990.
4.   Grading Manual, ESMOD, Paris, 1994.
5.   Skiving Manual, First Edition, 1994 CLRI, Madras.
6.   A course manual on leather garment pattern designing.
7.   Leather garments making, NIMI publication, 2012.
8.   Leather and sports goods – Pattern and Template marker, NIMI Publications, 2011

TT5691	TECHNICAL FIBRES	L T P C
		3 0 0 3

OBJECTIVES
- To enable the students to learn about production, properties and application of various technical fibres

UNIT I   **9**
Introduction: Classification of textile fibres according to their nature and origin, essential and desirable properties of textile fibres, staple fibre and continuous filament, comparison of natural and manmade fibres.

UNIT II   **9**
Linear polymer fibres, polyaramide fibres, high modulus-high tenacity polyethylene and other such fibres; their structure, properties and applications.

UNIT III   **9**
Carbon fibres, classification – based on raw materials, heat treatment, strength and modulus; physical properties and applications glass fibres, classification, principle of fibre manufacturing, physical properties and applications.

UNIT IV   **9**
Chemical resistance fibres- their structure, properties and applications; thermal resistance fibres, their structure, properties and applications.

UNIT V   **9**
Ceramic fibres, classification, effect of heat treatment on properties, physical properties and applications; derivatives of ceramic fibres; hollow and profile fibres- properties and applications.

TOTAL : 45 PERIODS

COURSE OUTCOMES
Upon the completion of this course, the students will have knowledge on
        CO1: Classification and properties of textile fibres
        CO2: Properties and applications of high modulus-high tenacity fibres
        CO3: Properties and applications of carbon fibres
        CO4: Properties and applications of chemical resistant fibres
        CO5: Properties and applications of ceramic, hollow and profiled fibres

TEXT BOOKS
1. Kothari V.K., "Textile Fibres: Development and Innovations", Progress in Textiles, Vol. 2,   IAFL Publications, 2000.
2. Hearle J.W.S., "High Performance Fibres", Woodhead Publishing Ltd, Cambridge,   England, 2001.
3. Peebles L.H., "Carbon Fibres", CRC Press, London, 1995.
4. Hongu T. and Phillips G.O., "New Fibres", Woodhead Publishing Ltd., England, 1997.

TT5692 **GARMENT MANUFACTURING MACHINERY** **L T P C**
3 0 0 3

OBJECTIVES
- To impart knowledge on the machineries and equipments used for garment production
- To instruct on latest developments in the garment production machineries.

UNIT I **FABRIC INSPECTION AND SPREADING MACHINES** **9**
Garment manufacture – sequence of operations; introduction to pattern making, marker planning, cutting, sewing and finishing; fabric inspection machine – manual and automatic, fabric control; spreading machines – manual, semi-automatic and fully automatic machines, fabric control devices in spreading machines.

UNIT II **CUTTING MACHINES** **9**
Mechanism of straight knife cutting machines, rotary cutting machines, band knife cutting machines, die cutting, laser cutting, plasma cutting, water jet cutting and ultra-sonic cutting; Notches, drills and thread markers; computer interfaced cutting machines.

UNIT III **SEWING MACHINES** **9**
Lock stitch and chain stitch sewing machine - types, driving arrangement, function of elements, stitch formation, timing, settings and feed mechanism; needles – geometry, types and selection of machine and process parameters for different applications.

UNIT IV **SPECIAL SEWING MACHINES** **13**
Over lock, flat lock, feed off arm, button fixing and button holing –driving arrangement, stitch formation, timing, settings and feed mechanism.

UNIT V **FINISHING MACHINES** **5**
Pressing machineries – buck pressing, iron pressing, block or die pressing, form pressing, steamers and advanced pressing machineries; folding and packing machines.

TOTAL: 45 PERIODS

COURSE OUTCOMES
After successful completion of this course, the students would understand the,
 CO1: Principle and working of machines used for fabric inspection and spreading
 CO2: Principle and working of fabric cutting machines
 CO3: Construction and working principle of sewing machines
 CO4: Construction and working principle of special sewing machines
 CO5:Construction and working principle of finishing machines used for garment manufacture.

TEXT BOOKS
1. Harold Carr& Barbara latham, "The Technology of Clothing Manufacture", Black well Sciences, 1996.
2. Jacob Solinger., "Apparel Manufacturing Handbook ", Van Nostrand Reinhold CompanY,1980.
3. Ruth E. Glock and Grace I. Kunz, "Apparel Manufacturing Sewn Product Analysis",Pearson Prentice Hall, 2005.

CT5691 **CERAMICS MATERIALS FOR ENGINEERS** **L T P C**
3 0 0 3

COURSE OBJECTIVE
The course is aimed to
- To understand the traditional ceramic materials, its characteristics and applications
- To understand about the structure and properties of glass and glass ceramics
- To understand the structure and properties of advanced ceramic materials
- To gain knowledge on the ceramic materials used for functional applications
- To understand the ceramic materials used for biological applications

UNIT I   CLASSIC CERAMICS   9

Introduction – natural clay minerals, formation of clay minerals, structure and properties of important clay minerals – kaolinite, illite, montmorillonite - synthetic raw materials – structure and properties of phase systems – silica, Al_2O_3 – SiO_2, CaO - Al_2O_3 – SiO_2, K_2O - Al_2O_3 – SiO_2.

UNIT II   GLASS AND GLASS CERAMICS   9

Introduction – viscosity – properties – defects in glass - heterogenous glass – yttrium aluminium glass – coloring glass – glass laser – precipitates in glass – crystallizing glass – glass as glaze and enamel - types of ceramic glasses – natural glass – physics of glass – glass fibres.

UNIT III   ADVANCED CERAMICS   9

Introduction - Synthesis, Structure, Properties and applications of oxides and its based materials – alumina, mullite, spinel, zirconia, titania, non oxides – carbides – boron carbide, silicon carbide, nitrides – boron nitride, silicon nitride, aluminium nitride, silicon nitride, SiAlONs

UNIT IV   FUNCTIONAL CERAMICS   9

Introduction – Definition and Properties of Ferroic, Smart and Intelligent materials - Structure and Properties of dielectric materials- ferroelectric ceramics – barium titanate, PZT, ferroelectric relaxor ceramics, piezoelectric and pyroelectric ceramics – electro-optic ceramics – PLZT – superconducting ceramics

UNIT V   BIOCERAMICS   9

Introduction – basic aspects of biomineralization – concept and definition of biocompatibility – interaction of implant materials and living tissues – bioceramic materials – bio inert ceramics – alumina, yttria stabilized zirconia, bioconductive ceramics – bioglasses, hydroxyapatite, calcium-titanium-zirconium phosphates, resorable calcium phosphate ceramics.

TOTAL : 45 PERIODS

COURSE OUTCOMES

After the completion of the course, the students will be able

CO1   To apply the traditional materials for various traditional ceramic applications
CO2   To have the ability to know about the concepts of glass and glass ceramics
CO3   To apply the concepts of advanced ceramic materials in various applications
CO4   To be familiar with the underlying concepts of functional ceramic materials
CO5   To have gained knowledge on the materials used for biological applications

TEXT BOOKS

1. Phillippe Boch, Jean-Claude Niepce, "Ceramic Materials – Processes, Properties and Applications", Hermes Science Publications, 2001
2. Carter C Barry, Norton M Grant, "Ceramic Materials – Science and Engineering", 2007

REFERENCE BOOKS

1. Bikramjit Basu and Kantesh Balani, "Advanced Structural Ceramics", Wiley Publications, 2011
2. Wolfram Holand and George Beall, "Glass Ceramic Technology", The American Ceramic Society, 2002

CT5692   **PROCESSING OF CERAMICS**   **L T P C**
3 0 0 3

COURSE OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the preparation of ceramic powder by mechanical and chemical methods.
- Have studied the types & role of additives in various ceramic forming processes.
- Have a better understanding on the mechanisms of sintering and grain growth during sintering.

- ✓ Have learnt the advanced processing and sintering.
- ✓ Have learnt about ceramic machining methods.

UNIT I   POWDER PREPARATION   9
Powder preparation by mechanical methods – comminution, mechano-chemical synthesis. Powder synthesis by chemical methods – solid state reaction, liquid solutions, vapour phase reactions.

UNIT II   ADDITIVES   9
Types of additives in ceramic forming – solvents, dispersant, binder, plasticizer, other additives. Effect/role of additive in ceramic forming - density, fluidity, viscosity, deflocculation, pH, zeta potential, plasticity.

UNIT III   FORMING METHODS   9
Wet forming – Plaster mould, slip casting, pressure casting, gel casting, tape casting, electrophoretic deposition. Plastic forming methods - injection molding. Dry forming - Uniaxial pressing –vibration compaction, isostatic pressing.

UNIT IV   SINTERING   9
Definition, types of sintering – solid state sintering, liquid phase sintering; grain growth – different grain growth process and control of grain growth. Advanced sintering – pressure assisted sintering, reaction bonded sintering and microwave sintering.

UNIT V   MACHINING OF CERAMICS   9
Basic machining requirements of ceramics – Grinding – Ductile Mode – ELID Grinding, Zirconia, Aluminium nitride – LASER assisted grinding – Ultrasonic machining – Abrasive water jet machining – High energy beam machining – EB, IB. Surface finishing methods – Ultrasonic lapping, MRAF.

TOTAL : 45 PERIODS

COURSE OUTCOMES
On completion of this Course, Students are expected to
CO1   Evaluate suitable method for ceramic powder preparation
CO2   Identify suitable Additives for Wet Processing
CO3   Identify suitable Wet, dry forming methods
CO4   Identify suitable temperature range, Sintering aid and other Physical
        Parameters for sintering process
CO5   Identify suitable machining method for ceramic materials

TEXT BOOKS
1. Mohamed N.Rahaman, Ceramic Processing, Taylor & Francis, 2007.
2. Loan D. Marinescu, Handbook of Advanced Ceramic Machining, CRC press, 2007.

REFERENCE BOOKS
1. Alan G.King, Ceramic Technology and Processing, Noyes Publication, USA, 2001.
2. James S. Reed, Principle of Ceramic Processing, John Willey and Sons, NY, 1988.
3. David W. Richerson, Modern Ceramic Engineering, 3rd Edn., Taylor & Francis, 2005.
4. Paul De Garmo E, Black J.J and Ronald A.Kohser, Materials and Processes in Manufacturing, 8th Edn, Prentice - Hall India Pvt. Ltd., New Delhi, 1997.
5. Reed J.S, Introduction to the Priciples of Ceramic Processing, Willey, New York, 1988.
6. John G.P.Binner (Ed), Advanced Ceramics Processing and Technology, Noyes Publications, New Jersey, 1990.
7. Burtrand Lee and Sridhar Komarnei (Eds.), Chemical Processing of Ceramics, 2nd Edn., Taylor & Francis, 2005.
8. Loan D. Marinescu, Toshiro Doi, Eckart Uhlmann, Handbook of Ceramics Grinding and Polishing, Elsevier, 2014.

PM5691   **INTRODUCTION OF CANCER BIOLOGY**   **L T P C**
                                                                          3 0 0 3

OBJECTIVES
- To impart basic concepts of cancer biology and various stages in carcinogenesis.
- To gain insight on cancer metastasis and its molecular mechanism.
- To understand cancer prognosis.

UNIT I   CELL STRUCTURE, FUNCTION AND DIVISION   9
Cell organization, structure of organelles, extra cellular matrix and cell junctions. Cell cycle – mitosis, meiosis, cell cycle regulation and apoptosis.

