

**RAJALAKSHMI ENGINEERING COLLEGE**  
(An Autonomous Institution Affiliated to Anna University, Chennai)

**Open Electives offered by all Departments as per R2019**

SL.NO.	COURSE CODE	COURSE TITLE	CATGRY	L	T	P	C
1	OAE1901	Introduction to Aeronautical Engineering	OE	3	0	0	3
2	OAE1902	Fundamentals of Jet Propulsion	OE	3	0	0	3
3	OAE1903	Introduction to space flight	OE	3	0	0	3
4	OAE1904	Industrial Aerodynamics	OE	3	0	0	3
5	OAT1901	Automotive Systems	OE	3	0	0	3
6	OAT1902	Automotive sensors and actuators	OE	3	0	0	3
7	OAT1903	Elements of Electric and Hybrid Vehicles	OE	3	0	0	3
8	OAT1904	Fundamentals of Automotive Electronics	OE	3	0	0	3
9	OBM1901	Introduction to Human Anatomy and Physiology	OE	3	0	0	3
10	OBM1902	Biomaterials and Artificial Organs	OE	3	0	0	3
11	OBM1903	Fundamentals of Medical Instrumentation	OE	3	0	0	3
12	OBM1904	Engineering Mechanics for Medical Applications	OE	3	0	0	3
13	OBT1901	Food and Healthy Living	OE	3	0	0	3
14	OBT1902	Man and Microbes	OE	3	0	0	3
15	OBT1903	Basic Bioinformatics	OE	3	0	0	3
16	OBT1904	Biotechnology in Product Development	OE	3	0	0	3
17	OBT1905	Medical Sciences for Engineers	OE	3	0	0	3
18	OBT1906	Application of Biotechnology for Environmental protection	OE	3	0	0	3
19	OBT1907	Fermentation Technology	OE	3	0	0	3
20	CH19031	Introduction to Fertilizer Technology	OE	3	0	0	3
21	CH19032	Introduction to Process Technology	OE	3	0	0	3
22	OCE1901	Natural Hazard & Disaster Management	OE	3	0	0	3
23	OCE1902	Green Building Design	OE	3	0	0	3
24	OCS1901	Data Structures Using C	OE	0	0	6	3

SL.NO.	COURSE CODE	COURSE TITLE	CATGRY	L	T	P	C
25	OCS1902	OOPS using JAVA	OE	0	0	6	3
26	OEC1901	MEMS and its applications	OE	3	0	0	3
27	OEC1902	Consumer Electronics	OE	3	0	0	3
28	OEC1903	Digital Image Processing and its applications	OE	3	0	0	3
29	OEC1904	Pattern Recognition and Artificial Intelligence	OE	3	0	0	3
30	OEC1905	Electronics Engineering	OE	3	0	0	3
31	OEE1901	Electrical Safety and Quality Assurance	OE	3	0	0	3
32	OEE1902	Electric Power Utilization	OE	3	0	0	3
33	OFT1901	Emerging Techniques in Food Processing	OE	3	0	0	3
34	OFT1902	Food Safety	OE	3	0	0	3
35	OFT1903	Crop Process Engineering	OE	3	0	0	3
36	OFT1904	Food Supply Chain Management	OE	3	0	0	3
37	OIT1901	Business Intelligence	OE	3	0	0	3
38	OIT1902	Cyber Security	OE	3	0	0	3
39	OMT1901	Elements Of Automation	OE	3	0	0	3
40	OMT1902	CNC Systems -Design And Applications	OE	3	0	0	3
41	OMT1903	Mobile Robotics	OE	3	0	0	3
42	OMT1904	Medical Mechatronics	OE	3	0	0	3
43	OME1901	Supply Chain Management	OE	3	0	0	3
44	OME1902	Basics of 3D Printing and Additive Manufacturing	OE	3	0	0	3
45	OCY1901	Green Chemistry in Energy and Environment	OE	3	0	0	3
46	OGE1901	German Language	OE	3	0	0	3
47	OHS1901	Professional Communication and Life Skills	OE	3	0	0	3
48	OMA1901	Computer Based Numerical Methods	OE	3	0	0	3
49	OPH1901	Materials Synthesis and Characterization Techniques	OE	3	0	0	3

## OPEN ELECTIVE OFFERED BY AERONAUTICAL ENGINEERING

OAE1901

INTRODUCTION TO AERONAUTICAL ENGINEERING

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

### OBJECTIVES

- To introduce history and classification of aircraft
- To understand properties of atmosphere
- To study basic aerodynamics
- To introduce basic concepts of aircraft structure
- To introduce piston and jet engines

### UNIT I AIRCRAFT CONFIGURATIONS

8

History of Flight-Wright Brothers-Different types of flight vehicles, classification, components and functions of typical transport aircraft, Helicopter and UAV parts and functions,

### UNIT II PROPERTIES OF ATMOSPHERE

7

Physical properties and structure of the atmosphere, ISA, lapse rate –different layer of atmosphere-different types of altitudes-temperature, pressure and altitude relationships-calculations.

### UNIT III BASICS OF AERODYNAMICS

12

Newton's law of motions applied to aeronautics - aerofoil and wing geometry, NACA series airfoils, generation of lift, Mach number and ranges, aerodynamic center, pressure coefs, aspect ratio, types of drag, induced drag, lift and drag curves, sweepback on wing, shock waves in supersonic flight-basics of Pitot tube.

### UNIT IV AIRPLANE STRUCTURES AND MATERIALS

9

General types of construction, monocoque and semi-monocoque, typical wing and fuselage structure, metallic and non-metallic materials, use of aluminium alloy, titanium, stainless steel, plastics, composite materials and applications.

### UNIT V POWER PLANTS

9

Basics about piston, turbojet, turboprop and turbofan - concept of propeller and jets for thrust production, principles of operation of rocket, types of rockets and typical applications, exploration into space- India

**TOTAL: 45 PERIODS**

### OUTCOMES

- Identify the types and component of aircraft
- Understand properties of atmosphere
- Performs basic calculation on lift, drag and moment.
- Identifies suitable materials for aircraft structure
- Identifies types of jet and rocket engines

### TEXT BOOKS

1. Anderson, J.D., "Introduction to Flight", Tata McGraw-Hill, 2010.

### REFERENCES

1. Kermode, A.C., "Mechanics of Flight", Pearson Education; 11<sup>th</sup> edition.
2. Kermode, A.C., "Flight without Formula", Pearson Education; 5<sup>th</sup> edition .

**OBJECTIVES**

- To understand the principles of operation of jet and rocket propulsion.
- Also to understand about the types, operation and performance of various parts of the gas turbine engines.

**UNIT I FUNDAMENTALS OF GAS TURBINE ENGINES 8**

Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics.

**UNIT II BASICS OF GAS TURBINE ENGINE COMPONENTS 9**

Subsonic and supersonic inlets for gas turbine engines – inlet performance – axial flow and centrifugal flow compressors and their efficiencies & principle of operation – gas turbine combustion chambers & types – axial flow turbines and their performance – jet engine nozzles and their efficiency

**UNIT III RAMJET PROPULSION 8**

Operating principle of ramjet engine – various components of ramjet engines and their efficiencies – Combustion in ramjet engine – critical, subcritical and supercritical modes of operation -ramjet engine and its performance characteristics – sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets.

**UNIT IV HYPERSONIC AIRBREATHING PROPULSION 9**

Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion – salient features of scramjet engine and its applications for hypersonic vehicles – problems associated with supersonic combustion – engine/airframe integration aspects of hypersonic vehicles

**UNIT V ROCKET PROPULSION 10**

Operating principle – specific impulse of a rocket – internal ballistics –solid propellant rockets – selection criteria of solid propellants –liquid propellant rockets – selection of liquid propellants – various feed systems for liquid rockets -thrust control in liquid rockets – cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets - introduction to hybrid propulsion – advantages and limitations of hybrid propulsion -.Electrical propulsion – Arcjet, resistojet – MPD thrusters, nuclear propulsion.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Pearson education (2009).

**REFERENCES**

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Pearson Education Canada; 6th edition, 2008.
2. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.
3. “Rolls Royce Jet Engine”, Rolls Royce; 4th revised edition, 1986.
4. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition,2014.

<b>OAE1903</b>	<b>INTRODUCTION TO SPACE FLIGHT</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**UNIT I HISTORY OF INTERNATIONAL SPACE FLIGHT 8**

Manned space flight – Mercury, Gemini, Apollo, Skylab, Apollo-Soyuz, Space shuttle, Soviet manned spaceflights and International manned space flight. Unmanned space flight – Earth observation, space environment, planetary exploration, space exploration, commercial satellites, military satellites.

**UNIT II INDIAN SPACE RESEARCH ORGANIZATION 8**

Organisation structure, Test facilities, Launch facilities, tracking and control facilities, Launch vehicles – SLV, ASLV, PSLV, GSLV, GSLV III and future launch vehicles. Satellite programmes, human space flight programme. Chandrayaan, Mangalyaan

**UNIT III SKY COORDINATES AND MOTIONS 8**

Sky coordinates and motions - Earth Rotation - Sky coordinates - seasons - phases of the Moon - the Moon's orbit and eclipses - timekeeping (side real vs synodic period)

**UNIT IV ORBITAL PRINCIPLES 12**

Kepler's laws, Newton's laws - angular momentum, total energy, orbital velocities, orbital properties – field of view, ground track, maximum time in view, number of revolutions per day, and revisit time. Useful orbits – low earth orbits, polar orbits, geostationary orbits, sun-synchronous orbit. Orbit establishment, orbital maneuvers – simple impulse maneuver, Hoffmann transfer, simple plane changes

**UNIT V SATELLITE DESIGN 9**

Mission, payload, launch vehicle and site selection, subsystems - attitude reference and control, power, thermal, orbital maintenance, data handling, TT&C, onboard computer, structure. Ground support systems.