UNIT II   INTRODUCTION TO CANCER   9
Definition, causes, cancer types and stages, hallmarks of cancer, modulation of cell cycle in cancer, carcinogenesis – initiation, promotion and progression, carcinogen and its types, diet and cancer.

UNIT III   CANCER PROGRESSION   9
Benign and malignant tumors, progress towards metastatic cancer, metastatic cascade and tumor cell invasion, angiogenesis.

UNIT IV   CANCER GENES AND SIGNAL TRANSDUCTION   9
Activation of kinases, oncogenes/proto-oncogenes activity, retrovirus and oncogenes, tumor suppressor genes and growth factors related to transformation.

UNIT V   CANCER DETECTION AND THERAPEUTICS   9
Detection using biochemical assays, tumor markers, molecular tools for early diagnosis of cancer. Types of therapy – chemotherapy, immunotherapy, radiotherapy and gene therapy.

TOTAL : 45 PERIODS

OUTCOMES
- To create an awareness about cell structure and cell cycle regulation
- To make the students aware of what is cancer and how changes in cell cycle can trigger carcinogenesis
- To create an understanding of the cancer microenvironment and its influence on the human system
- To have an idea about potential carcinogens and the triggers involved
- To have understanding on medical applications for cancer

TEXT BOOKS
1. Lodish, Harvey etal., "Molecular Cell Biology", 5 th Edition, W.H.Freeman, 2005.
2. Cooper, G.M. and R.E. Hansman "The Cell: A Molecular Approach", 4 th Edition, ASM Press, 2007.
3. Alberts, Bruce etal., "Molecular Biology of the Cell", 4 th Edition, Garland Science (Taylors Francis), 2002.
4. Weinberg, R.A. "The Biology of Cancer" Garland Science, 2007.

REFERENCES
1. McDonald, F etal., " Molecular Biology of Cancer" 2nd Edition, Taylor & Francis, 2004.
2. King, Roger J.B. "Cancer Biology" Addison Wesley Longman, 1996.

IB5691   **INTRODUCTION TO BIOTECHNOLOGY**   **L T P C**
                                                                          3 0 0 3

OBJECTIVES
- To give an introduction to biotechnology
- To make the students aware of the basic principles and techniques in biotechnology
- To make the students aware of the interdisciplinary potentials of biotechnology

UNIT I   INTRODUCTION TO BIOTECHNOLOGY & IT'S SCOPE   9

Definition of biotechnology, mile stones in biotechnology – Who can be a biotechnologist? Applications of biotechnology in interdisciplinary (Mathematics, Chemistry, Microbiology, Aquaculture etc) and engineering (Fermentation Technology, Electronics, Plastic Technology etc) specialties, Future prospects of biotechnology industries – GM crops, animals, microbes, etc.

UNIT II   PROTEINS AS PRODUCTS   9

Definition of Proteins: Amino Acids – Structure, Functions and Uses; Structure, Function and Importance of Proteins. Uses of Proteins: Therapeutic proteins eg. used for treatment of irritable bowel syndrome, Branch Chain Amino Acids; A protein from the industry using microbes: Corynebacterium sp. – A case study, recombinant proteins, enzymes: Streptokinase, amylase, lipase etc., Production of recombinant human insulin.

UNIT III   DNA, GENES, GENOMES & RDNA TECHNOLOGY   9

DNA: Structure – Gene: One gene one Enzyme concept, One Gene many enzymes concept, one gene many polypeptides concept, Genomes, what is genomics? – Transgenic animals and their applications, DNA Vaccines, Edible vaccines, what is recombinant DNA Technology? – A Case study

UNIT IV   MEDICAL BIOTECHNOLOGY   9

Gene testing – identification of protein and genetic disorders, Gene screening – a tool for phenotypic screening e.g., Cancer identification & Gene therapy e.g., Cystic Fibrosis as a case study, Transgenic Pigs as an artificial organ donor

UNIT V   DNA FINGERPRINTING,FORENSIC SCIENCE & ETHICS IN BIOTECHNOLOGY 9

Case study – Homicide, Disputed parentage, Immigration issues, Ethics in Biotechnology – GM crops – Ethical issues; Golden Rice – Eradication of Blindness

TOTAL: 45 PERIODS

OUTCOMES
- to make the students aware of the basic principles of biotechnology
- to be aware of the various techniques in biotechnology
- to make the students aware of the applications of biotechnology in the field of pharmaceuticals and medicine
- to make the students understand the importance of biotechnological techniques in the detections and early intervention against diseases
- to make the students aware of the prospects of biotechnology in crime detection and also make them aware of the ethic and regulations involved

TEXT BOOKS
1. "Essential Cell Biology", third edition, Alberts, Bray et al, Garland Science,2010.
2. "An Introduction to Genetic Engineering", third edition Desmond S T Nicholl Cambridge University Press   2008

REFERENCES
1. "An Introduction to human molecular genetics -mechanisms of inherited diseases", second edition Jack J Pasternak, Wiley-LSS,2005.
2." Diagnostic tests in Genetics ", ed Jean Louis Serre, John Wiley & Sons,2006.

FT5691   **BIOMOLECULES**   **L T P C**
                                                    3 0 0 3

COURSE OBJECTIVE
- To learn about the chemistry and structures of biomolecules
- To know the properties of different biomolecules
- To know the physiological functions of biomolecules

UNIT I   BASICS OF BIOMOLECULES   9
Introduction to Organic Biochemistry, History, Role of Berzelius Wohler, formation of urea. Structure of carbon compounds, valence electrons covalent bonds, electron dot formula. Tetrahedral structure, structural formula, empirical formula, molecular formula, condensed structural formula, Isomers, Homologus series and functional groups

UNIT II   CARBOHYDRATES   9
Classification of carbohydrates – Monosaccharides, General terminology, stereoisomerism, Steriochemistry cyclic forms of sugars, muta-rotation, Important of Monosaccharides (Glucose, fructose, galactose, mannose) & Disaccharides (Sucrose, Maltose), glycosidic bond, reducing sugars, classification of polysaccharides-Homo & Hetero polysaccharides. Glycans, glysaminoglycans, glycoproteins.

UNIT III   LIPIDS   9
Classification of Lipids, simple lipids, fatty acids, physical properties of lipids, chemical properties of lipids, waxes, compound lipids, phospholipids, sphingolipids, cholesterol, steroid hormones and prostaglandins hypercholesterolemia and cardiovascular disease, statins as Cholestrol reducing drugs, lipoproteins.

UNIT IV   PROTEINS   9
Classifications and functions of proteins, Amino acid structures, general properties of amino acids, peptide bonds, primary, secondary, tertiary and Quaternary structures of proteins. Properties of proteins, electrochemical properties, denaturation, nutritive value of proteins compared to fats and carbohydrates.

UNIT V   NUCLEIC ACIDS   9
Structure of nucleic acids, deoxyribo nucleicacid (DNA), Experimental that DNA was hereditary material, Chargaff's rule, structure of DNA – Watson crick, RNA types - mRNA, tRNA, and rRNA. Genetic code. Recombinant DNA and its technology.

TOTAL: 45 PERIODS

COURSE OUTCOMES
At the end of the course the students will be able to,
- CO1: have a strong foundation in the structure and reactions of biomolecules.
- CO2: have in depth knowledge on classification, properties of carbohydrates.
- CO3: have in depth knowledge on classification, properties and functions of lipids.
- CO4: have in depth knowledge on classification, and functions of proteins.
- CO5: have in depth knowledge on structure of Nucleic acid and rDNA.

TEXT BOOKS:
1. Nelson, D. L., Cox, M. M. (2021). Principles   of   Biochemistry. United   States: W.   H. Freeman.
2. Satyanarayana, U., Chakrapani, U. (2017). Biochemistry: (with Biomedical Concepts, Clinical Correlates & Case Studies). India: Elsevier Relx India Pvt. Limited.
3. Rastogi, S. C. (2010). Biochemistry 3E. India: McGraw-Hill Education (India) Pvt Limited.
4. Conn, E. E. (1995). Outlines of Biochemistry. Singapore: J. Wiley.

REFERENCES:
1. Gatto, G. J., Berg, J. M., Tymoczko, J. L., Stryer, L. (2015). Biochemistry. United States: W. H. Freeman.
2. Voet, D., Voet, J. G. (2011). Biochemistry. United Kingdom: Wiley.
3. Kennelly, P. J., Botham, K. M., Rodwell, V. W., Bender, D., Weil, P. A. (2015). Harpers llustrated Biochemistry 30th Edition. Greece: McGraw-Hill Education.

CH5691   **ENVIRONMENTAL POLLUTION PATHWAYS**   **L T P C**
                                                                        3 0 0 3

OBJECTIVES:
- To introduce the basic concepts of Environment and pollutants and its pathways.
- To impart knowledge on the industrial pollutants from various sources
- To inculcate sound understanding of radioactive and hazardous pollutants

UNIT I   HUMAN INTERACTIONS WITH ENVIRONMENT   9
Relationship between human activity and environment- Types of Pollutants- Sources-characteristics- Pathways of pollution-Emission and exposure pathways - Transport pathways for persistent and non-persistent pollutants in air, water and soil.

**UNIT II   INDUSTRIAL CHEMICALS, AGRICULTURAL PESTICIDES AND CHEMICAL
                  FERTILIZERS   9**
Introduction- Hazardous properties- Sources- Environmental pathways- Human health- Risk reduction and future trends- Pesticides – Fertilizers- Risk reduction for pesticides and chemical fertilizers-

UNIT III   AIRBORNE PARTICLES   9
Introduction - Hazardous properties - Sources - Global pathways - Health effects of inhaled particulate material- Risk reduction and future trends-

**UNIT IV   PHARMACEUTICALS, PERSONAL-CARE PRODUCTS AND ENGINEERED
                  NANOMATERIALS   9**
Introduction- Useful and hazardous properties- Anthropogenic sources – Sources of nanoparticles-Pathways and environmental fate- Physiological effects- Risk assessment- Regulations and reduction- Future trends

**UNIT V   TRACE ELEMENTS, TOXIC TRACE ELEMENTS, RADIOACTIVITY AND RADIO
                  ELEMENTS   9**
Introduction - Hazardous properties - Sources - Environmental pathways- Effects on human receptors- Risk reduction- S-R-P model.

                                                        TOTAL : 45 PERIODS
OUTCOMES:
On the completion of the course students are expected to
CO1: Describe the routes of transport by which a pollutant travel from its source to human
        populations
CO 2: Understand the pollutants and its pathways
CO 3: Formulate risk assessment on various pollutants
CO 4: Analyze different Pollutant types and its toxicity to the environment
CO 5: Perform regulation and reduction models for future.

TEXT BOOKS:
1. Jane A. Plant , Nick Voulvoulis , K. Vala Ragnarsdottir , "Pollutants, Human Health and the Environment: A Risk Based Approach" Wiley-Blackwell, 2011.
2. Daniel H. Chen,"Sustainable Water Technologies"", Springer International Publishing, 2016.

REFERENCES:
1. Lois Wright Morton, Susan S. Brown, "Pathways for Getting to Better Water Quality: The Citizen Effect," Springer-Verlag New York,2011.
2. M. H. Unsworth,, D. Fowler, "Deposition of Pollutants on Plants and Soils; Principles and Pathways" Springer Netherland,1988.
3. Brian Alloway, David C. Ayres, "Chemical Principles of Environmental Pollution, Second Edition", CRC Press, 1997.