**TOTAL: 45 PERIODS**

**TEXT BOOKS**

1. Bruce A. Campbell and Samuel Walter McCandless, Jr., Introduction to Space Sciences and Spacecraft Applications, Gulf Professional Publishing (1996)

**REFERENCES**

1. 2. Brown, C. D., Spacecraft Mission Design , 2nd ed., AIAA Edu. Series (1998).
2. Escobal, P. R., Methods of Orbit Determination, 2nd ed., Krieger Pub. Co. (1976).
3. Web link: <https://www.isro.gov.in/>

<b>OAE1904</b>	<b>INDUSTRIAL AERODYNAMICS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES**

- To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

**UNIT I ATMOSPHERE 9**

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows

**UNIT II WIND ENERGY COLLECTORS 9**  
Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory

**UNIT III VEHICLE AERODYNAMICS 9**  
Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of racing car, trains and Hovercraft

**UNIT IV BUILDING AERODYNAMICS 9**  
Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, Building ventilation and architectural aerodynamics

**UNIT V FLOW INDUCED VIBRATIONS 9**  
Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

**TOTAL: 45 PERIODS**

#### **OUTCOMES**

- Use of aerodynamics for non- aerodynamics such as vehicle, building.
- Solve the problems and able to analyse vibrations during flow

#### **TEXT BOOKS**

1. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles", Plenum press, New York, 1978.
2. Sachs. P., "Winds forces in Engineering", Pergamum Press, 1978.

#### **REFERENCES**

1. Blevins. R.D., "Flow Induced Vibrations", Van Nostrand, 1990.
2. Calvent. N.G., "Wind Power Principles", Charles Griffin & Co., London, 1979.

## Open Electives offered by Automobile Engineering

Subject Code	Subject Name	Category	L	T	P	C
OAT1901	Automotive Systems	OE	3	0	0	3

<b>Course Objective:</b>							
1. To understand the basic knowledge about engine working, mounting and vehicle frames. 2. To review the knowledge about the constructional features various types of suspension systems. 3. To understand the basic working principles clutch, gearbox, transmission system 4. To understand the basic knowledge about automatic transmission and semi-automatic transmission system 5. To understand the working principle of various types of steering system, wheel alignment, wheel, tyres and types of rear axle drive and front axle types.							
<b>UNIT-I</b>	<b>ENGINE MOUNTING AND FRAME</b>						<b>9</b>
Vehicle Classification and Layouts Study various vehicle layouts as front engine and front wheel drive, front engine & rear wheel drive, rear engine & rear wheel drive, Four wheel drives, Chassis Frames and Body Types of Chassis frames & body							
<b>UNIT-II</b>	<b>SUSPENSION SYSTEM</b>						<b>9</b>
Material, Unitized construction Suspension System Purpose, Types of suspension system, Front and rear suspension, Coil spring, types of rubber & Leaf spring, Torsion bars, Shock absorbers, Air and rubber suspension, Plastic suspensions, Hydro-pneumatic suspension, Independent suspension							
<b>UNIT-III</b>	<b>CLUTCH, BRAKING SYSTEM</b>						<b>9</b>
Recent advances in Clutch and Brakes Electromagnetic and hydraulic clutches, Lining material, Release mechanism, Fluid flywheel Function, Internal expanding brakes, Brake lining material, Properties, Hydraulic braking system, Brake oil, Bleeding of brakes, Pneumatic braking system, Vacuum brakes, Exhaust brakes, Electrical brakes, Parking brake and braking efficiency							
<b>UNIT-IV</b>	<b>TRANSMISSION SYSTEM</b>						<b>9</b>
Components of transmission system, Automatic transmission system Semi-automatic and automatic transmission system Requirements, types, Torque converter, Hydro-static and hydro-dynamic transmission, Continuously variable transmission, Belt and friction drive							
<b>UNIT-V</b>	<b>STEERING, TYRE AND FINAL DRIVE</b>						<b>9</b>
Types of Steering system and Steering gears, Steering geometry, Wheel alignment, Power steering, Types of front axle & stub axles, Propellers shaft, Types of drive as torque tube and hotch kiss drive, Final drive types, Type of drive axles & differential – double reduction gear and clutch type differential, Fully or semi floating and three quarter floating, . Tractive efforts and draw bar pull, Tyres Types of wheel rims, Tread patterns, Types of tyres, Cross ply, Radial & tubeless tyres,							
<b>Total Contact Hours</b>						<b>:</b>	<b>45</b>

<b>Course Outcomes:</b>
1. Understand the engines mounting and the various types of frame and layouts. 2. Understand the different types of suspension systems. 3. Understand the functions of different types of clutches and brakes.

4. Understand the types of automatic transmission and semi-automatic transmission systems.
5. Understand the steering requirements and types of wheel rims, tyres, front and rear axle drive

**Text Books:**

1	Kirpal Singh, “Automobile Engineering Vol.1& 2”, Standard Publisher Distributors, 14 <sup>th</sup> Edition, 2017.
2	R.S. Khurmi& J. K. Guptha, “A Textbook of Machine Design”, 34th edition, S. Chand publication. 2014.
3	R K Rajput “ A Textbook of Automobile engineering” Lakshmi Publication pvt. Ltd.,
4	Automobile Engineering Vol-I & II Dr. K.M. Gupta

**REFERENCE BOOKS:**

1.	Devaradjane. Dr. G., Kumaresan. Dr. M., “Automobile Engineering”, AMK Publishers, 2013.
2.	Judge.A.W., “Modern Transmission System”, Chapman and Hall Ltd, 2000.
3.	Giri, N.K., “Automobile Mechanics”, Khanna publishers, New Delhi, 2007
4.	Automotive mechanics by W. Crouse, - TMH.
5.	Motor vehicle Newton and sted

Subject Code	Subject Name	Category	L	T	P	C
OAT1902	AUTOMOTIVE SENSORS AND ACTUATORS	OE	3	0	0	3

**Objectives:**

●	To make the students to understand the various types of sensors and its characteristics used in automobiles.
●	To make the students to understand the various types of sensors used for position and speed and their applications in automobiles.
●	To make the students to understand the various types of sensors used for acceleration, pressure, force and torque and their applications in automobiles.
●	To make the students to understand the various types of sensors used for temperature, flow and climate control and their applications in automobiles.
●	To make the students to understand the various types of optoelectronic sensors and Actuators used in automobiles

<b>UNIT-I</b>	<b>INTRODUCTION</b>	9
Automotive sensors, Terms and definitions, Automotive applications, Features of vehicle sensors, sensor classification based on application, types of characteristic curves, types of output signals, types of error signals, tolerance requirements, reliability. Main requirements and trends, overview of the physical effects for sensors, selection of sensors.		
<b>UNIT-II</b>	<b>POSITION, SPEED AND RPM SENSORS</b>	9
<b>Position sensors:</b> Characteristics, measured variables, Potentiometer sensors, magnetically inductive type sensors, Wave-propagation sensors, GPS position and distance travelled measurement. <b>Speed and rpm sensors:</b> measured variables, measuring principles, relative rpm and speed measurement, Absolute rotating speed measurement.		
<b>Applications: Accelerator-pedal sensors:</b> potentiometric accelerator pedal sensor, hall angular position sensors. <b>Engine speed sensors:</b> Inductive speed sensors, Active speed sensors, Hall phase sensors, Speed sensors for transmission control, Wheel speed sensors, Micromechanical yaw rate sensors, Piezoelectric-Tuning fork yaw rate sensor. <b>Position sensors for transmission control:</b> application, requirements, Linear position determination on the basis of Hall switches, Rotational position determination on the basis of eddy		

currents. <b>Steering angle sensors:</b> Application and operating principle of steering angle sensor. <b>Axle sensors:</b> Application and operating principle.		
<b>UNIT-III</b>	<b>ACCELERATION, PRESSURE, FORCE AND TORQUE SENSORS</b>	9
<p><b>Acceleration sensors:</b> measured variables, measuring principles: displacement or travel measuring system, systems for measuring mechanical stress, Thermal acceleration sensors, packaging. <b>Pressure sensors:</b> measured variables, Measuring principles: Direct pressure measurement, Diaphragm type sensors, transfer to a force sensor. <b>Force and torque sensors:</b> measured variables, measuring principles: Strain measuring force sensors, Travel measuring force sensors. <b>Torque sensor:</b> strain measuring sensor, angle measuring sensors, eddy current sensors.</p> <p><b>Applications: Acceleration sensors:</b> Surface micromechanical (SMM) acceleration sensors, Micromechanical bulk silicon acceleration sensors, piezoelectric acceleration sensors. <b>Micro mechanical pressure sensors:</b> application, Version with the reference vacuum on the component side, version with reference vacuum in a special chamber, High pressure sensors. <b>Force sensor, Torque sensor, Piezoelectric knock sensors:</b> application and operating principle, mounting.</p>		
<b>UNIT-IV</b>	<b>TEMPERATURE, FLOW AND CLIMATE CONTROL SENSORS</b>	9
<p><b>Temperature sensors:</b> Measured variables, measuring principles for direct contact sensors: Resistive sensors, sintered ceramic NTC resistors, PTC thin-film / thick-film metallic resistors, thick film resistors (PTC/NTC), mono crystalline silicon semiconductor resistors (PTC), Thermocouples, semiconductor depletion layers. Measuring principles for non-contacting temperature measurement: bolometer, thermopile sensor, single point sensors, imaging sensors. <b>Flow meters:</b> measured variables, Measuring principles. <b>Gas sensors and concentration sensors:</b> measured variables, Measuring principles</p> <p><b>Applications: Temperature sensors:</b> Application: engine temperature sensor, air temperature sensor, engine oil temperature sensor, fuel temperature sensor, exhaust gas temperature sensor, operating principles. <b>Hot film air mass meters:</b> application, HFM5 type, HFM6 type. <b>Climate control sensor.</b></p>		
<b>UNIT-V</b>	<b>OTHER SENSORS AND ACTUATORS</b>	9
<p><b>Optoelectronic sensors:</b> Internal photoelectric effect, Light sensitive sensor elements: photo resistors, semiconductor PN junctions, Imaging sensors: intergrading photodiodes, CCD imaging sensors, CMOS imaging sensors. Applications of optoelectronics sensors.</p> <p><b>Other Sensors:</b> Working principle of Ultrasonic sensor, Rain/light sensor, Dirt sensor, Two step lambda oxygen sensors, Planar wide band lambda oxygen sensors, crash sensor.</p> <p><b>Actuators:</b> Working principle and applications of solenoids, relays, piezo actuators and electric motors: stepper motors, permanent magnet field motors. Applications: Solenoid and Piezo based fuel injectors, Starter motor relay function, windshield wiper operation</p>		
		<b>Total Contact Hours : 45</b>

<b>Course Outcomes:</b>	
On completion of the course students will be able to	
●	The students will be able to explain the working of various sensors and its characteristics used in automobiles.
●	The students will be able to explain the working and selection of various sensors used to determine position and speed in automobiles.
●	The students will be able to explain the working and selection of various sensors used to determine acceleration, pressure, force and torque in automobiles.
●	The students will be able to explain the working and selection of various sensors used to determine temperature, flow and climate control in automobiles.
●	The students will be able to explain the working and selection of optoelectronic sensors and actuators used in automobiles.