CH5692   **INTRODUCTION TO NANOTECHNOLOGY**   **L T P C**
                                                                          3 0 0 3

OBJECTIVES:

The course content has been structured to help the student to gain an understanding of the principles of nanotechnology and its application in various fields.

UNIT I   NANOTECHNOLOGY BACKGROUND   9

Scientific revolution- Atomic Structures-Molecular and atomic Size-Bohr radius – Emergence of Nanotechnology – Challenges in Nanotechnology - Carbon age–New form of carbon (from Graphene sheet to CNT).

UNIT II   TYPES OF NANOMATERIALS   9

Classification based on dimensionality-Quantum Dots, Wells and Wires- Carbon-based nanomaterials (buckyballs, nanotubes, graphene)– Metal-based nanomaterials nanogold, nanosilver, and metal oxides) -Nanocomposites- Nano polymers – Nanoglasses –Nanoceramics - Biological nanomaterials.

UNIT III   SYNTHESIS OF NANOMATERIALS   9

Preparation of nanoscale metal oxides, metals, CNT, functionalized nanoporous adsorbents, nanocomposite- Chemical vapor deposition, sol-gel, sonochemical, microwave, solvothermal, plasma, pulsed laser ablation, magnetron sputtering, electrospinning, Molecular Condensation- Green synthesis.

UNIT IV   NANOMATERIALS CHARACTERIZATION AND PROPERTIES   9

SEM, TEM, XRD, ESCA, IR & Raman, UV-DRS, of nanomaterials for structural & chemical nature, Size-dependent properties - Mechanical, Physical and Chemical properties.

UNIT V   APPLICATIONS OF NANOMATERIALS   9

Nanomaterials as adsorbents for wastewater treatment – biofuels and bioenergy application – drug delivery – biomedical-biosensor -Nanomaterials for data storage –food-biological application-Environmental applications

                                                                    TOTAL:45 PERIODS

OUTCOMES:

On the completion of the course, students are expected to

CO1: To know the nanomaterial synthesis methodology.

CO2: To know the classification of nanomaterials.

CO3: To know the recent application of nanomaterials in various fields.

CO4: To cultivate interest in the research and development of nanotechnology for future advancement of the career.

CO5: To gain a sense of critical thinking about carrying out research in the field of Nanotechnology

TEXTBOOKS:

1. M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Nanotechnology: Basic science and Emerging technologies, Overseas Press India Pvt Ltd, New Delhi, First Edition, 2005.
2. C.N.R.Rao, A.Muller, A.K.Cheetham (Eds), The chemistry of nanomaterials: Synthesis, Properties, and applications, Wiley VCH Verlag Gmbh &Co, Weinheim, 2004.
3. Pradeep T., "A Textbook of Nanoscience and Nanotechnology", Tata McGraw Hill Education, Pvt. Ltd., 2012.

REFERENCES

1. C.S.S.R.Kumar, J.Hormes, C.Leuschner, Nanofabrication towards biomedical applications,
2. Wiley –VCH Verlag GmbH & Co, Weinheim,2004.
3. W. Rainer, Nano Electronics and Information Technology, Wiley, 2003.
4. G.Cao, Nanostructures, and Nanomaterials: Synthesis, properties, and applications, Imperial College Press, 2004.
5. Kenneth J. Klabunde (Eds), Nanoscale Materials Science, John Wiley & Sons, Inc, 2001.

CH5693   **INTRODUCTION TO PETROLEUM STREAMS**   **L T P C**
                                                                          2 1 0 3

OBJECTIVES
To impart detailed knowledge on petroleum refining upstream & downstream operations and to get awareness on the importance of plant safety and risk analysis in petroleum industries.

UNITI   INTRODUCTION TO SOURCE ROCKS AND CLASSIFICATION   9
Definition of source rock, Characteristics of Reservoir rocks, Reservoir pore space, porosity-primary and secondary porosity, effective porosity, fracture porosity - permeability – effective and relative permeability relationship between porosity, permeability and texture, Entrapment and accumulation of hydrocarbons, Sedimentary basins -origin and classification

UNIT II   PETROLEUM EXPLORATION   9
Overview of petroleum exploration in India, Introduction to Geophysical/Geological methods used in petroleum exploration. Basic concepts of Gravity/Magnetic methods, seismic methods

UNIT III   OIL RECOVERY TECHNIQUE   9
Calculation of hydrocarbon volumes, Material balance applied to oil reservoirs, Reservoir drive mechanism- Solution gas drive- Gas cap drive- Natural water Drive- Compaction drives under related pore compressibility phenomena. Oil Recovery Techniques

UNIT IV   PETROLEUM REFINING   9
Overall refinery operations & Indian scenario, Crude oil classification, Petroleum Products and their specifications, Atmospheric and Vacuum distillation units, Reforming, cracking and hydro treating processes.
UNIT V   HEALTH AND SAFETY   9
Introduction to environmental control in the petroleum industry, Guidelinesfor occupational health monitoring in oil and gas industry. Hazard identification- Hazard evaluation- Classification of fires- The fire triangle- Distinction between fires and explosions- Flammability characteristics of liquids and vapors- Well blowout fires and their control- Fire fight equipment- Suppression of hydrocarbons fires.
                                                          TOTAL : 45 PERIODS

OUTCOMES:
CO1: To learn the types of petroleum source rocks and classification
CO2: To learn the exploring methods of crude,
CO3: To know the different oil recovery techniques
CO4: To learn basic refinery operations
CO5: To understand the importance of environmental aspects and safety measures

TEXT BOOKS :
1. A.I. Levorsen, "Geology of Petroleum", 2nd Edition. CBS, Publishers, 2006.
2. John Milsom and AsgerEriksen, "Field Geophysics" 4th Edition, John Wiley, 2011.
3. W.L. Nelson, "Petroleum Refinery Engineering", 4th edition, Mc Graw Hill, 1985
4. Jones, D.S.J. and Pujadó, P.R., "Handbook of petroleum processing", Springer, The Netherlands, 2006

REFERNCES :
1. Donaldson, E.C. and G. V. Chilingarian, T. F. Yen, "Enhanced oil Recovery – I & II"
2. Parkash, S., "Refining processes handbook", Gulf Professional Publishing, 2003

AS5691   **PETROLEUM REFINING AND PETROCHEMICALS**   **L T P C**
                                                                  3 0 0 3

OBJECTIVE:
- To understand the origin, exploration and testing of petroleum crude and its products
- To know about petroleum purification and refining process
- To acquire knowledge about the aliphatic and aromatic products from the hydrocarbon crude and its various uses
- To study about the various petrochemicals and their processing in industries
- To learn the production of second and third generation petrochemicals

UNIT I   INTRODUCTION TO HYDROCARBONS   9
Origin and formation of petroleum; identification and exploration of reservoir; petroleum reservoir in the world; Evaluation of petroleum crude: physical properties and testing methods of crude and petroleum products.

UNIT II   HYDROCARBON CRUDE PROCESSING   9
Primary Refining: dehydration and desalination of crudes, distillation (ADU & VDU) of petroleum. Thermal and Catalytic processes: Thermal and catalytic cracking processes; Coking and Air Blowing of Bitumen; Solvent extraction; hydro treatment processes; polymerization; isomerisation; Purification Process: Dewaxing, Clay Treatment and Hydrofining.

UNIT III   PETROLEUM PRODUCTS EXTRACTION   9
Aliphatic and Aromatics derived from thermal cracking of naphtha, pyrolysis gasoline hydrogenation process. Utilization of aromatics; Separation of BTX from Reformate and its isolation; Alkylation of benzene; production of phthalic anhydride

UNIT IV   INTRODUCTION TO PETROCHEMICALS   9
Introduction to petrochemicals: feed stocks survey of petrochemical industry. Resources and generation of different feed stocks-their purification, separation of individual components by adsorption, low temperature fractionation and crystallization.

**UNIT V   SECOND AND THIRD GENERATION OF PETROCHEMICALS
               MANUFACTURING   9**
Production of Petrochemicals like Dimethyl Terephthalate (DMT), Ethylene Glycol, Synthetic Glycerine, Linear Alkyl Benzene (LAB), Acrylonitrile, Methyl Methacrylate (MMA), Vinyl Acetate Monomer, Phthalic Anhydride, Maleic Anhydride, Phenol and Acetone, Methanol, Formaldehyde, Acetaldehyde, Pentaerythritol and Production of Carbon Black

                                                                TOTAL: 45 PERIODS
COURSE OUTCOMES:
On successful completion of this course, the students will be able to
CO1: Learn about the formation, exploration of hydrocarbon and analysing the physical properties
CO2: Gain the knowledge behind primary refining process and purification of Hydrocarbon
CO3: Understand the concept about the primary generation of petrochemicals and its production method
CO4: Impart the knowledge about petrochemical industries and their fed stock processing
CO5: Know the manufacturing process of some petrochemicals and their applications

TEXT BOOKS
1. J.H. Gary et al, "Petroleum Refining", CRS press, New York, 5th ed., 2007, 6th edition, 2019
2. B.K. Bhaskara Rao, "Modern Petroleum Refining Processes", Oxford & IBH Publishing Co. Pvt. Ltd., 5th ed., 2008
3. Bhaskara Rao, B. K. "A Text on Petrochemicals", 5th Edn., Khanna Publishers, New Delhi, 2004

REFERENCE BOOK
1. Hobson, G.D., "Modern Petroleum Refining Technology", Fourth Edition, Institute of Petroleum U.K, 1973
2. SrikumarKoyikkal, "Chemical Process Technology and Simulation", PHI Learning Ltd
3. Uttam Ray Chaudhuri "Fundamentals of Petroleum and Petrochemical Engineering." University of Calcutta Calcutta, India, 2011.
4. Nelson, W. L., "Petroleum Refinery Engineering", 4th Edn., McGraw Hill, New York, 1985.
5. Wiseman. P., Petrochemicals, UMIST Series in Science and Technology.

AS5692　　　　　**LIFESTYLE MODIFICATIONS AND HEALTH IN UNISON**　　　**L T P C**
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　3 0 0 3

OBJECTIVES

The course is aimed to
- To Understand Glycemic index value and importance of millet foods
- To Know the important values for immunization scheduling and avoiding cervical cancer
- To Impart the knowledge about ORS
- To Gain the knowledge about HDL and LDL cholesterol and Thyroid stimulating hormone
- To create an awareness about pollution and hazards among students

UNIT I　IMPORTANCE OF MICRONUTRIENTS AND ADHERING TO LOW GLYCEMIC INDEX FOODS　10

Millets and fibre rich foods –Their high nutritive value –Dangers of consumption of refined foods –Iron protein combination –Micronutrients–Their importance in upkeep of good health –Overcoming their deficiency –Foods rich in micronutrients –Glycemicindex -Its importance –Comparative glycemic index of various foods.

UNIT II　IMMUNIZATION SCHEDULING – NEED FOR ADHERENCE　9

Protein calorie malnutrition –Importance of intake of folic acid supplements to prevent genital abnormalities –Necessity to avoid early marriage –Need for various immunizations their dosage schedules-Need to immunize adolescent girl children to prevent cervical cancer.

UNIT III　LIFE SAVING CHILD SURVIVAL STRATEGIES　8

Drastically cutting down mortality and morbidity –Causative factors of dehydration –Warning symptoms - Need to administer lifesaving Oral Rehydration Salt solution (ORS) Methodology of preparing ORS solution-Importance of zinc as an additive.

UNIT IV　STRATEGIES FOR INCREASING HDL AND LOWERING LDL CHOLESTEROL　9

Healthy fats –Need to avoid saturated and trans fats - Optimum value of HDL and LDL cholesterols –Need to lower triglycerides - Ways of reducing bad LDL cholesterol –Role of Thyroid Simulating Hormone (TSH) - Importance of mental health –Positive and optimistic outlook on life –Pranic breathing as a stress relief mechanism.

UNIT V　DRINKING WATER STANDARDS　9

WHO Standards of drinking water – Importance of dissolved oxygen – Effect of biodegradable organic particulate matter on dissolved oxygen – Estimation of sulphate in water – air pollution hazards – Domestic air pollutants.

TOTAL: 45 PERIODS

COURSE OUTCOMES

On completion of the course students are expected to

CO1: Get the knowledge about Glycemic index value and regular usage of millet foods in our daily life.

CO2: Know the necessity of regular immunization from birth and to avoid cervical cancer in girls

CO3: Learn the preparative methodology and advantages of lifesaving OR solution

CO4: Understand about the bad cholesterol and ways of reducing it and about TSH

CO5: Apply their Knowledge in day today life to avoid pollution.

TEXT BOOK
1. Himanshu Publications Complete Lifestyle Modification Management Through Nutrition Exercise and Yoga Hardcover – 1 Himanshu Publications, 2017.
2. The Basic Guide To Health: A Guide To Health And Fitness Through Lifestyle Modification Kindle Edition by Heath Claussen Heath Claussen, 2016.

REFERENCES
1. KedarN.Prasad, Micronutrients in Health and Disease, CRC Press, 1st Edition, 2010.
2. Relieve Your Health Issues By The Change: Lifestyle Modifications for More Control of Common Health Issues in Addition to Medications, by Alaa George
3. Lifestyle Modification Practices of Persons with Hypertensionby Dsilva Fatima, George Rosakutty, LAP Lambert Academic Publishing, 2012.
4. Internet Addiction and Lifestyle Modificationsby Farzana BegumScholars' Press, 2019

AS5693   **PETROLEUM OPERATIONS**   **L T P C**
                                                                              3 0 0 3

OBJECTIVE:
- To provide an overview of petroleum industry.
- Petroleum exploration and exploitation techniques, oil and gas reserve identification and evaluation.
- Drilling and production of oil and gas.
- Understand the latest trends in the petroleum industry

UNIT I   RESERVOIR GEOLOGY   9
Earth science - Origin, migration, accumulation of petroleum, occurrence of petroleum Rocks and traps. Reservoir rocks and properties. Classification of oil and gas reserves Reservoir mechanics and drive mechanism. Properties of oil & natural gas, Reservoir deliverability, petrophysical properties of reservoir rocks, Reserve estimation.

UNIT II   WELL DRILLING   9
Drilling – introduction to drilling of oil and gas wells. Drilling rigs and equipment's. Well planning, Rig operating systems, drilling fluids and cementing - functions & properties, drill bit types & their applications, drill string, drilling problems- their control & remedies.

UNIT III   FORMATION EVALUATION   9
Logging techniques. Various types of logs. Formation parameters. Log applications. Formation evaluation. Well completion.

UNIT IV   PRODUCTION OPTIMIZATION   9
Petroleum exploitation – Well testing, production potential and well performances. Petroleum production system, formation damage, well stimulation techniques, artificial lift techniques, Nodal system analysis.

UNIT V   RECOVERY METHODS AND LATEST TRENDS   9
Basic principle & mechanism of EOR, Screening of EOR process, recovery efficiency, permeability heterogeneity, EOR methods: chemical flooding, thermal recoveries (steam stimulation, steam flooding, ISC), microbial EOR Latest trends – Coal Bed Methane, Shale gas, Oil shale, gas hydrate, heavy oil.

                                                                      TOTAL: 45 PERIODS

COURSE OUTCOMES
On completion of the course students are expected to
CO1: Understand the concept of accumulation and formation of crude oil
CO2: Apply the concepts related to exploration and development of reservoir through drilling

CO3: Apply the concepts evaluating the reservoir through formation evaluation
CO4: Understanding process of production optimization from the reservoir
CO5: Identify the various recovery methods and latest trends in the petroleum industry

TEXT BOOK:
1. Rober F. Mitchell, Stefan Z. miska, "Fundamentals of Drilling engineering:, Society of Petroleum Engineers (2001).
2. "Standard Handbook of Petroluem and Natural Gas Engineering, 5th Edition, William C Lyons, Gary C Pilisga, Gulf Professional Publishing, 2015.
3. Principles of oil production by T.E.W Nind- 2nd edition Mc Graw-Hill, 1981.

REFERENCES:
1. Geology of Petroleum by Leverson A.L.- 2nd edition The AAPG foundation, 2006.
2. Standard Hand Book of Petroleum & Natural Gas Engineering" – 3nd Edition 2015-William C.Lyons & GaryJ.Plisga-Gulf professional publishing comp (Elsevier).
3. Wellsite Geological Techniques for petroleum exploration, Oxford and IBH publishing company, 1988

PH5691	ELECTROMAGNETIC THEORY	L T P C
		3 0 0 3

OBJECTIVE
- To learn the electromagnetic theory due to the fields produced by stationary and moving charges and propagation of fields

UNIT I   ELECTROSTATICS AND POLARIZATION   9
Gauss's law – Field due to an infinite, straight, uniformly charged wire – Multipole expansion of a charge distribution -- Field inside a uniformly polarized sphere – Electric field inside a dielectric – Electric displacement and polarizability – Claussius-Mossotti relation – Polarization of polar molecules and Langevin equation and Debye relation – Electrostatic energy.

UNIT II   BOUNDARY VALUE PROBLEMS IN ELECTROSTATICS   9
Boundary conditions – Potential at a point between the plates of a spherical capacitor – Potential at a point due to uniformly charged disc – Method of image charges – Point charge in the presence of a grounded conducting sphere -- Point charge in the presence of a charged, insulated conducting sphere -- Conducting sphere in a uniform electric field– Laplace equation in rectangular coordinates.

UNIT III   MAGNETOSTATICS   9
Magnetic scalar and vector potentials – Magnetic dipole in a uniform field – Magnetization current – Magnetic intensity – Magnetic susceptibility and permeability – Hysteresis –Correspondences in electrostatics and magnetostatics.

UNIT IV   FIELD EQUATIONS AND CONSERVATION LAWS   9
Continuity equation – Displacement current – Maxwell's equations and their physical significance – Poynting theorem – Energy in electromagnetic fields – Electromagnetic potentials – Maxwell's equations in terms of electromagnetic potentials – Lorentz and Coulomb gauges.

UNIT V   ELECTROMAGNETIC WAVES AND WAVE PROPAGATION   9
Electromagnetic waves in free space – Propagation of electromagnetic waves in isotropic dielectrics and in anisotropic dielectrics – Reflection and refraction of electromagnetic waves: Kinematic and dynamic properties – TM and TE modes – Propagation in rectangular waveguides – Cavity resonator.

TOTAL: 45 PERIODS

OUTCOMES

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

- understand the electrostatics and polarization principles
- acquire knowledge on boundary value problems, physics of charges and electric fields
- get knowledge on magnetostatics, hysteresis and correspondence between electro- and magnetostatics
- have the necessary understanding on filed equations and conservation laws
- gain knowledge on principles of electromagnetic wave propagation and its applications in waveguides.

REFERENCES

1. D.J.Griffiths, Introduction to Electrodynamics, Pearson Education, 2015.
2. J.D.Jackson, Classical Electrodynamics, Wiley, 2007.
3. M.N.O.Sadiku and S.V.Kulkarni, Principles of Electromagnetics, Oxford University Press, 2015.
4. T.L.Chow. Introduction to Electromagnetic Theory, Jones and Bartlett Learning, 2012.
5. E.C.Jordan and K.G.Balmain, Electromagnetic Waves and Radiating Systems. Pearson, 2015.

PH5692	PHYSICS OF SEMICONDUCTOR DEVICES	L T P C
		3 0 0 3

OBJECTIVE

- To learn the physics principles behind the operation of some important semiconductor devices.

UNIT I   PROPERTIES OF SEMICONDUCTORS   9

Crystal structure - reciprocal lattice - Brillouin zone and rules for band (k - space) representation. Dynamics of electrons in periodic potential: Kronig - Penny and nearly free electron models - Real methods for band structure calculations; Bandgaps in semiconductors - Holes and effective mass concept - Properties of conduction and valance bands – semiconductor defects - lattice mismatched structures – strained epitaxy.

UNIT II   ELECTRONIC LEVELS IN SEMICONDUCTORS   9

Particles in an attractive potential, bound states – Bloch theorem - Fermi distribution and energy - Density of states - Valance and conduction band density of states - intrinsic carrier concentration - intrinsic Fermi level. Extrinsic semiconductors: n and p type doping - Densities of carriers in extrinsic semiconductors and their temperature dependence - extrinsic semiconductor Fermi energy level - Degenerate and non - degenerate semiconductors – Tailoring electronic properties: alloys & quantum wells.

UNIT III   CHARGE TRANSPORT   9

Scattering Mechanism: electron - electron and electron - phonon scattering. Transport under an electric field – carrier transport by diffusion – charge injection and quasi-Fermi levels – Carrier generation and recombination – current conductivity.

UNIT IV   OPTICAL TRANSPORT   9

Electron - hole pair generation and recombination: band to band (direct and indirect band gap transitions) and intra band (impurity related) transitions, free - carrier & phonon transitions. Excitons : Origin, electronic levels and properties. Radiative and non-radiative recombination (Shockley - Read - Hall and Auger) processes. Carrier transport - continuity equations. Optical constants: Kramers - Kronig relations.

UNIT V   SEMICONDCUTOR DEVICES   9

Processing of Semiconductor devices - p-n Semiconductor junctions - Homo and hetero junctions. Semiconductors – MOS capacitor – MOSFET – Zener-Bloch oscillations – Resonant tunnelling - Quantum structures, density of states and excitons, semiconductor photonic structures: 1D, 2D

and 3D photonic crystals. Active and passive optoelectronic devices: performance and response enhancement

<div align="right">**TOTAL : 45 PERIODS**</div>

OUTCOMES

At the end of the course, the students will able to
- gain knowledge on various crystal structures, energy bands and semiconductor defects
- acquire knowledge on the basics of electronic energy levels, carrier concentration and tuned electronic properties
- get knowledge on carrier transport mechanisms
- have the necessary understanding on the concepts of optical transport mechanisms
- have adequate knowledge on different functional semiconductor devices

REFERENCES

1. D.Neamen and D.Biswas, Semiconductor Physics and Devices, McGraw-Hill Education, 2017.
2. R.F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006
3. S.M.Sze and K.K. Ng. Physics of Semiconductor Devices, Wiley, 2008.
4. K.F.Brennan. The Physics of Semiconductors: With Applications to Optoelectronic Devices, Cambridge University Press, 1999.
5. U.K. Misra and Jasprit Singh, Semiconductor Device Physics and Design, Springer, 2014.

PH5693   NANO-SCALE MATERIALS AND APPLICATIONS   L T P C
<div align="right">**3 0 0 3**</div>

OBJECTIVE
- To learn about basis of nanomaterial science, preparation method, types and application

UNIT I   INTRODUCTION   9

Definition of Nano, Scientific revolution-Atomic Structure and atomic size, Size effect , 3D, 2D, 1D and zero dimensional structures- Quantum confinement of electrons in semiconductor nanostructures- Quantum dots - nano wires- Nanotubes - Single walled and Multi walled Nanotubes (SWNT and MWNT) – nanofibers.