<b>Text Books:</b>	
1	Automotive Sensors by Robert Bosch GmbH, 2007
2	Joseph Bell —Diesel Engineering – Electricity and Electronics  Cengage learning, Indian Edition, 2007.

<b>Reference Books / Web links:</b>	
1	Steve V. Hatch —Electronic Engine controls  Cengage learning, Indian Edition, 2009
2	Sean Bennett —Diesel Engineering – Electronic diesel engine diagnosis  Cengage learning, Indian Edition, 2007.
3	Ian Sinclair, —Sensors and Transducers , Newnes, Elsevier, Indian Edition, 2011

<b>OAT1903</b>	<b>Elements of Electric and Hybrid Vehicles</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>OBJECTIVES:</b>						
<ol style="list-style-type: none"> <li>To understand the need for alternative power train system</li> <li>To provide adequate knowledge in high energy and power density batteries and fuel cells.</li> <li>To give basic knowledge in power controls and motors used in EV and HEV applications.</li> <li>To make the students understand the calculations involved in the basic design of electric vehicle</li> <li>To understand the fundamentals of hybrid electric vehicle</li> </ol>						
<b>UNIT I      NEED FOR ALTERNATIVE SYSTEM      9</b>						
Energy demands for transportation sector- Emission regulations-Need of electric vehicles hybrid vehicles – comparative study of diesel, petrol, pure electric and hybrid vehicles. Limitations of electric vehicles. Basic layout of electric and hybrid vehicles						
<b>UNIT II      ENERGY SOURCES : BATTERIES AND FUEL CELLS      9</b>						
Battery Parameters-Power requirement of electric vehicles- Different types of batteries - Lead acid- Nickel based-Sodium based-Lithium based- Metal Air based. Battery charging- Charger design- Quick charging devices- Charging profile for batteries. Battery Management System. Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series- water management in the PEM fuel cell- Thermal Management of the PEM fuel cell						
<b>UNIT III      TRACTION MOTORS AND CONTROLLERS      12</b>						
Requirements of motors for EV and HEV application. Characteristic of permanent magnet and separately excited DC motors.PMSM and SRM motors- AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers. DC-DC convertors – AC-DC convertors. DC-AC convertors.						
<b>UNIT IV      VEHICLE DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES      6</b>						
Aerodynamic-Rolling resistance- Transmission efficiency- Vehicle mass- Electric vehicle chassis and Body design considerations - Gradability requirements. Heating and cooling systems- Controllers- Power steering- Tyre choice- Wing Mirror, Aerials and Luggage racks						
<b>UNIT V      HYBRID VEHICLES      9</b>						
Concept of hybridization. Types of Hybrid- Series, parallel, split – parallel, series - parallel - Advantages and Disadvantages. Power split device – Energy Management System - Design consideration - HEV driving modes. Plug-in hybrid vehicles. Case study – Toyota prius, Honda civic.						
<b>TOTAL :    45 PERIODS</b>						

<b>COURSE OUTCOMES:</b>	
<ol style="list-style-type: none"> <li>1. The students will be able to explain the need for alternative power trains for automobiles.</li> <li>2. The students will be able to explain about high energy and power density batteries and fuel cells.</li> <li>3. The students can suggest the type of motor that can be used for a particular type of EV.</li> <li>4. The students can calculate the different resistance experienced by the automobile and suitability arrive at the power requirement need for EV propulsion.</li> <li>5. The students will be able to discuss about the fundamentals of hybrid electric vehicles.</li> </ol>	
<b>TEXT BOOKS:</b>	
1	James Larminie and John Lowry, “Electric Vehicle Technology Explained “ John Wiley & Sons,2003
2	Iqbal Husain, “ Electric and Hybrid Vehicles-Design Fundamentals”, CRC Press,2003
3	MehrdadEhsani, “ Modern Electric, Hybrid Electric and Fuel Cell Vehicles”, CRC Press,2005
<b>REFERENCE BOOKS:</b>	
1	Ron HodKinson, “light Weight Electric/ Hybrid Vehicle Design”, Butterworth Heinemann Publication,2005
2	Lino Guzzella, “ Vehicle Propulsion System” Springer Publications,2005

OAT1904	FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS	Category	L	T	P	C
		OE	3	0	0	3
<b>OBJECTIVES:</b>						
<ol style="list-style-type: none"> <li>1. To learn about the fundamental principles of automotive electronics</li> <li>2. To know about the various sensors used in automobiles</li> <li>3. To know about the electronic engine management systems for Petrol engines</li> <li>4. To know about the electronic engine management systems for diesel engines</li> <li>5. To understand the chassis management systems used in modern vehicles</li> </ol>						
<b>UNIT I</b>	<b>FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS</b>	<b>9</b>				
Microprocessor architecture, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Parameters to be controlled in SI and CI engines and in the other parts of the automobile.						
<b>UNIT II</b>	<b>SENSORS</b>	<b>9</b>				
Inductive, Hall effect, hot wire anemometer, thermistor, piezo electric, piezo resistive, based sensors. Throttle position, air mass flow, crank shaft position, cam position, engine and wheel speed, steering position, tire pressure, brake pressure, steering torque, fuel level, crash, exhaust oxygen level (two step and linear lambda), knock, engine temperature, manifold temperature and pressure sensors.						
<b>UNIT III</b>	<b>SI ENGINE MANAGEMENT</b>	<b>9</b>				
Three-way catalytic converter, conversion efficiency versus lambda. Layout and working of SI engine management systems like Bosch L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Working of the fuel system components. Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cut off. Fuel control maps, open loop control of fuel injection and closed loop lambda control. Electronic ignition systems and spark timing control. Closed loop control of knock.						

<b>UNIT IV</b>	<b>CI ENGINE MANAGEMENT</b>	<b>9</b>
Fuel injection system parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valves		
<b>UNIT V</b>	<b>VEHICLE MANAGEMENT SYSTEMS</b>	<b>9</b>
Electric power steering, Supplementary Restraint System of air bag system – crash sensor, seat belt tightening. Cruise control. Vehicle security systems- alarms, vehicle tracking system. On board diagnostics. Collision avoidance Radar warning system		
		<b>TOTAL : 45 PERIODS</b>

<b>COURSE OUTCOMES:</b>	
<ol style="list-style-type: none"> <li>1. The student will be able to explain the various control strategies used in automotive electronics</li> <li>2. The student will be able to explain the working principle of various sensors and its applications in automobiles</li> <li>3. The student will be able to explain various principles involved in electronic engine management systems for Petrol engines</li> <li>4. The student will be able to explain various principles involved in electronic engine management systems for diesel engines</li> <li>5. The student will be able to explain the control system operation behind the function of various chassis management systems</li> </ol>	
<b>TEXT BOOKS:</b>	
1	William B Ribbens“Understanding Automotive Electronics”, SAE Publications, 1998
2	Eric Chowanietz“Automobile Electronics” SAE Publications, 1994
<b>REFERENCE BOOKS/WEBLINK:</b>	
1	Robert Bosch,“Diesel Engine Management”,SAE Publications, 2006
2	Robert Bosch, “Gasoline Engine Management” SAE Publications, 2006
3	<a href="https://nptel.ac.in/courses/108/108/108108147/">https://nptel.ac.in/courses/108/108/108108147/</a>



**OUTCOMES:**

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

- explain basics of human body and structure and functions of cell
- learnt about anatomy and physiology skeletal and muscular systems of human body
- explain important aspects of cardiovascular and respiration systems.
- learnt about anatomy and physiology of neural and special sensory systems
- explain the significance of digestive and urinary systems

**TEXT BOOK:**

1. Elaine.N. Marieb , “Essential of Human Anatomy and Physiology”, Eight Edition, Pearson Education, New Delhi

**REFERENCES:**

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, “Fundamentals of Anatomy and Physiology”. Tenth Edition, Pearson Publishers
2. Gillian Pocock, Christopher D. Richards, “The human Body – An introduction for Biomedical and Health Sciences”, Oxford University Press, USA
3. William F.Ganong, “Review of Medical Physiology”, 22nd Edition, Mc Graw Hill, New Delhi.
4. Eldra Pearl Solomon, “Introduction to Human Anatomy and Physiology”, 2nd edition, W.B. Saunders Company
5. Guyton & Hall, “Medical Physiology”, 13th Edition, Elsevier Saunders

**OBM1902**

**BIOMATERIALS AND ARTIFICIAL ORGANS**

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

**OBJECTIVES:**

- To learn characteristics and classification of Biomaterials.
- To understand different metals and ceramics used as biomaterials.
- To study the different polymeric materials.
- To know the different types of soft and hard tissue implants.
- To learn artificial organ developed using these biomaterials.

**UNIT I INTRODUCTION TO BIO-MATERIALS**

**9**

Definition and classification of bio-materials, Characterization of biomaterials: mechanical properties, surface properties, wound healing process, body response to implants, blood compatibility.

**UNIT II METALLIC AND CERAMIC MATERIALS**

**9**

Metallic implants : Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy. Ceramic implant: bioinert, biodegradable or bio resorbable, bioactive ceramics, applications of ceramic and metallic implants.

**UNIT III POLYMERIC IMPLANT MATERIALS**

**9**

Polymerization, factors influencing the properties of polymers, polyamides, Acrylic polymers, rubbers, high strength Thermoplastic, Bio polymers: Collagen and Elastin, Medical Textiles: Silica, Chitosan, PLA composites, medical applications.

**UNIT IV TISSUE REPLACEMENT IMPLANTS****9**

Soft tissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, Internal fixation device, joint replacements.

**UNIT V ARTIFICIAL ORGANS****9**

Artificial blood, Artificial skin, Artificial Heart, Cardiac pacemaker, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants.

**TOTAL: 45 PERIODS****OUTCOMES:**

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

- Analyze different types of Biomaterials and its classification.
- Identify metals and ceramic implants used for medical applications
- Compare different types of synthetic and bio polymers as biomaterials.
- Perform combinations of materials that could be used as a tissue replacement implant.
- Explain the working of heart lung machine, dialysis unit and other artificial organs.

**TEXT BOOKS:**

1. Sujata V. Bhatt, "Biomaterials", Second Edition, Narosa Publishing House, 2005.
2. Park J.B, R.SLakes "Biomaterials An Introduction", Springer, 2007.

**REFERENCES:**

1. Joseph D Bronzino, "Biomedical engineering Fundamentals", CRC press, Third Edition, 2006.
2. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran, "Woodhead Medical Textiles and Biomaterials for Healthcare", Publishing Limited 2006.
3. Andrew F.VonRacum, "Handbook of Biomaterials Evaluation: Scientific, Technical and Clinical Testing of Implant Materials", Second Edition, CRC Press, 1998.
4. BD Ratner, AS Hoffmann, FJ Schoen, JE Lemmons, "An Introduction to Materials in Medicine" Academic Press, Third Edition, 2013

**OBM1903****FUNDAMENTALS OF MEDICAL INSTRUMENTATION**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES**

- To study the methods of recording various bio potentials
- To study how to measure biochemical and various physiological information
- To understand the working of units which will help to restore normal functioning of human
- To understand the use of radiation for diagnostic and therapy
- To understand the need and technique of electrical safety in Hospitals

**UNIT I ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING****9**

The origin of Bio-potentials; biopotential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, EOG, lead systems and recording methods, typical waveforms and signal characteristics.

**UNIT II BIOCHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT****9**

PH, PO<sub>2</sub>, PCO<sub>2</sub>, PHCO<sub>3</sub>, Electrophoresis, colorimeter, photometer, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood cell counters.

<b>UNIT III</b>	<b>ASSIST DEVICES AND BIO-TELEMETRY</b>	<b>9</b>
Cardiac pacemakers, DC Defibrillator, Telemetry principles, frequency selection, Biotelemetry, radio-pill and tele-stimulation.		
<b>UNIT IV</b>	<b>RADIOLOGICAL EQUIPMENTS</b>	<b>9</b>
Ionising radiation, Diagnostic x-ray equipments, use of Radio Isotope in diagnosis, Radiation Therapy.		
<b>UNIT V</b>	<b>RECENT TRENDS IN MEDICAL INSTRUMENTATION</b>	<b>9</b>
Thermograph, endoscopy unit, Laser in medicine, Diathermy units, Electrical safety in medical equipment.		

**TOTAL: 45 PERIODS**

**OUTCOMES:**

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

- To analyze the methods of recording various bio potentials.
- To measure biochemical and various physiological information.
- To develop working units which will help to restore normal functioning of human.
- To identify the appropriate radio isotope in diagnosis.
- To apply electrical safety procedures in Hospitals.

**TEXT BOOK:**

1. Leslie Cromwell, "Biomedical instrumentation and measurement", Prentice Hall of India, New Delhi, 2007.

**REFERENCES:**

1. Khandpur, R.S., "Handbook of Biomedical Instrumentation", TATA McGraw-Hill, New Delhi, 2003.
2. Joseph J.Carr and John M.Brown, "Introduction to Biomedical equipment Technology", John Wiley and Sons, New York, 2004.

<b>OBM1904</b>	<b>ENGINEERING MECHANICS FOR MEDICAL APPLICATIONS</b>	<b>L T P C</b>
		<b>3 0 0 3</b>

**OBJECTIVES:**

- Understand the fluid mechanics.
- Learn the mechanics of physiological systems.
- Be familiar with the mathematical models used in the analysis of biomechanical systems.
- Be exposed to the advancements in biomechanics.

<b>UNIT I</b>	<b>BIO-FLUID MECHANICS</b>	<b>9</b>
Newton's laws, Stress, Strain, Elasticity, Hooks-law, viscosity, Newtonian fluid, Non-Newtonian fluid, Viscoelastic fluids, vascular tree, Relationship between diameter, velocity and pressure of blood flow, Resistance against flow. Bioviscoelastic fluid: Viscoelasticity - Viscoelastic models, Maxwell, Voight and Kelvin Models, Response to Harmonic variation, Use of viscoelastic models, Bio- Viscoelastic fluids: Protoplasm, Mucus, Saliva, Synovial fluids.		



## Open Electives offered by Bio-Technology Engineering

S. No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	OBT1901	Food and Healthy Living	OE	3	3	0	0	3
2	OBT1902	Man and Microbes	OE	3	3	0	0	3
3	OBT1903	Basic Bioinformatics	OE	3	3	0	0	3
4	OBT1904	Biotechnology in Product Development	OE	3	3	0	0	3
5	OBT1905	Medical Sciences for Engineers	OE	3	3	0	0	3
6	OBT1906	Application of Biotechnology for Environmental protection	OE	3	3	0	0	3
7	OBT1907	Fermentation Technology	OE	3	3	0	0	3

<b>OBT1901</b>	<b>FOOD AND HEALTHY LIVING</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### Course objectives:

This course will enable the students

- To develop comprehensive understanding of different nutraceuticals and functional foods.
- To understand the potential of various functional foods in promoting human health.
- To familiarize students with food preservation, spoilage and basic techniques used in identification of food adulterants.

### **UNIT I CHEMISTRY AND BIOCHEMISTRY OF FOOD 9**

Introduction, Classification, digestion, functions, dietary sources, food nutrients- Carbohydrates, Proteins, Lipids, Vitamins, Water, Minerals, Trace elements and its importance, Physico-chemical and functional properties, clinical manifestations of deficiency, factors affecting absorption food nutrients.

### **UNIT-II MICROBIOLOGY OF FOOD 6**

Sources of microorganisms in foods: Common types of spoilage producing microbes, type's fruits and vegetables involved: Fermented foods and beverages: Food borne diseases and its control measures.

### **UNIT-III FOOD PROCESSING, PRESERVATION AND ENGINEERING 10**

General principles of food preservation, Food processing and preservation by Dehydration, Food preservation by application of heat (Blanching, Pasteurization and canning), Freezing /Refrigeration and Irradiation, Food unit operation-Separation, concentration and Evaporation, Packaging.

### **UNIT-IV NUTRITION FOR HEALTH AND FITNESS 10**

Nutritional requirements of children, adult, pregnant women: Malnutrition- Etiology and management: Significance of physical fitness and nutrition in the prevention and management of obesity, diabetes weight control, cardiovascular disorders, tumor and bone health: Concept of Public health nutrition and its impotence: Environment and health (Water, Air): Major nutritional problems: Etiology, prevalence, clinical manifestations and Prevention.

**UNIT-V APPLIED FOOD SCIENCE AND QUALITY MANAGEMENT****10**

Concept of balanced Diet, Food Groups: Food adulteration- common adulterants, techniques used identify the food adulterants, **Food quality and Safety Management System- ISO 22000, GMP, GHP, HACCP, FSMS, FSSAI**, Entrepreneurial development- Business opportunity Identification, Assessment, development of entrepreneurial skills and become a successful entrepreneur.

**Total Contact Hours : 45****Course outcomes:**

Upon completion of the course, the students will be able to

- Understand different nutraceuticals and functional foods.
- Know the potential of various functional foods in promoting human health.
- Familiarize with food preservation, spoilage and basic techniques used in identification of food adulterants.

**Text/Reference books:**

- Frazier, W.C. and Westhoff, D.C. (1998) : Food Microbiology. Tata McGraw Hill Book 12. Company, New Delhi, 4th Edition.
- Sizer, F & Whitney, E. (2000); Nutrition Concepts & Controversies. 8 . th Edition, Wadsworth, An International Thomson Publishing Co.
- Sivasankar, B. (2002) Food Quality, in Food Processing and Preservation. Prentice-Hall of India Private Limited, New Delhi, 345.
- L.K. & Ecott Stump, S.(2000): Krause’s Food Nutrition and Diet therapy. Edition, W.B. .Saunders Ltd.
- Whitney, E.N. & rolfes, S.R. (1999); Understanding Nutrition, 8 . th Edition, West/ Wadsworth Thomson learning.
- Vasant Desai (2012) Fundamentals of Entrepreneurship and Small Business Management, Himalya Publishing House Pvt. Ltd., Mumbai.

**OBT1902****MAN AND MICROBES****Category****L T P C****OE****3 0 0 3****Course objectives:**

This course will enable the students to

- Understand the base of microbes in day- today life.
- Apply analytical skills using microscopy.
- Understand the role of pathogens in common man life.
- Gain knowledge about industrial applications of beneficial microbes
- Learn about various diseases caused due to pollution in the environment.

**UNIT I INTRODUCTION TO MICROBIOLOGY 9**

History (scientists and discoveries) and scope of microbiology, Concept of single celled organisms. Concept of species and strains. Classification and nomenclature of microorganisms. General properties of bacteria, viruses, algae, fungi, yeast and actinomycetes. Greatest evolution of microbiology in 20th century: Confutation of a biogenesis: discovery of penicillin: discovery of vaccination.