UNIT II   PROPERTIES   9

Length Scales involved and size effect on properties: Mechanical, Electrical, Electronic, Optical, Thermal and Magnetic properties; Gaint magnetoresistance, Tunneling magnetoresistance, Colossal magnetoresistance, Superparamagnetism, Superconducting nano-materials & their properties and applications.

UNIT III   SYNTHESIS   9

Gas phase condensation–Vacuum deposition-Physical vapor deposition (PVD)-chemical vapordeposition (CVD)–laser ablation -Sol-Gel- Sonochemical methods - Ball milling–Electro deposition- spray pyrolysis–plasma based synthesis process (PSP)-hydrothermal synthesis–carbon nanotubes and graphene synthesis

UNIT IV   APPLICATIONS   9

Biological and environmental, membrane based applications, polymer based application, Molecular electronics and nanoelectronics Single electron transistors, nanoparticles based solar cells and quantum dots based white LEDs and lasers–CNT based transistors, Nanoscale electronic devices including CMOS, Potentiometric sensors etc., MRAM devices, Spintronic devices including spin valves

UNIT V   RECENT DEVELOPMENT   9

Nanopolymers- polymer based nanocomposites, Nanoparticles polymer ensembles- Applications, Nanocomposites - Metal-Metal nanocomposites, Polymer-Metal nanocomposites, Ceramic nanocomposites, Dielectric and CMR based nanocomposites,

OUTCOMES

Upon completing this course, the students will
- familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in the technological applications of the nanomaterial

REFERENCES

1. D.C. Agrawal Introduction to Nanoscience and Nanomaterials, World Scientific Publishing Company, 2013.
2. G.Cao and Y.Wang. Nanostructures and Nanomaterials - Synthesis, Properties & Applications, World Scientific Publishing Company, 2011.
3. Y.W.Mai and Z.Z.Yu (Eds). Polymer Nanocomposites, Woodhead Publishing, 2006.
4. N John DiNardo. Nanoscale Characterization of Surfaces and Interfaces, Wiley VCH, 1994.
5. M.F.Ashby, P.J.Ferreira and D.L.Schodek. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers. 2011.
6. M.S.Shubra Singh and Ramachandra Rao. Nanoscience and Nanotechnology: Fundamentals to Frontiers, Wiley, 2013.

PH5694	QUANTUM PHYSICS FOR ENGINEERS	L T P C
		3 0 0 3

OBJECTIVE
- To make the students to understand the basics of quantum mechanics.
- To equip the students with the knowledge of statistical quantum mechanics.
- To elucidate the importance of single quantum systems.
- To make the students to understand the principles of particles in simple potentials.
- To make the students to understand the working of nano-devices.

UNIT I   QUANTUM MECHANICS   9

Basics of quantum mechanics – Schrodinger equation and hydrogen atom – quantum number – periodic table and Zeeman effect – electron spin – exclusion principle – atomic structure – angular momentum – molecules in motion – atomic bond – diatomic molecules –rotational, vibrational and electronic states of molecules.

UNIT II   STATISTICAL MECHANICS   9

Statistical distributions – Maxwell-Boltzmann distribution – molecular systems with quantum states – distribution of vibrational, rotational and translational energies – quantum statistics : distinguishable and indistinguishable particles – Planck's radiation formula – absorption, emission and lasers – Bose-Einstein condensation – Fermi-Dirac statistics.

UNIT III   SINGLE QUANTUM SYSTEMS   9

Interaction of light with single two-level quantum systems – local field probes – mapping the filed distribution – energy transfer and quenching. Near-field microscopy of second-harmonic generation – SHG at metal surfaces – apertureless SHG – imaging of functional materials.

UNIT IV   PARTICLES IN SIMPLE POTENTIALS   9

Free particle problem and density of states – particle in a quantum well: square quantum well, triangular quantum well, arbitrary quantum well, confined levels in semiconductor transistors, periodic potential and Bloch theorem – tunneling problem – ohmic contacts – field emission devices – STM – Josephson junction – RTD.

UNIT V NANOSCALE PHYSICS AND DEVICES 9

Introduction – nanoscale quantum confinement of matter –- overview of microelectronics to nanoelectronics – derivation of new Ohm's law – quantum cellular automata – single electron devices - quantum computing – quantum information processing – quantum communication.

TOTAL: 45 PERIODS

OUTCOMES

After completion of this course, the students should able to

- Understand the basics of quantum mechanics.
- Use the knowledge of statistical quantum mechanics.
- Understand the importance of single quantum systems.
- Know thenature of particles in different potentials.
- Understand the working principles of different nano-devices.

REFERENCES

1. Paul Sanghera. Quantum Physics for Scientists and Technologists, Wiley-Blackwell, 2011.
2. Jasprit Singh. Quantum Mechanics: Fundamentals and Applications to Technology, Wiley-VCH, 2004.
3. D.A.B. Miller, Quantum Mechanics for Scientists and Engineers, Cambridge University Press, 2008.
4. Peter Deak. Essential Quantum Mechanics for Electrical Engineers, Wiley VCH, 2017.
5. A.F.J. Levi. Applied Quantum Mechanics. Cambridge University Press, 2006.

HS5691 **ENGLISH FOR COMPETITIVE EXAMINATIONS** **L T P C**
3 0 0 3

Course Description:

Students aspiring to take up competitive exams of which the English language is a vital component will find this course useful. Designed for students in the higher semesters, the course will help students to familiarise themselves with those aspects of English that are tested in these examinations.

Objectives:

- To train the students in the language components essential to face competitive examinations both at the national (UPSC, Banking, Railway, Defence) and the international level (GRE, TOEFL, IELTS).
- To enhance an awareness of the specific patterns in language testing and the respective skills to tackle verbal reasoning and verbal ability tests.
- To inculcate effective practices in language-learning in order to improve accuracy in usage of grammar and coherence in writing.

UNIT I 9

Orientation on different formats of competitive exams - Vocabulary – Verbal ability – Verbal reasoning - Exploring the world of words – Essential words – Meaning and their usage – Synonyms-antonyms – Word substitution – Word analogy – Idioms and phrases – Commonly confused words – Spellings – Word expansion – New words in use.

UNIT II 9

Grammar – Sentence improvement –Sentence completion – Rearranging phrases into sentences – Error identification –Tenses – Prepositions – Adjectives – Adverbs – Subject- verb agreement – Voice – Reported speech – Articles – Clauses – Speech patterns.

UNIT III 9

Reading - Specific information and detail – Identifying main and supporting ideas – Speed reading techniques – Improving global reading skills – Linking ideas – Summarising – Understanding argument – Identifying opinion/attitude and making inferences - Critical reading.

UNIT IV   9

Writing – Pre-writing techniques – Mindmap - Describing pictures and facts - Paragraph structure – organising points – Rhetoric writing – Improving an answer – Drafting, writing and developing an argument – Focus on cohesion – Using cohesive devices –Analytic writing – Structure and types of essay – Mind maps – Structure of drafts, letters, memos, emails – Statements of Purpose – Structure, Content and Style.

UNIT V   9

Listening and Speaking – Contextual listening – Listening to instructions – Listening for specific information – Identifying detail, main ideas – Following signpost words – Stress, rhythm and intonation - Speaking to respond and elicit ideas – Guided speaking – Opening phrases – Interactive communication –Sentence stress – Speaking on a topic – Giving opinions – Giving an oral presentation – Telling a story or a personal anecdote – Talking about oneself - Utterance – Speech acts- Brainstorming ideas – Group discussion.

Teaching Methods:

Instructional methods will involve discussions, taking mock tests on various question papers – Objective, multiple-choice and descriptive. Peer evaluation, self-check on improvement and peer feedback - Practice sessions on speaking assessments, interview and discussion – Using multimedia.

Evaluative Pattern:

Internal Tests – 50%
End Semester Exam - 50%

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

- expand their vocabulary and gain practical techniques to read and comprehend a wide range of texts with the emphasis required
- identify errors with precision and write with clarity and coherence
- understand the importance of task fulfilment and the usage of task-appropriate vocabulary.

TEXT BOOK:

1. R.P.Bhatnagar - *General English for Competitive Examinations.* Macmillan India Limited, 2009.

REFERENCE BOOK

1. Educational Testing Service - *The Official Guide to the GRE Revised General Test,* Tata McGraw Hill, 2010.
2. *The Official Guide to the TOEFL Test,* Tata McGraw Hill, 2010.
3. R Rajagopalan- *General English for Competitive Examinations,* McGraw Hill Education (India) Private Limited, 2008.

Websites

1. http://www.examenglish.com/, http://www.ets.org/ , http://www.bankxams.com/
2. http://civilservicesmentor.com/, http://www.educationobserver.com
3. http://www.cambridgeenglish.org/in/

HS5692	SCIENCE FICTION	L T P C
		3 0 0 3

Course Description

This course is designed to teach creative and critical thinking, language and communication skills and problem solving skills through science fiction. Science fiction and allied science writings are used as materials to generate discussions on language, ideas, problems and solutions.

Objectives
- ✓ To familiarize students with the genre of science fiction.
- ✓ To help students appreciate the nuances of the language used in science fiction.
- ✓ To provide students with the material to discuss common themes of human concern as perceived by science fiction writers.
- ✓ To help students speak and write critically about common human problems and solutions.
- ✓ To encourage students to write creatively about futuristic contexts

UNIT I   SCIENCE FICTION – AN INTRODUCTION   9
Definition of the genre - The beginnings of the genre - Gothic fiction and fantasy - Early writers - Science as a reflection of the spirit of scientific enquiry of the time, Science fiction as a forerunner of future developments in science
Text for study: H.G.Wells' *Time machine*

UNIT II   SOCIAL SCIENCE FICTION   9
Use of science fiction to criticize contemporary world and predict the future - Utopian vs dystopian fiction Text for study: George Orwell's *1984*

UNIT III   MAN AND MACHINE   9
Exploration of the relationship between man, machine and morality - Man vs machine, Artificial intelligence
Text for study: 'Robby' from Isaac Asimov's *I, Robot*

UNIT IV   OTHER WORLDS   9
Exploring the idea of aliens and other worlds – Space colonization
Text for study: *Mars is Heaven* by Ray Bradbury

UNIT V   BIOLOGICAL SCIENCES   9
Exploring the forays into biological research - Dangers and ethical issues in cloning
Text for study: *Barney* by Will Stanton
                                                              TOTAL: 45 PERIODS

LEARNING OUTCOMES
By the end of the course students will be able to
- ✓ read and understand science fiction texts and the literary tools and strategies used by writers to communicate their meaning.
- ✓ collect, organize and present details about the writers, the historical and general contexts of the texts.
- ✓ discuss, analyse and argue about issues related to science and technology and their impact on society, culture, war, race, gender and the like.
- ✓ write critically and analytically about common social problems.
- ✓ speak and write imaginatively about futuristic contexts.