**UNIT-II MICROSCOPY 6**

**Principles and applications:** Bright field microscope, Dark field Microscope, Fluorescent Microscope, Phase contrast Microscope and Electron Microscopy (SEM and TEM)

**UNIT-III EPIDEMIOLOGY AND PATHOGENESIS OF MICROBES 10**

Principles of epidemiology (Epidemic, Endemic and Pandemic), Current Epidemics (AIDS, Nosocomial, Acute respiratory Syndrome). Entry of pathogens into the host, types of bacterial pathogens, Mechanism of bacterial pathogenicity, colonization and growth, Virulence, Virulence factors – exotoxins, enterotoxins, endotoxins, neurotoxins – avoidance of host defense mechanisms, damage to host cell, Host factors for infection and innate resistance to infection.

**UNIT-IV INDUSTRIAL APPLICATION OF MICROBES 10**

Fermentation and its uses. Outline of the production of Antibiotics-Penicillin, Beer, Wine, Vinegar; Microbiologically fermented food products- Curd, cheese and yogurt; Biofertilizers – *Rhizobium*, Biopesticides – *Bacillus thuringiensis*; Probiotics; Bioremediation.

**UNIT-V ENVIRONMENTAL MICROBIOLOGY 10**

**Soil microbiology-** Soil microorganisms, Role microbes in biogeochemical cycles, carbon, nitrogen, sulfur cycle (outline only), different kinds of association between soil microflora, methane production. Air microbiology- Microorganisms in the air, sampling techniques, air borne pathogens. Microbiology of water- Microbiology of fresh water and wastewater (sewage), BOD, COD (definitions), general outline of water treatment process: (Sedimentation, Activated sludge and Trickling filter process).

**Total Contact Hours : 45**

**Course outcomes:**

Upon completion of the course, the students will be able to

- Gain knowledge about different microbes
- Apply analytical skill using microscopy
- Gain knowledge about the pathogens
- Understand the microbes in a variety of industrial applications
- Be aware of the diseases caused due to environment

**Text/Reference books:**

- Stanier RY, Ingrahm JI, Wheelis ML and Painter PR.—General Microbiology. 15<sup>th</sup> edition, McMillan Press. 1986.
- Ananthanarayanan, R. and C.K. Jayaram Paniker, —Textbook of Microbiology, 4<sup>th</sup> Edition, Orient Longman, 1990.
- Schlegel, H.G.—General Microbiology, 7<sup>th</sup> Edition, Cambridge University Press, 1993.
- Prescott, S.C. and Cecil G. Dunn, —Industrial Microbiology, Agrobios (India), 2005.

**Course objectives:**

This course will enable the students

- This course aims to develop the skills of the students in Bioinformatics. At the end of this course, the students would have learnt about powerful OS, Unix and get exposure to R and open source software package Bioconductor for biological data analysis
- The objectives are to familiarize students with different biological databases and how to retrieve data.
- Learn about different sequence analysis algorithm including machine learning and statistical methods
- Learn regarding evolution of protein and nucleotide sequences
- The another objectives are to familiarize students with high throughput biological data and their analysis

**UNIT I INTRODUCTION 9**

Basic UNIX commands – telnet – ftp – protocols – search engines – search algorithms – Introduction to R/Bioconductor.

**UNIT-II DATABASES 9**

Data management – data life cycle – database technology – interfaces and implementation – different biological databases and their uses

**UNIT-III SEQUENCE ALIGNMENT, PATTERN MATCHING AND STATISTICAL METHODS 9**

Pairwise sequence alignment – local vs. global alignment – multiple sequence alignment – dot matrix analysis – substitution matrices – dynamic programming – bayesian methods – tools – BLAST – FASTA- machine learning – neural networks – statistical methods – Hidden Markov models

**UNIT-IV PHYLOGENY 9**

Introduction; mutations; irrelevant mutations; controls; mutations as a measure of time; distances; reconstruction; distances between species; estimating time intervals from distances.

**UNIT-V ADVANCED TOPICS IN BIOINFORMATICS 9**

Concept of Central Dogma, Gene, Genome, Proteome, Pathway, Gene Expression Data. Examples of high throughput data analysis and data visualisation. Scatter plots Heat maps.

**Total Contact Hours : 45**

**Course outcomes:**

Upon completion of the course, the students will be able to

- Apply UNIX commands and R to analyse different types of files of biological data
- Retrieve biological information from databases and analyse them.
- Use machine learning techniques and statistical methods to analyse biological sequences
- Gain knowledge regarding evolution of protein and nucleotide sequences.
- Use high throughput data visualisation techniques to understand sequencing and microarray data.

**Text/Reference books:**

- B. Bergeron, Bioinformatics Computing, PHI, 2002.
- Westhead, D.R., Parish, J.H., Twyman, R.M., Instant Notes In Bioinformatics, BIOS Scientific Publishers, 2000.
- C. Gibas& P. Jambeck, Developing Bioinformatics Skills, O'Reilly, 1999.

<b>OBT1904</b>	<b>BIOTECHNOLOGY IN PRODUCT DEVELOPMENT</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course objectives:**

This course will enable the students to

- Gain knowledge about biotechnology industry and technology.
- Learn about bioentrepreneurship and start-up of biotech companies.
- Demonstrate the wide spectrum of possible biotechnology intervention
- Learn about bioethical issues in developing and marketing biotech products to the public.
- Understand the intricacies of product commercialisation.

**UNIT I OVERVIEW OF BIOTECHNOLOGY INDUSTRIES 9**

Scope - Biotechnology Industries in India and Abroad - Fundamentals of Biotechnology for business - Trends and key issues in Biotechnology, Technology basis in industrial segment, emerging technologies and technical convergences issues.

**UNIT-II NEW VENTURE CREATION 9**

Entrepreneurship Plant tissue culture lab construction – Equipment, glassware and chemical requirements - techniques in culturing of plants. Export of tissue cultured plants to abroad – Vermitechnology – Mushroom cultivation - single cell protein - Biofertilizer technology and production - Commercialization of R&D - Fermentation technology: Bakery, Dairy products.

**UNIT-III PRODUCT DEVELOPMENT 9**

Beer, wine and ethanol production using different sources– Enzyme: production, purification and characterization - Organic acids (Citric, lactic) production - Antibiotic production - Biogas technology - Azolla cultivation, biocement - Product development and project management, transition from R&D to business units. Institute– industry interaction and partnership/ alliances.

**UNIT-IV INTELLECTUAL PROPERTY RIGHTS 9**

Bioethics and Legal Issues - Intellectual property rights in Biotech, Patent laws - Bioethics and current legal issues - Marketing and public perceptions in product development – Genetically modified products and organisms (Transgenic products), Technology licensing and branding concerns.

**UNIT-V BUSINESS PLANS FOR BIOTECHNOLOGISTS 9**

Healthcare, Biomedical Sciences, Agriculture and Agrobiotechnology. Transfer and business planning - Bank loan and finance strategy – Budget plan – licensing and Branding Concerns and Opportunities, Policy and regulatory Concerns and Opportunities. Financial assistance for R&D projects and entrepreneurship. Corporate partners marketing – Model project: Case studies of different industries and their strategic planning.

**Total Contact Hours : 45**

**Course outcomes:**

Upon completion of the course, the students will

- Know various areas of biotechnology industries in India and abroad based on industry segment
- Understand the intricacies in developing new ventures in biotechnology
- Identify the domains that are ripe for bioproduct interventions
- Develop and market bioproducts within legal and ethical structures
- Plan how to commercialize various bioproducts from R&D stage to business units

**Text/Reference books:**

- Richard Oliver. “The coming Biotech age: The business of Biomaterials”, McGraw Hill Publications, New York, USA, 2000.
- Karthikeyan, S. and Arthur Ruf, “Biobusiness”.MJP Publications. Chennai, India. 2009.
- Ruth Ellen Bulger. “The ethical dimensions of the Biological sciences: Cambridge University Press”. New York. 1993.
- GurinderShahi. “BioBusiness in Asia: How countries Can Capitalize on the Life Science Revolution” Pearson Prentice Hall, 2004.
- Cynthia Robbins., “The business of Biotechnology”, UK, HarperCollins, 2001.

<b>OBT1905</b>	<b>MEDICAL SCIENCES FOR ENGINEERS</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course objectives:**

This course will enable the students

- To create awareness among students about the various lifestyle diseases
- To make consciousness about drug, alcohol and self-medication
- To enable the students to create a consciousness on stress management
- To develop the knowledge of students on the clinical symptoms of common diseases

**UNIT I INTRODUCTION TO LIFESTYLE DISORDERS 9**

Lifestyle disorders- causes, symptoms and management – obesity, diabetics, CVDs, Cancer, ulcer, stones etc., and their relation to living environment.

**UNIT-II RISK FACTORS AND DRUG ABUSE 9**

Drug abuse and drug induced toxicities- hazards of smoking, alcohol and related diseases, self-medication.

**UNIT-III HEALTHY LIVING 9**

Importance of balanced diet, adequate water intake, mental health – stress and how to overcome stress. Importance of antioxidants.PUFA, EAA and EFA in diet, exercise, yoga.

**UNIT-IV PREVENTION AND MANAGEMENT OF COMMON ILLNESS 9**

Clinical Symptoms of common illness, their prevention and management (eg. Common cold, dehydration, food poisoning etc.).

**UNIT-V MOLECULAR MECHANISM****9**

Basic molecular mechanism - etiology and treatment of common diseases. Discussion and brain storming sessions with specific case studies.

**Total Contact Hours : 45****Course outcomes:**

Upon completion of the course, the students will be able to

- Understand the lifestyle disorders and diseases.
- Conscious about drug, alcohol and self-medication
- Handle stress and how to manage.
- Understand clinical symptoms and molecular mechanism of common diseases.
- Comprehend molecular mechanism of general diseases.

**Text/Reference books:**

- Guide to prevention of lifestyle diseases- M.N. Kumar, R.Kumar, Deep & Deep Publications, ISBN: 817629518.
- Textbook of Biochemistry: With Clinical Correlations by Thomas M. Devlin, 7<sup>th</sup> edition, John Wiley & son inc.
- The BASIC – Strategies for coping with stress and building personal resilience for physicians. OMA. <http://php.oma.org/PDF%20files/The%20Basics/TheBasics-full%20version.pdf>
- The health consequences of smoking—50 years of progress: a report of the Surgeon General. U.S. Department of Health and Human Services, 2014.<http://www.surgeongeneral.gov/library/reports/50-years-of-progress/exec-summary.pdf>

<b>OBT1906</b>	<b>APPLICATION OF BIOTECHNOLOGY FOR ENVIRONMENTAL PROTECTION</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**Course objectives:**

This course will enable the students to

- Gain sound knowledge about the scientific and engineering principles of microbiological treatment technologies to clean up contaminated environments and to generate valuable resources for the human society.
- Have indepth knowledge about Conventional treatment methodologies that can be replaced with the advancements in biotechnological field such as molecular biology and genetic engineering strategies.
- Study the ways for the alternate sources of energy to avoid environmental issues.

**UNIT I INTRODUCTION****9**

Microbial flora of soil, Ecological adaptations, Interactions among soil microorganisms, biogeochemical role of soil microorganisms. Biodegradation, Microbiology of degradation and its mechanism, Bioaugmentation, Biosorption, Bioleaching, Bioremediation- Types of Bioremediation, Bioreactors for Bioremediation, Metabolic pathways for Biodegradation for specific organic pollutants.

**UNIT-II CONVENTIONAL METHODS OF POLLUTANT TREATMENT****9**

Pollution- Sources of pollutants for Air, Water, and Land and its characteristics- Environmental monitoring & sampling - Air pollution- control. Modes of Biological treatment methods for wastewater- aerobic digestion, anaerobic digestion, Anoxic digestion, the activated sludge process, Design and modeling of activated sludge processes, Aerobic digestion, Design of a trickling biological filter, Design of anaerobic digester.

**UNIT-III INDUSTRIAL WASTE MANAGEMENT****9**

Industrial waste management- Dairy, Paper & Pulp, Textile, leather, hospital and pharmaceutical industrial waste management, e-waste- radioactive and nuclear power waste management- Solid waste management

**UNIT-IV MOLECULAR BIOLOGY TECHNIQUES****9**

Molecular biology tools for Environmental management, rDNA technology in waste treatment, Genetically modified organisms in Waste management, Genetic Sensors, Metagenomics, Bioprospecting, Nanoscience in Environmental management, Phytoremediation for heavy metal pollution, Biosensors development to monitor pollution.

**UNIT-V MODERN TECHNOLOGIES TO PROTECT ENVIRONMENT****9**

Alternate Source of Energy, Biomass as a source of energy, Biocomposting, Vermiculture, Biofertilizers, Organic farming, Biofuels, Biomineralization, Bioethanol and Biohydrogen, Bioelectricity through microbial fuel cell, energy management and safety.

**Total Contact Hours : 45****Course outcomes:**

Upon completion of the course, the students will be able to

- Understand about the microbial flora, bioremediation and biodegradation of organic pollutants.
- Learn about various types of pollution, its control and management.
- Gain knowledge about waste management in various industries like dairy, paper, textile and solid waste management.
- Learn about molecular biology tools for environmental protection.

**Text/Reference books:**

- Environmental Biotechnology by Alan Scragg (1999); Longman.
- Chakrabarty K.D., Omen G.S., Biotechnology And Biodegradation, Advances In Applied Biotechnology Series, Vol.1, Gulf Publications Co., London, 1989.
- Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) McGraw Hill.
- Environmental Biotechnology, Forster, C. F and Waste, D.A. J. (1987) Ellis Horwood Halsted Press.
- Biochemical Engineering Fundamentals 2nd Ed. Bailey, J. E. and Ollis, D. F. (1986) Mac Graw Hill, New York.
- Stanier R.Y., Ingraham J.L., Wheelis M.L., Painter R.R., General Microbiology, Mcmillan Publications, 1989.
- New Processes of Waste water treatment and recovery. G.Mattock E.D. (1978) Ellis Horwood.
- Environmental Biotechnology, Jogdand, S.N. (1995) Himalaya Publishing House, New Delhi.

**REFERENCES**

1. Stanier R.Y., Ingraham J.L., Wheelis M.L., Painter R.R., General Microbiology, Mcmillan Publications, 1989.
2. New Processes of Waste water treatment and recovery. G.Mattock E.D. (1978) Ellis Horwood.
3. Environmental Biotechnology, Jogdand, S.N. (1995) Himalaya Publishing House, New Delhi.

**Course objectives:**

This course will enable the students

- To impart knowledge on design and operation of fermentation processes with all its prerequisites
- To learn about different media and sterilization techniques employed in fermentation
- To learn the production of primary and secondary metabolites for various industrial applications
- To instruct the important concepts in fermentation engineering

**UNIT I OVERVIEW OF FERMENTATION PROCESSES 9**

Basic configuration of fermentor and ancillaries, General requirements of fermentation processes, main parameters to be monitored and controlled in fermentation processes. Methods of Fermentation: Batch, Fed Batch and Continuous. Types of fermenters.

**UNIT-II RAW MATERIALS AND MEDIA DESIGN FOR FERMENTATION PROCESS 9**

Criteria for good medium, medium requirements for fermentation processes, Types of medium, medium formulation of optimal growth and product formation, design of various commercial media for industrial fermentations, medium optimization methods.

**UNIT-III STERILIZATION KINETICS 6**

Thermal death kinetics of microorganisms, heat sterilization of liquid media, filter sterilization of liquid media, design of sterilization equipment- batch and continuous.

**UNIT-IV PRODUCTION OF PRIMARY AND SECONDARY METABOLITES 12**

Product Recovery: Sedimentation, Centrifugation, Filtration, Precipitation, Chromatography, and Crystallization. Organic feed stocks produced by Fermentation – Ethanol, Organic acids (Citric acid and Lactic acid), Amino acids – L-Glutamic acid and Tryptophan. Mechanism of secondary metabolite production, Antibiotics (Penicillin, Cephalosporin), Vitamins (Vitamin B12, Riboflavin).

**UNIT-V MODERN FERMENTATION TECHNOLOGY 9**

Microbial fungicides and Pesticides, Chemicals and Pharmaceuticals made by fermentation, Biopolymers. Microbial leaching, Fermentation economics and its calculations, Future of fermentation technology, Case Study on any two fermented products.

**Total Contact Hours : 45**

**Course outcomes:**

Upon completion of the course, the students will be able to

- Determine the substrates used for industrial fermentation process
- Understand and gain knowledge about different media and sterilization kinetics
- Differentiate the various product recovery techniques
- Investigate the applications of primary and secondary metabolites
- Design the flow chart of fermentation economics and its calculations

**Text/Reference books:**

- Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Science & Technology Books.
- Doran, Pauline “of Bioprocess Engineering Principles “. Elsevier, 1995.
- Shuler, Michael L. and Fikret Kargi, “ Bioprocess Engineering “, Prentice Hall, 1992.
- Bailey, James E. and David F. Ollis, “ Biochemical Engineering Fundamentals”, IInd Edition. McGraw Hill , 1986.
- Harvey W. Blanch, Douglas S. Clark, Biochemical Engineering, Marcel Dekker, Inc.



**REFERENCES:**

1. Sauchelli, V.; "The Chemistry and Technology of Fertilizers", ACS MONOGRAPH No. 148, Reinhold Publishing Cor. New York, 1980.
2. Fertiliser Manual, "United Nations Industrial Development Organisation", United Nations, New York, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, New York, 1966.

**CH17032****INTRODUCTION TO PROCESS TECHNOLOGY****L T P C****3 0 0 3****OBJECTIVE:**

To impart knowledge on various aspects of production engineering and enable the students to understand the practical methods of production in a chemical factory

**UNIT I CHLOR ALKALI INDUSTRIES, SULPHURIC ACID MANUFACTURE 9**

Flow charts and standard symbols used for devices, industrial safety and pollution, Manufacture of Soda ash, chlorine and caustic soda, sulphur trioxide and sulphuric acid

**UNIT II CEMENT AND NITROGEN INDUSTRIES 9**

Types and manufacture of Portland cement, Manufacture of glasses, Synthetic ammonia, Nitric acid, Urea

**UNIT III FERTILIZER INDUSTRIES 9**

Growth elements, functions, phosphoric acid, ammonium phosphate, potassium chloride, single, triple super phosphate introduction to pesticides, herbicides and bio-fertilizers.

**UNIT IV ORGANIC INDUSTRIES 9**

Manufacture of paper from pulp, Manufacture of Raw and refined sugar, extraction methods of oils, hydrogenation of oils, Petroleum refining, physical and chemical conversion products

**UNIT V POLYMER INDUSTRIES 9**

Manufacture of Nylon 6. 6., manufacturer of Cellulosic Fibres – Viscose Rayon, Polymerization processes – different types -Natural rubber; Synthetic rubber such as SBR, manufacture of films - cellulose Acetate, PVC.

**TOTAL : 45 PERIODS****OUTCOMES:**

Student to integrate various courses and to give the young engineers some comprehension on various fields of production into which he will enter or with which he will be affiliated during the course of study or after completion of the study

**TEXTBOOKS:**

1. "Shreve's Chemical Process Industries Handbook", Fifth Edition, McGraw-Hill 1998.
2. Dryden, C.E., "Outlines of Chemical Technology", Edited and Revised by Gopala Rao. M. and M. Sitting, Second edition, Affiliated East-West press, 52, 1993.

**REFERENCES**

1. Shukla and G.N. Pandey "Text book on Chemical Technology", Vikas publishing company 1997.
2. Srikumar Koyikkal, "Chemical Process Technology and Simulation", PHI Learning Ltd (2013).