REFERENCES
1. Parrinder, Patrick. *Science Fiction: A Critical Guide.* Routledge, 2014
2. Prucher, Jeffrey (ed) *Brave new words: the Oxford dictionary of science fiction,* USA: OUP, 2006
3. James, Edward & Farah Mendelsohn, eds. *The Cambridge Companion to Science Fiction.* 2003
4. http://onlinebooks.library.upenn.edu/webbin/serial?id=sfstudies
5. http://www.sfhub.ac.uk/

HS5693   BUSINESS COMMUNICATION FOR ENTREPRENEURS   L T P C
                                                                 3 0 0 3
Course Description
This course is designed to help students who have entrepreneurial ambitions to communicate their business ideas both in formal and informal contexts using both the spoken and the written medium. It aims to teach them to create effective business documents and use group / team communication.

Course Objectives
- To enable learners to communicate effectively in a business environment.
- To familiarize learners with 21st century skills in global workplace contexts.
- To present their ideas and opinions clearly and effectively in both spoken and written communication.
- To create clear, concise and concrete business documents.
- To evaluate their target audience and make appropriate choices of communication methods.

UNIT I   INTRODUCTION TO BUSINESS COMMUNICATION   9
The business context – Communication needs – Barriers to Communication - Self-introduction – Taking part in conversations – listening - making small talk – business writing –Memos, Circulars, Notices – reading and understanding business documents

UNIT II   TELEPHONE / EMAIL COMMUNICATION   9
Listening and responding in formal telephone conversation – Spoken and written messages - Cross cultural communication – reading business letters /emails – writing business letters / emails – Good news and bad news letters / emails, complaint and enquiry letters / emails

UNIT III   INTERPERSONAL AND GROUP COMMUNICATION   9
Meetings and making notes – Writing minutes for a meeting – reading and interpreting business articles - taking part in group discussion – GD etiquette – expressing opinions - persuasive communication – negotiation – conflict and consensus

UNIT IV   BUSINESS PRESENTATIONS   9
Company profile – job advertisements – job application – Resume writing – facing an interview – making a presentation – planning a business pitch – gauging the target audience - using graphical material

UNIT V   BUSINESS REPORTS   9
Reading proposal advertisements – Proposal writing – budget, feasibility, background research – Reports - Designing a questionnaire/ opinionnaire – Data collection – Use of graphical materials – Abstract writing – Report writing – Survey report – Feasibility report

TOTAL: 45 PERIODS

Learning Outcomes
At the end of the course students will be able to
- read and comprehend business related documents
- write different business related documents clearly
- express ideas and views precisely and convincingly
- make persuasive presentations using visual aids
- collect business data and present it in a business report

REFERENCES

1. Lesikar, Flatley and Rentz. Basic Business Communication. New Delhi: Tata McGraw Hill Education, 1995.
2. Sweeney, Simon. English for Business Communication: Student's Book. Cambridge: Cambridge University Press, 1997.
3. Sullivan, Jay. Simply Said: Communicating Better at Work and Beyond. New Jersey: Wiley, 2017
4. Bolton, Robert. People Skills: How to Assert Yourself, Listen to Others and Resolve Conflicts. New York: Simon and Schuster, 1979.
5. Lind, Patti. Communication at Work. Portland: Inkwater Press, 2012.

CY5691   **NUTRITIONAL AND MEDICINAL CHEMISTRY**   **L T P C**
                                                                    3 0 0 3

COURSE OBJECTIVES:
- To learn the state of art of vitamins and minerals and their role in human nutrition
- To appreciate the difference in proteins and carbohydrates and their importance
- To identify the fats and oils and the analysis of the same
- To impart basic knowledge in methodology and diagnostics within Clinical Chemistry
- To understand the working principle of the diagnostic medical devices and spectroscopic equipment

UNIT I   VITAMINS AND MINERALS   9
Vitamins - definition, types – fat soluble and oil soluble vitamins, sources and deficiency diseases - Minerals - types, sources and deficiency diseases - the function and role of vitamins and minerals - metabolism of vitamins and minerals.

UNIT II   PROTEINS AND CARBOHYDRATES   9
Proteins - definition, sources - classification – aminoacids – essential and non essential aminoacids - structure and functions of proteins – Carbohydrates: sources – classification (mono, di and poly) - structure and functions of carbohydrates - Qualitative and quantitative tests for proteins and carbohydrates.

UNIT III   OILS AND FATS   9
Edible and non edible oils - Extraction and processing of oils and fats - Oils and fats as food materials and their Rancidity process, tests for rancidity - Hydrogenation of oils - analysis of fats and oils - Flow test, cloud test, consistency test, penetration method, saponification value, acid value and free fatty acid.

UNIT IV   CLINICAL CHEMISTRY   9
Estimation of glucose, electrolytes, T3, T4, and TSH, Thyroid peroxidase (TPO) antibodies, LDH, phosphatases, amylase, creatine, proteins – Its effect on health - Clinical significance of pH and blood gas parameters: pH, PCO_2, PO_2, bicarbonate, carbonic acid, excess base, oxygen saturation, fractional oxyhemoglobin, hemoglobin oxygen (binding) capacity, oxygen content and total CO_2.

UNIT V   DIAGNOSTIC MEDICAL DEVICES   9
Commonly used diagnostic tools: Thermometer, Stethoscopes, Sphygmomanometers, Ophthalmoscopes, Otoscopes, Electrocardiographs - Principles and instrumentation of spectrophotometry, potentiometry, electrophoresis, immunoassay, and chromatography.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
The student will be able to
- understand the basis of the interactions with food and medicines
- familiar with common healthy diets required for a human being
- comprehend vitamins and minerals supplementation and fortification
- attain knowledge about the processing technologies of fats and oils
- critically evaluate the diverse technologies and the consequent chemical and physico-chemical modifications on oils and fats
- gain knowledge on the various diagnostic tools and spectroscopic equipments

REFERENCES:

1. S.P. Bhutani, "Chemistry of Biomolecules", 2nd Edition, CRC Press, 2019
2. Alice Callahan, Heather Leonard, Tamberly Powell, "Nutrition Science and Everyday Application", Open Oregon Educational Resources, 2020
3. Frank Gunstone, "The Chemistry of Oils and Fats Sources, Composition, Properties and Uses", Wiley Publisher, 2009
4. H. Kenneth Walker, W. Dallas Hall and J. Willis Hurst, "Clinical Methods: The History, Physical, and Laboratory Examinations", 3rd edition, Boston: Butterworths; 1990

5. D.M Vasudevan, S. Srikumari and Kannan Vaidyanathan, "Textbook of Biochemistry for Medical students", 6th edition, Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, 2011
6. Simon Walker, Geoffrey Beckett, Peter Rae and Peter Ashby, "Clinical Biochemistry", 9th Edition, A John Wiley & Sons, Ltd. 2013
7. Scoot M. Strayer, Peter L. Reynolds and Mark H. Ebell, "Handhelds In Medicine A Practical Guide For Clinicians", Springer Publications, 2004
8. Ary L. Goldberger, D. Goldberger and Alexei Shivilkin, "Goldberger's Clinical Electrocardiography - A Simplified Approach", Elsevier India, 2007

CY5692	CHEMISTRY IN EVERYDAY LIFE	L T P C
		3 0 0 3

OBJECTIVES:
- To understand the role of cosmetics.
- To acquire knowledge about the cleaning products.
- To enable students to understand the importance of kitchen chemistry
- To learn about the chemistry involved in pharmacy.
- To gain knowledge in the field of dyes and pigments.

UNIT I   COSMETICS   9
Face powder, facial creams and lotion – lipsticks, eyeliner – sunscreen lotion and moisturizer, soaps – types, shampoos, nail polish, perfumes and deodorant – tooth paste – types, mouthwash and its purpose , Hair color -hazards of cosmetics.

UNIT II   CLEANING PRODUCTS   9
Floor cleaners and their types, Dish washing liquids and powders, toilet cleaners, hand wash, hand sanitizer, detergents, stain remover.

UNIT III   KITCHEN CHEMISTRY   9
Proteins, fats – definition and their importance as food constituents. Balanced diet – calorie – minerals and vitamins (sources and their importance) – Food additives and their ill effects.

UNIT IV   PHARMACEUTICAL CHEMISTRY   9
Analgesics and antipyretics – paracetamol and aspirin, antibiotics – types. Hand sanitizer, antiseptics – disinfectants - Antifungals – action, use of clotrimazole, miconazole.

UNIT V   DYES AND PIGMENTS   9
Pigments and dyes – examples and applications, natural food colours and their health aspects, dyes in bioanalysis and medical diagnostics.

TOTAL: 45 PERIODS

OUTCOMES:
- Will be aware of cosmetics used in everyday life.
- Will be conversant with cleaning products used in households and industries.
- Will be familiar with the dietary importance of proteins, fats and minerals.
- Will acquire knowledge about analgesics, antipyretics, antibiotics and antifungals.
- Will understand the importance of dyes and pigments.

REFERENCES:
1. W.A. Poucher, H. Butler, Perfumes Cosmetics and Soaps, Vol 3 Cosmetics,9th Edition, Springer, 2012.
2. B.P.Sen, A Handbook of Synthetic Detergents,Das Gupta & Company (P) Ltd; 1st edition, 2004.
3. Donald Cairns, Essentials of Pharmaceutical Chemistry 4th Edition,Pharmaceutical Press, 2012.
4. Klaus Hunger, Industrial Dyes: Chemistry, Properties, Applications, Wiley-VCH Verlag, 2003.
5. Sreeraj Gopi, Kitchen Chemistry, Notion Press; 1st edition, 2021.

CHEMISTRY OF FORENSIC STUDIES

COURSE OBJECTIVES:
- To introduce the fundamentals of forensic chemistry and materials used.
- To teach the significance and procedures of analytical techniques such as separation, spectroscopic and chromatography in forensic analysis.
- Tofacilitate the understanding of fingerprint detection techniques in various surfaces and to understand the examination of papers and inks.
- To introduce the role and analysis of materials in crime investigationincluding fire and arson.
- To impart knowledge of the chemistry of drugs and poisons in forensic analysis.

UNIT I   FUNDAMENTALS OF FORENSIC CHEMISTRY   9
Introduction: Definition of forensic Science, History and development, multidisciplinary nature, the role of the forensic laboratory.Introduction to Forensic Chemistry, branches of and cases involved in Forensic chemistry. **Examples of materials in forensics:**Organic (dyes, pigments, inks, fibers,drug, food and food additives), inorganic (metals and alloys, acids and bases, analytical reagents), biological substances (DNA and mitochondrial DNA, blood, hair, semen, saliva) and industrial products (polymers, glass, sugar, oils and fats, paints, cosmetics, petroleum, fertilizers, insecticides, explosives, liquor). Phenolphthalein in trap case: Chemistry and Forensic examination of Phenolphthalein used in bribe trap cases

UNIT II   ANALYTICAL METHODS IN FORENSICS   9
Nature and scope of analytical chemistry in forensic chemical analysis; **Methods of sample preparation** - Chemical separation Techniques: Solvent extraction (Liquid-liquid extraction), Solid phase extraction, Solid phase microextraction (SPME). **Spectroscopic analysis:**Analytical Protocols, Interpretation and Forensic applications of: Fluorescence, Phosphorescence and Chemiluminescence spectrometry, UV-Visible spectroscopy, FT-IR and AAS.**Chromatography:** Classification of chromatographic techniques, Basic Principle, Instrumentation and Forensic applications of HPTLC, Gas Chromatography (GC), High Performance Liquid Chromatography (HPLC) and Pyrolysis gas Chromatography.

UNIT III   ANALYSIS OF FINGERPRINTS AND QUESTIONED DOCUMENTS   9
Fingerprint Detection: Optical Detection Techniques;Chemistry of fingerprint detection on Porous, nonporous and adhesive surfaces, Latent Fingermark Detection. **Examination of Paper:** Types of Paper; Paper GSM; Testing of Paper- Nondestructive and Destructive Tests; Comparison of Paper, **Examination of Inks:**Detection and comparison of inks using spectroscopy, chromatography and Chemical Tests; Dating of paper and inks.

UNIT IV   MATERIAL EVIDENCES   9
Role of materials in crime investigation: Glass, paints, dyes and pigments, soil, fibers and textiles, tools and tool marks, gunshot residue, fertilisers,insecticides and biological samples; Adulteration in consumer items- oils and fats, food additives, cosmetics, gold, silver.**Samples from fire and arson:**Extraction of samples from debris (Direct and solvent extraction methods, Head Space method, SPME, Distillation), Clean-up (Filtration & Acid stripping) andAnalysis (only application of GC, GC-MS, FTIR & SEM).
Case studies: Students to present on investigation of crime through any two material evidence analysis.

UNIT V   DRUGS AND POISONS   9
Drugs: Definition, Use & Misuse; Brain Chemistry: Drug Receptors, dependence and Addiction;Drugs of Abuse:Opium and Opioids analgesics, Stimulants (Cocaine, Amphetamine), Depressants (Barbiturates and Benzodiazepines), Hallucinogens (Cannabis, LSD, Psilocybine and Mescaline), OTC, Inhalant and Volatile Substances.
Poisons: Animal Poisons: Insects and animal toxins, snake venoms, tests for identification and effect on body; Plant poisons: Classification and characteristics, extraction and stripping from matrices, analysis by chemical and instrumental techniques. Gaseous Poisoning: CO, HCN and Phosphine gas - signs and symptoms, methods of diagnosis, tests for identification. Food

Poisoning: Food poisoning due to chemicals and bacteria, extraction, isolation, detection and identification by colour test and Instrumental techniques.

TOTAL: 45 PERIODS

COURSE OUTCOME:

At the end of the course the students will be able to:
- Identify the class of materials and their significance in forensic investigation.
- Apply chemical and sophisticated analysis towards forensic investigation.
- Recommend suitable identification method for fingerprint and document analysis.
- Identify and quantify the various evidence materials used in forensics.
- Use the knowledge of drugs and poisons for forensic examinations.

REFERENCES:
1. Nikunj N Dave, 2021, "Forensic Chemistry", Notion Press.
2. Iqbal S.A., "Textbook of Forensic Chemistry", Discovery Pubishing Pvt. Ltd.
3. David Ellen, Stephen Day, Christopher Davies, 2018, "Scientific Examination of Documents: Methods and Techniques", 4th Edition, Taylor & Francis.
4. ChaudheryMustansarHussain, DeepakRawtani, GauravPandey, MaithriTharmavaram, 2020, "Handbook of Analytical Techniques for Forensic Samples: Current and Emerging Developments", Elsevier Science.
5. Suzanne Bell, 2009, Drugs, Poisons, and Chemistry, Infobase Publishing, 2009.
6. Mathew E. Johll, 2009,"Investigating Chemistry: A Forensic Science Perspective", W. H. Freeman Publishers.
7. DFS Manuals of Forensic Chemistry and Narcotics, Directorate of forensic science services, Ministry of Home affairs, GOI, New Delhi.

ME5694   **FUEL CELLS**   **L T P C**
                                                                        3 0 0 3

UNIT I   INTRODUCTION   9
Fuel cell basics –Attractive features - Batteries and fuel cells – Principle and working of fuel cells - Types of fuel cells

UNIT II   CLASSIFICATION OF FUEL CELLS   9
Proton exchange membrane fuel cell (PEMFC) - Direct methanol fuel cell (DMFC) - Alkaline fuel cell (AFC) - Solid oxide fuel cells (SOFC) - Molten carbonate fuel cell (MCFC) – Bio fuel cell (BFC) – Enzymatic and Microbial

UNIT III   THERMODYNAMICS AND KINETICS   9
Basics of electrochemistry – Cyclic Voltammetry – Chronoamperometry – Chronocoulometry - Fuel cell thermodynamics - Efficiency of fuel cells -fuel cell electrochemistry - Nernst equation, Electrochemical Kinetics - Butler-Volmer equation

UNIT IV   CONSTRUCTION AND WORKING OF FUEL CELLS   9
Fuel cell design and components - Cell components, stack components, system components – Membrane electrode assembly (MEA) preparation - Fuel Cell Performance - Current density and Power density

UNIT   APPLICATIONS OF FUEL CELLS   9
Hydrogen as Green energy – Energy sectors – Automobile and other industries
                                                                        TOTAL: 45 PERIODS

REFERENCES:
1.   J. Larminie and A. Dicks, Fuel Cell Systems Explained, 2nd Edition, Wiley (2003)
2.   Xianguo Li, Principles of Fuel Cells, Taylor and Francis (2005)
3.   B. Viswanathan and M. Aulice Scibioh, Fuel cells principles and applications, Universities Press (India) Pvt Ltd (2006)
4.   Frano Barbir, PEM Fuel cells – Theory and Practice, Elsevier Academic Press (2005)
5.   Suddhasatwa Basu, Recent trends in Fuel Cell Science and Technology, Anamaya Publishers (2007)

ME5695   SUSTAINABLE ENERGY TECHNOLOGIES AND   L   T   P   C
                  ASSESSMENT   3   0   0   3

COURSE OBJECTIVES:
1.   To study and understand the global and Indian energy scenario
2.   To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
3.   To learn how to design and conduct performance analysis in various energy systems
4.   To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement
5.   To impart basic knowledge related to numerical simulation analysis

UNIT I   ENERGY SCENARIO STATUS AND POLICY   9
Indian and global energy scenario in various sectors – domestic, industrial, commercial, agriculture & transport – Current conventional and renewable energy status in India – Potential of renewable energy sources in India: Present status and future promise – Energy modelling, regression analysis and double moving average – Energy in economic development and social transformation.

UNIT II   SOLAR THERMAL & PHOTO VOLTAIC TECHNOLOGY   9
Solar radiation – Measurements of solar radiation and sunshine – Solar thermal collectors and applications – Principle of working, types, design and operation of solar heating and cooling systems

– Solar Desalination – Solar cooker – Solar Pond – Solar drying – Semiconductor – properties & energy levels – SPV system design & optimization – Standalone, hybrid, centralized, grid connected and decentralized SPV systems – SPV system maintenance, market analysis and economics.

UNIT III   WIND ENERGY, BIO ENERGY, OTEC & GEOTHERMAL ENERGY   9

Wind data assessment – Site selection for windfarms – Horizontal & vertical axis wind turbine – Environmental issues and applications – Biomass direct combustion – thermochemical & biochemical conversion – Biomass gasifier – Types of biomass gasifiers – Cogeneration & trigeneration – Biogas plants and digesters – Small hydro – Tidal energy – Wave energy – Open and closed cycle ocean thermal energy conversion (OTEC) – Geothermal energy sources – Types of geothermal power plants & Applications.

UNIT IV   ENERGY STORAGE TECHNOLOGIES   9

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications – Thermal storage types – Modelling of thermal storage units – Simple water and rock bed storage system – Fundamental concept of batteries & types, charging and discharging, storage & energy density and safety issues – Hydrogen storage – Flywheel, Super capacitors – Compressed air Energy storage & Concept of Hybrid Storage. TRYNSYS, PY SYST, TONATIUH, ANSYS & COMSOL.

**UNIT V   ENERGY: NODAL AGENCIES, RESEARCH CENTRES &   9
                  GOVERNMENT SHEMES**

TNEB, TANGEDCO, TANTRANSCO & TEDA – MNRE ministry – NIWE, NISE & NIOT – Government of India initiatives – Green Energy Corridor – Net Metering Policy – International Solar Alliance – Surya Mitra Scheme – International Energy Agency (IEA) – NREL – Platforma Solar De Almeria.

TOTAL: 45 PERIODS

REFERENCES:
1. Armstrong J.Scott (ed.), Principles of forecasting: a hand book for researchers and practitioners, Norwell, Massachusetts: Kluwer Academic Publishers.2001.
2. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
3. Solar Energy International, Photovoltaic – Design and Installation Manual, New Society Publishers, 2006
4. Lovegrove K., Stein W., Concentrating Solar Power Technology, Woodhead Publishing Series in Energy, Elsevier, 1st Edition, 2012
5. John A. Duffie, William A. Beckman, Solar Engineering of Thermal Processes, John Wiley & Sons, 2013
6. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.
7. Rai.G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
8. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002.
9. Robert Huggins, Energy Storage: Fundamentals, Materials and Applications, 2nd edition, Springer, 2015
10. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

ME5696   **MODERN HEALTHCARE MACHINES - I**   **L T P C**
                                                               3 0 0 3

OBJECTIVES:
1. To create awareness about over modern healthcare machines
2. To understand the basic equipment's/machines in Healthcare industry
3. To appreciate the application of Intelligent machines and applications of AI & ML in imaging
4. To recognise the role of maternal machines in future
5. To explain the role of Digital technologies in modern healthcare Industry

UNIT I   INTRODUCTION   9
Healthcare and hospitals, Need- Resilience in a crisis- past & present Technologies, contents of First-aid-kit-digital healthcare-AI in healthcare, -Barriers to digital transformation-strategic partnerships- global leaders in healthcare- Skills-sustainable systems-Emergency codes-Advantages and Limitations.

UNIT II   BASIC EQUIPMENT'S   9
History-Stethoscope- Thermometer-weigh scale-BP Machine-Air purifier- Blood glucose meter-Pulse-oximeter-Nebuliser-ECG- working – input data and output interpretation methodology- Inside ICU: Patient Monitor-ventilator-Role of Mobility solutions-Analytics and alarm management, case studies.

UNIT III   INTELLIGENT IMAGING MACHINES   9
Contrast Media-Fluoroscopy- Computer Tomography- Magnetic Resonance-Mammograpgy, Molecular Imaging, Radiography (X-Ray)-Dual Energy X-Ray Absorptiometry (DXA)-Ultrasound Imaging- Application of AI & ML in Imaging-Case studies.

UNIT IV   MATERNAL MACHINES   9
CASA- Anaesthesia workstation- ICSI Equipments-Warmers- Incubation carestation- Resuscitation Systems-Phototherapy system - Fetal Monitors-Application of AI in Maternal Machines-Case studies

UNIT V   DIGITAL HEALTHCARE   9
Transformation history- Personalised Healthcare-3D printing-TeleHealthcare - Health 4.0-MIoT-Digital Twin in Healthcare-Societal and Ethical aspects- Case studies.

                                                                        TOTAL : 45 PERIODS

OUTCOMES:
The students will able to
1. Remember the role modern healthcare machines
2. Ability to understand and Interpret the results from basic healthcare equipment's
3. Appreciate the role of AI and ML in Medical Imaging
4. Understand the capability of Maternal Machines
5. Discover the role digital technologies in modern healthcare industry

REFERENCES:
1. Geddes LA and Baker L.E Principals of Applied Biomedical Instrumentation, 3rd Edition, John Wiley and sons, New york 1989
2. Joseph J Carr and John Brown - Introduction to Biomedical equipment Technology- Pearson Education 4th edition New Delhi 2001.
3. Seeram Ramakrishna, Lingling Tian, Charlene Wang, Susan Liao, Wee Eong Teo, Medical Machines, 1st edition, Elseiver, 2015, ISBN: 9780081002896
4. Shivani Chandra, Ankur Saxena, Artificial Intelligence and Machine Learning in Healthcare, Springer Imprint, 2021
5. Abdulmotaleb El Saddik, Digital Twins for Healthcare, Elsevier Science, 2022, 97803239916

COURSE OBJECTIVES:

- To understand the importance of various materials used in electrical, electronics and magnetic applications
- To acquire knowledge on the properties of electrical, electronics and magnetic materials.
- To gain knowledge on the selection of suitable materials for the given application
- To understand the fundamental concepts in Semiconducting materials
- To get equipped with the materials used in optical and optoelectronic applications.