## Open Electives offered by Civil Engineering

Course Code	Course Title	Periods /Week				Credits	CAT
		L	T	P	Total		
OCE1901	Natural Hazard & Disaster Management	3	0	0	3	3	OE
OCE1902	Green Building Design	3	0	0	3	3	OE

### OPEN ELECTIVES OFFERED BY CIVIL DEPARTMENT

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
<b>OCE1901</b>	<b>NATURAL HAZARD &amp; DISASTER MANAGEMENT</b>	<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Objectives:</b>						
<input type="checkbox"/>	To gain knowledge on exposure to disasters, their significance and types.					
<input type="checkbox"/>	To understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.					
<input type="checkbox"/>	To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR).					
<input type="checkbox"/>	To acquire knowledge on hazard and vulnerability profile of India, Scenarios in the Indian context, Disaster damage assessment and management.					
<input type="checkbox"/>	To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity.					
<b>UNIT-I</b>	<b>INTRODUCTION</b>					<b>9</b>
Definition: Hazard, Disaster, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.						
<b>UNIT-II</b>	<b>APPROACHES TO DISASTER RISK REDUCTION (DRR)</b>					<b>9</b>
Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayat Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.						
<b>UNIT-III</b>	<b>INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT</b>					<b>9</b>
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.						
<b>UNIT-IV</b>	<b>DISASTER RISK MANAGEMENT IN INDIA</b>					<b>9</b>
Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment and Management, Response and Recovery Phases of Disaster – Disaster Damage Assessment.						

<b>UNIT-V</b>	<b>DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS</b>	<b>9</b>
Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.		
		<b>Total Contact Hours : 45</b>
<b>Course Outcomes</b>		
<input type="checkbox"/>	On completion the course, the students will be able to	
<input type="checkbox"/>	Get familiarized with various disasters, causes and their impact on environment and society.	
<input type="checkbox"/>	Assess vulnerability and various methods of risk reduction measures as well as mitigation.	
<input type="checkbox"/>	Assess factors affecting vulnerabilities, differential impacts, impacts of major developmental projects, changes in land-use, climate change adaptation.	
<input type="checkbox"/>	Get familiarized with hazard and vulnerability profile of India, Scenarios in the Indian context, Disaster damage assessment and management.	
<input type="checkbox"/>	Manage disaster, vulnerability assessment of buildings and infrastructure, case studies on coastal flooding, landslides, floods, forest fire, Manmade disasters and its mitigation.	
<b>Text Book (s):</b>		
<b>1</b>	Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 9789380386423.	
<b>2</b>	Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2010. ISBN-10: 1259007367, ISBN-13: 978-1259007361]	
<b>Reference Books(s) / Web links:</b>		
<b>1</b>	Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011.	
<b>2</b>	Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.	
<b>3</b>	Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.	
<b>4</b>	Government of India, National Disaster Management Policy, 2009.	

<b>Subject Code</b>	<b>Subject Name (Theory course)</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>OCE1902</b>	<b>GREEN BUILDING DESIGN</b>	<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Objectives:</b>						
<input type="checkbox"/>	To comprehend the knowledge on environmental repercussions of the building materials and energy maintenance.					
<input type="checkbox"/>	To understand the concepts of various types of sustainable construction and waste recycling.					
<input type="checkbox"/>	To get acquainted with the knowledge on comforts of buildings.					
<input type="checkbox"/>	To apprehend the usage of solar energy in buildings.					
<input type="checkbox"/>	To acquire the perceptions on waste management and green cover.					

<b>UNIT-I</b>	<b>ENVIRONMENTAL IMPLICATIONS OF BUILDINGS</b>	<b>9</b>
Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for Building Materials; Maintenance Energy for Buildings.		
<b>UNIT-II</b>	<b>IMPLICATIONS OF BUILDING TECHNOLOGIES EMBODIED ENERGY OF BUILDINGS</b>	<b>9</b>
Framed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts. Recycling of Industrial and Buildings Wastes. Biomass Resources for buildings.		
<b>UNIT-III</b>	<b>COMFORTS IN BUILDING</b>	<b>9</b>
Thermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Building Techniques. Incidence of Solar Heat on Buildings-Implications of Geographical Locations.		
<b>UNIT-IV</b>	<b>UTILITY OF SOLAR ENERGY IN BUILDINGS</b>	<b>9</b>
Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.		
<b>UNIT-V</b>	<b>GREEN COMPOSITES FOR BUILDINGS</b>	<b>9</b>
Concepts of Green Composites. Water Utilisation in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.		
		<b>Total Contact Hours</b> : <b>45</b>
<b>Course Outcomes</b>		
	On completion the course, the students will be able to	
<input type="checkbox"/>	Comprehend the environmental repercussions of the building materials and energy maintenance.	
<input type="checkbox"/>	Understand the concepts of various types of sustainable construction and waste recycling.	
<input type="checkbox"/>	Acquaint the knowledge on comforts of buildings.	
<input type="checkbox"/>	Apprehend the usage of solar energy in buildings.	
<input type="checkbox"/>	Perceive the ideas on waste management and green cover.	
<b>Text Book (s):</b>		
<b>1</b>	K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, 2007.	
<b>2</b>	Low Energy Cooling For Sustainable Buildings. John Wiley and Sons Ltd, 2009.	
<b>Reference Books(s) / Web links:</b>		
<b>1</b>	Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.	
<b>2</b>	Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010.	
<b>3</b>	Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009.	
<b>4</b>	Fundamentals of Integrated Design for Sustainable Building By Marian Keeler, Bill Burke.	

## Open Electives offered by CSE

Subject Code	Subject Name ( Laboratory Course)	Category	L	T	P	C
OCS1901	DATA STRUCTURES USING C	OE	0	0	6	3
<b>Objectives:</b>						
●	To apply the concepts of List ADT in the applications of various linear and nonlinear data structures.					
●	To demonstrate the understanding of stacks, queues and their applications.					
●	To be able to incorporate various searching and sorting techniques in real time scenarios.					
●	To analyze the concepts of tree data structure and understand the implementation of graphs and their applications.					
●	To analyze an algorithm and learn the fundamental algorithmic strategies.					

List of Experiments	
<b>1</b>	<b>LINEAR DATA STRUCTURES – LIST</b>
	<ul style="list-style-type: none"> <li>a. Conceptual Understanding: LIST ADT - Arrays, and Linked List.</li> <li>b. Problem solving using LIST concepts</li> <li>c. Competitive Programming tips and techniques in LIST concepts.</li> </ul>
<b>2</b>	<b>LINEAR DATA STRUCTURES – STACKS, QUEUES</b>
	<ul style="list-style-type: none"> <li>a. Conceptual Understanding: Stack using Arrays and Linked List.</li> <li>b. Conceptual Understanding: Queue using Arrays and Linked List.</li> <li>c. Problem solving using STACK and QUEUE concepts.</li> <li>d. Competitive Programming tips and techniques in STACK and QUEUE concepts.</li> </ul>
<b>3</b>	<b>SEARCHING AND SORTING</b>
	<ul style="list-style-type: none"> <li>a. Conceptual Understanding: Linear Search and Binary Search.</li> <li>b. Conceptual Understanding: Simple and optimized Sorting Technique</li> <li>c. Problem solving using Searching and sorting techniques.</li> <li>d. Competitive Programming tips and techniques in Searching and sorting concepts.</li> </ul>
<b>4.</b>	<b>TREE AND GRAPHS</b>
	<ul style="list-style-type: none"> <li>a. Conceptual understanding : Binary Search Tree</li> <li>b. Conceptual understanding : Graph Traversal</li> <li>c. Problem solving using Searching and sorting techniques.</li> <li>d. Competitive Programming tips and techniques in Tree and Graph</li> </ul>
<b>5.</b>	<b>ALGORITHM ANALYSIS AND DESIGN TECHNIQUES</b>
	<ul style="list-style-type: none"> <li>a. Conceptual Understanding : Analysis of Algorithms</li> <li>b. Problem solving using Brute Force.</li> <li>c. Problem solving using Divide and Conquer Technique.</li> <li>d. Problem solving using Dynamic Programming.</li> <li>e. Competitive Programming tips and techniques in algorithm optimization</li> </ul>
<b>Total Contact Hours</b>	
<b>: 90</b>	

Course Outcomes:	
●	Analyze the various data structure concepts.
●	Apply the different linear and non-linear data structures to problem solutions.
●	Apply tree and graph algorithms for real world applications.
●	Apply different Sorting, Searching algorithms.
●	Analyze running times of algorithms based on asymptotic analysis and apply different algorithmic approaches to solve problems.

<b>Text Book(s):</b>	
1	Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 1997.
2	Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012.

<b>Reference Books(s) / Web links:</b>	
1	Ellis Horowitz, Sartaj Sahni and Susan Anderson-Freed, Fundamentals of Data Structures in C, 2nd Edition, University Press, 2008.
2	<a href="https://www.hackerrank.com/">https://www.hackerrank.com/</a>
3	<a href="https://www.geeksforgeeks.org/">https://www.geeksforgeeks.org/</a>
4	<a href="https://leetcode.com/">https://leetcode.com/</a>

Subject Code	Subject Name ( Lab Course)	Category	L	T	P	C
OCS1902	OOPS USING JAVA	OE	0	0	6	3

<b>Objectives:</b>	
●	To understand Object Oriented Programming concepts and characteristics of Java.
●	To know the principles of classes, abstraction and inheritance.
●	To create packages, exceptions and usage of strings.
●	To emphasize the Input/output streams and collections classes.
●	To analyze and design algorithms.