UNIT I   DIELECTRIC MATERIALS   9

Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

UNIT II   MAGNETIC MATERIALS   9

Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and Hysteresis

UNIT III   SEMICONDUCTOR MATERIALS   9

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques. concept of superconductivity; theories and examples for high temperature superconductivity; discussion on specific superconducting materials; comments on fabrication and engineering applications.

UNIT IV   MATERIALS FOR ELECTRICAL APPLICATIONS   9

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

UNIT V   OPTICAL AND OPTOELECTRONIC MATERIALS   9

Principles of photoconductivity - effect of impurities - principles of luminescence-laser principles - He-Ne, injection lasers, LED materials - binary, ternary photoelectronic materials - LCD materials - photo detectors - applications of optoelectronic materials - optical fibres and materials - electro optic modulators - Kerr effect - Pockel's effect.

                                                                TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students will be able to

- Understand various types of dielectric materials, their properties in various conditions.
- Evaluate magnetic materials and their behavior.
- Evaluate semiconductor materials and technologies.
- Select suitable materials for electrical engineering applications.
- Identify right material for optical and optoelectronic applications

TEXT BOOKS:

1. Pradeep Fulay, "Electronic, Magnetic and Optical materials", CRC Press, taylor and Francis, 2nd illustrated edition, 2017.
2. "R K Rajput", "A course in Electrical Engineering Materials", Laxmi Publications, 2009.

REFERENCES:
1. T K Basak, "A course in Electrical Engineering Materials", New Age Science Publications, 2009
2. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
3. Adrianus J. Dekker, "Electrical Engineering Materials", PHI Publication, 2006.
4. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.
5. C. Kittel, "Introduction to Solid State Physics", 7th Edition, John Wiley & Sons, Singapore, (2006).

IE5692	INTRODUCTION TO APPLIED DATA ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:
- Learn the fundamental principles of analytics for business
- Visualize and explore data to better understand relationships among variables
- To understand the principles and techniques for data analysis
- Examine how analytics can be used in decision making Business Analytics.

UNIT I   INTRODUCTION   9
Introduction to analytics: Driven Decision Making, Importance, Relationship with Organisational Decision Making, Analytics for Competitive Advantage, analytics types, applications- Models: predictive models - descriptive models - decision models - applications - analytical techniques

UNIT II   UNDERSTANDING DATA   9
Data types and associated techniques – complexities of data – data preparation, pre-processing – exploratory data analysis

UNIT III   DESCRIPTIVE ANALYTICS   9
Descriptive Statistical Measures- Probability Distributions and Data Modelling- Sampling and Estimation- Statistical Inference

UNIT IV   PREDICTIVE ANALYTICS   9
Trend lines and Regression Analysis- Forecasting Techniques - Monte Carlo Simulation

UNIT V   PRESCRIPTIVE ANALYTICS   9
Optimization- Decision trees- Heuristics methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Understand the importance of analytics
CO2: Able to prepare and process data for the models
CO3: Learn about statistical analysis techniques used in Data Analytics
CO4: Ability to model data and establish baseline performance
CO5: Build and apply analytics in a variety of business contexts

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											1
CO2	2	2		3	2							1
CO3	2	2		3	3							1
CO4	2	2		3	3							1
CO5	1	3		3	3							1

TEXT BOOKS:
1. U Dinesh Kumar,Business Analytics The Science of Data –Driven Decision Making, Wiley,2017.
2. James Evans, Business Analytics, Pearson, 2019.

IE5693 **INTRODUCTION TO SUSTAINABILITY ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVE:
To inculcate in students awareness on global initiatives towards attaining sustainability.

UNIT I INTRODUCTION 9
Definitions - Basic Concepts – Evolution- Challenges - Reasons for Unsustainability, History of sustainable development, Pillars of sustainable development, Importance of sustainable development, Need for sustainable development.

UNIT II SUSTAINABLE DEVELOPMENT GOALS 9
Millennium Development Goals (MDGs), Sustainable Development Goals (SDGs), Clean Development Mechanism (CDM), Environmental Law and Sustainability

UNIT III SUSTAINABLE ENGINEERING THEORY AND CONCEPTS 9
Greenhouse effect, Global warming, Climate change, Ozone layer depletion, Carbon credits, carbon trading and carbon foot print, Ecological and Other Footprints, Sustainability Indicators, Industrial Ecology, Green Chemistry and Engineering, Life Cycle Concept, Design for Environment, Ecodesign.

UNIT IV SUSTAINABILITY ASSESSMENT 9
Goal Definition and Scope, Inventory Analysis, Mathematical Framework, Footprint Assessment, Energy and Material Flow Analysis, Exergy Analysis, Cumulative Exergy Consumption and Emergy Analysis, Life Cycle Impact Assessment- Life-Cycle Assessment Tools- Process-Based Life-Cycle Assessments- Input-Output LCA -Hybrid Approaches, Ecosystem Services in Sustainability Assessment.

UNIT IV SOLUTIONS FOR SUSTAINABILITY 9
Designing Sustainable Processes and Products, Industrial Symbiosis and the Circular Economy, Ecosystems in Engineering, Economic Policies, Societal Development

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After studying this course, students will be able to:
CO1: Understand various issues of sustainability
CO2: Get familiarity about Sustainable Development Goals (SDGs)
CO3: Understand and apply sustainability concepts in product developments and processes across various engineering disciplines.
CO4: Perform Sustainability Assessment
CO5: Provide Solutions for Sustainability

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1					2					1
CO2						3	3	2				1
CO3	2	2	2	2	2	3	3					2
CO4	3	2		2			2					1
CO5	3	2	3	3	3	3	3					2

TEXT BOOKS:
1. Bhavik R. Bakshi, "Sustainable Engineering Principles and Practice", Cambridge University Press, 2019
2. Catherine N. Mulligan, "Sustainable engineering : principles and implementation" , CRC Press, 2019

REFERENCES :
1. Allen, D. T. and Shonnard, D. R., "Sustainability Engineering: Concepts, Design and Case Studies", Prentice Hall. 2011.
2. Bradley. A.S; Adebayo,A.O., Maria, P. "Engineering Applications in Sustainable Design and Development", Cengage learning , 2016.

MF5692   **SUSTAINABLE DEVELOPMENT AND MANUFACTURING**   **L T P C**
                                                                    3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on the principles of balancing social, economic and environmental dimensions for the development and the associated international and national frameworks.
- To enlighten the sustainable indices, associated models, legal aspects and their importance so as to quantify the sustainable development of a real time system.
- To inculcate the culture of societal development and policies for a sustainable environment, protection and balanced consumption of natural resources.
- To impart knowledge on the creation of manufactured products that use processes that are non- polluting, conserve energy and natural resources, and are economically sound and safe for employees, communities and consumers.
- To familiarise new concepts and trends in energy generation and conservation, green supply chain and entrepreneurial exploitation.

UNIT I   SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL ISSUES   9

Sustainable Development - Challenges - Factors - linkages - determinants - Global Environmental Issues - Population, Income, and Urbanization - Health Care - Food, Fisheries and Agriculture - Materials and Energy Flows - Transportation - Precautionary Principle - Forestry - Water Resources - Valuation of Nature's Services - Coping with Global Problems.

UNIT II   SUSTAINABLE DEVELOPMENT INDICATORS   9

Need for Indicators - Statistical Procedures - Emissions, Diffusion and Impact Model - Aggregating Indicators - Other Weighting Systems - Use of Principal Component Analysis - Three Environmental Quality Indices - Environmental Assessment - Milestones in Environmental Management - Millennium Development Goals - Legislation, International Law and Multilateral Environmental Agreements.

UNIT III   SOCIAL DIMENSIONS   9

Social Dimensions and Policies - Social Development Indicators - The Economics of Sustainability - Sustainability: Externalities, Valuation and Time Externalities - Natural Resource Accounting - International Cooperation - Organizations Responsible for Sustainable Development - Peoples' Earth Charter - Sustainable Development: Crisis, Conflict and Compromise.

UNIT IV   SUSTAINABLE MANUFACTURING   9

Value Creation by Sustainable Manufacturing - Global Value Creation - Modelling - Lean Production Systems - Cleaner Production - Manufacturing Processes and Equipment - Process Improvement - Product - Production System - Combinations - Dry and Cryogenic Machining - Remanufacturing, Reuse and Recycling - Product Design for Resource Efficiency and Effectiveness.

UNIT V   ENERGY, ENVIRONMENT AND ECONOMICS OF SUSTAINABLE
                 MANUFACTURING   9

Innovative Energy Conversion - Green Supply Chain and Transportation - Adequate Environments for Entrepreneurial Initiative - Technology and Motivation in the Use of Renewable Energy - Enterprise Innovativeness - Knowledge Sharing - Economics for Sustainable Development.

                                                        TOTAL :45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will:

CO1: Gain knowledge about various factors that drive sustainability and will approach all aspects of engineering with a sustaining insight.

CO2: Be aware of significance of various sustainable indices and legal aspects.

CO3: Understand the relationship between social, economic and environmental elements and will strive for sustainable development of systems.

CO4: Be disciplined to follow strong sustainable principles and develop environment friendly manufacturing methods and products.

CO5: Realize the need to conserve energy and natural resources, and to carry out manufacturing in a sustainable way.

TEXT BOOKS:

1. Peter P. Rogers, Kazi F. Jalal and John A. Boyd, An Introduction to Sustainable Development, Glen Educational Foundation, 2008.
2. Sustainable Manufacturing: Shaping Global Value Creation, edited by Gunther Seliger, Springer Science & Business Media, 2012.

REFERENCES

1. Sayer. J. and Campbell. B., "The Science of Sustainable Development: Local Livelihoods and the Global Environment" (Biological Conservation, Restoration & Sustainability), Cambridge University Press, London, 2003.
2. Kirby. J., O Keefe P. and Timberlake, "Sustainable Development", Earth scan Publication, London, 1993.
3. Jennifer A. Elliott, "An Introduction to Sustainable Development", London: Routledge: Taylor and Francis group, 2001.
4. Low. N. Global Ethics and Environment, London: Routledge, 1999.
5. Douglas Muschett, Principles of Sustainable Development, St.Lucie Press, 1997.
6. J. Paolo Davim, Sustainable Manufacturing, John Wiley & Sons, 2013.
7. Mrityunjay Singh, Tatsuki Ohji, Rajiv Asthana, Green and Sustainable Manufacturing of Advanced Material, Elsevier, 2015.

	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	0.9	0.3	0.3			0.6	0.9					0.3	0.9	0.3	0.9
CO2	0.9	0.3	0.3		0.3	0.6	0.9					0.3	0.9	0.3	0.9
CO3	0.9	0.3	0.3	0.3		0.6	0.9					0.3	0.9	0.3	0.9
CO4	0.9	0.3	0.3			0.6	0.9					0.3	0.9	0.3	0.9
CO5	0.9	0.3	0.3			0.6	0.9					0.3	0.9	0.3	0.9