<b>List of Experiments</b>	
<b>1</b>	<b>JAVA FUNDAMENTALS</b>
	<p>Concepts and Programs to understand and apply the knowledge of java fundamentals through</p> <ol style="list-style-type: none"> <li>Implementing Data Types</li> <li>Using Variables to program simple java applications</li> <li>Implementing Arrays to access more number of input in single variable</li> <li>Using Operators to implement arithmetic, logical and relational expressions</li> <li>Implementing decision making strategy using Control Statements</li> <li>Getting Input to code with Command Line Arguments</li> </ol>
<b>2</b>	<b>CLASSES AND INHERITANCE</b>
	<p>Develop a java project by applying OOPS concepts</p> <ol style="list-style-type: none"> <li>Defining Classes : Methods, Constructors,</li> <li>Garbage Collection</li> <li>Access Specifiers</li> <li>Method Overloading</li> <li>Inheritance: Super keyword, this keyword, Method Overriding,</li> <li>Abstract Classes – Static Members -Final Method and Class</li> </ol>
<b>3</b>	<b>PACKAGES, EXCEPTION HANDLING AND STRINGS</b>
	<p>Programs to understand and develop concepts of Packages , Interfaces and Strings with Exception Handling</p> <ol style="list-style-type: none"> <li>Crte a java application to demonstrate java existing package</li> <li>Create a java project to create and use user defined packages</li> <li>Create a java application to include <ul style="list-style-type: none"> <li>➤ Interfaces</li> </ul> </li> </ol>

	<ul style="list-style-type: none"> <li>➤ Exceptions to understand and apply Exception Hierarchy – Throwing and Catching Exceptions</li> <li>➤ Built-in Exceptions, User defined Exceptions and Stack Trace Elements</li> </ul>
	d. Implement Strings - String Buffer concepts by solving case studies
<b>4.</b>	<b>I/O AND COLLECTIONS</b>
	<ul style="list-style-type: none"> <li>a) Implement Input / Output Basics with IO Streams – Byte streams and Character streams</li> <li>b) Create an java application to Read and Write data from Console</li> <li>c) Create java application to read and write data from file</li> <li>d) Solve case studies to implement Collection Interfaces – Collection Classes.</li> </ul>
<b>5.</b>	<b>COMPETITIVE PROGRAMMING USING JAVA</b>
	<ul style="list-style-type: none"> <li>a. Conceptual Understanding : Analysis of Algorithms</li> <li>b. Problem solving using Divide and Conquer Technique.</li> <li>c. Problem solving using Dynamic Programming.</li> <li>d. Competitive Programming tips and techniques in algorithm optimization</li> </ul>
<b>Total Contact Hours</b>	
	<b>: 90</b>

<b>Course Outcomes:</b>	
●	Develop Java programs using OOP principles.
●	Develop Java programs with the concept of inheritance.
●	Build Java applications using exceptions and strings.
●	Develop Java applications using I/O and collections.
●	Analyze and design optimal algorithms

<b>Text Book(s):</b>	
<b>1</b>	Herbert Schildt, —Java The complete reference, 11th Edition, McGraw Hill Education, 2019
<b>2</b>	Cay S. Horstmann, Gary cornell, —Core Java Volume –I Fundamentals, 9th Edition, Prentice Hall, 2012.
<b>3</b>	Kathy sierra, Bert bates – Head First Java: A Brain-Friendly Guide, 2nd Edition,2005.

<b>Reference Books(s) / Web links:</b>	
<b>1</b>	SCJP Sun Certified Programmer for Java 6 Study Guide. McGrawHill, 6 <sup>th</sup> edition,2008.
<b>2</b>	Steven Holzner, —Java 2 Black book, Dreamtech press, 2006.
<b>3</b>	Timothy Budd, —Understanding Object-oriented programming with Java, Updated Edition, Pearson Education,1993.
<b>4</b>	Paul Deitel, Harvey Deitel, —Java SE 8 for programmers, 3rd Edition, Pearson,2014.
<b>5</b>	<a href="https://www.javatpoint.com/java-tutorial">https://www.javatpoint.com/java-tutorial</a>

## Open Electives offered by ECE

S.NO	COURSE CODE	COURSE TITLE	CATE GORY	CONTAC T	L	T	P	C
1.	OEC1901	MEMS and its applications	OE	3	3	0	0	3
2.	OEC1902	Consumer Electronics	OE	3	3	0	0	3
3.	OEC1903	Digital Image Processing and its applications	OE	3	3	0	0	3
4.	OEC1904	Pattern Recognition and Artificial Intelligence	OE	3	3	0	0	3
5.	OEC1905	Electronics Engineering	OE	3	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
OEC1901	MEMS AND ITS APPLICATIONS	OE	3	0	0	3

### Objectives:

- To introduce the fundamental concepts of MEMS and the materials for MEMS.
- To gain a knowledge of standard MEMS Sensors.
- To understand the fundamental principles behind the operation of RF MEMS
- To understand the fundamental principles of gas sensor.
- To educate on the applications of Biomedical based sensor and actuators.

<b>UNIT-I</b>	<b>INTRODUCTION TO MEMS</b>	<b>9</b>
MEMS and Micro systems, evolution of micro fabrication, Introduction to Micro fabrication, Silicon, glass, metals, dielectrics and carbides, Silicon dioxide, silicon carbide, silicon nitride, and polycrystalline silicon, Polymer for MEMS, Polyimide, micromachining, working of MEMS sensors and actuators.		
<b>UNIT-II</b>	<b>MEMS SENSOR</b>	<b>9</b>
Case Study 01: Gyroscope, Accelerometer, Case Study 02: Pressure Sensors, tactical sensor.		
<b>UNIT-III</b>	<b>RF MEMS</b>	<b>9</b>
Switch parameters, Basics of switching, RF MEMS Switch, Integration and biasing issues for RF switches, Actuation mechanisms for MEMS devices, RF Antenna, Microstrip antenna and Micromechanical filters, Saw filters		
<b>UNIT-IV</b>	<b>GAS SENSOR</b>	<b>9</b>
Chemical Sensor, Metal Oxides Based Sensor, SAW Sensor, VOC sensor Oxygen sensor Humidity sensor, H <sub>2</sub> S Sensor, Hydrogen sensor, Nitrogen oxide sensor, Breath analysers, Case Study: Humidity sensor, Volatile organic sensor for Aliphatic gases.		
<b>UNIT-V</b>	<b>BIOMEMS SENSOR</b>	<b>9</b>
Blood Pressure Sensors, Micro filters, and Micro needles, Protein separation and analysis, Cell sorting, Drug discovery, Bio-Sensing for Bacteria DNA Food Toxin, Micro Channels, Micro reactor Micro Mixers, Micro Total Analysis Systems ( $\mu$ TAS), Lab-On-Chip, Case study: Biosensors for estimation of blood glucose, urea and uric acid.		
<b>Total Contact Hours</b>		<b>: 45</b>

### Course Outcomes: On completion of course students will be able to

- Design the micro devices, micro systems using the MEMS fabrication process
- Design and understand the operation of micro devices, micro systems and their applications
- Design the characteristics of RF MEMS devices
- Gain the physical knowledge underlying the operation principles and design of Chemical sensor system for indoor and outdoor applications
- Gain the technical knowledge required for Biomedical devices design, fabrication, analysis and characterization of Biosensors

<b>Text Books:</b>	
1	Tai Ran Hsu, "MEMS and Microsystems Design and Manufacture", Tata-McGraw Hill, New Delhi, 2007.
2	Stephen D Senturia, 'Microsystem Design', Springer Publication, 1st ed. 2000. Corr. 2nd printing 2004 Edition

<b>Reference Books / Web links:</b>	
1	Mark Madou, Fundamentals of Microfabrication, CRC Press, New York, 2002, eBook Published 8th Oct 2018. DOI <a href="https://doi.org/10.1201/9781482274004">https://doi.org/10.1201/9781482274004</a> .
2	Chang Liu, Foundations of MEMS, Pearson Education India, 2012.
3	Nadim Maluf, Kirt Willams, An Introduction to Microelectromechanical Systems Engineering Artech House Publishers, London, Second Edition, 2004
4	K.J. Vinoy, Vijay.K. Varadan, "RF MEMS and their Applications" John Wiley & Sons Reprint @2003.
5	Stephen Beeby, Graham Ensell, Michael Kraft, Neil White, "MEMS Mechanical Sensors" 2004, Artech House, Inc.

Subject Code	Subject Name	Category	L	T	P	C
OE1902	CONSUMER ELECTRONICS	OE	3	0	0	3

<b>Objectives:</b>	
●	To sketch and describe operating principles of different types of microphones.
●	To learn various components of composite video signal and differentiate between hue, brightness, saturation, luminance and chrominance.
●	To acquaint with various devices related to telecommunication system.
●	To describe working of Washing machine, Digital Camera system, Microwave ovens with sketches of block diagram.
●	To understand the working principles of various consumer electronic devices.

<b>UNIT-I</b>	<b>AUDIO SYSTEM</b>	<b>9</b>
Microphones, Tape recorder, Audio compact disc system, High fidelity Audio system, Stereo sound system, Loudspeaker, Public address system, Magnetic sound recording. Ribbon Microphone, Condenser Microphone, Electrodynamic loud speaker		
<b>UNIT-II</b>	<b>TELEVISION</b>	<b>9</b>
Introduction, Radio and TV Transmission & Reception, Block diagram of TV transmitter, Television studies and Equipment, Antenna for TV transmitter, Block diagram of TV receiver, TV camera tube, LED, LCD, OLED, Flexible displays, Basics of organic electronics, DTH, IP-TV.		
<b>UNIT-III</b>	<b>TELECOMMUNICATION SYSTEMS:</b>	<b>9</b>
Basics of Telephone system, Caller ID Telephone, Intercoms, Cordless Telephones, Cellular mobile systems, Fiber Optics Communication, Satellite Radio, Integrated services Digital Networks (ISDN).		
<b>UNIT-IV</b>	<b>HOME ELECTRONICS:</b>	<b>9</b>
Digital Camera system, Microwave ovens, Washing Machines, Air Conditioners and Refrigerators, WiFi Routers, Smart Surveillance system		
<b>UNIT-V</b>	<b>MISCELLANEOUS DEVICES:</b>	<b>9</b>
Smart watch, Pulse Oximeter, Digital Blood Pressures Monitoring, Digital Thermometer, Digital Glucometer, Virtual Reality Box, Cellular telephone, Battery charger, IC regulator, UPS, Inverter, Decorative Lighting, Microwave oven, LCD tunes with alarm.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b> On completion of course students will be able to	
●	List technical specification of electronics Audio system (microphone and speaker).
●	Trouble shoots consumer electronics products like TV, washing machine and AC.
●	Identify and explain working of various colour TV transmission blocks.
●	Understand various functions of Cam coder and shoot a video and take snapshots and save them in appropriate format.
●	Understand the basic functions of various consumer electronic goods.

<b>Text Books:</b>	
1	S.P. Bali, Consumer Electronics, Pearson Education, 2005 and onwards.
2	R. R. Gulati, “Monochrome and Color Television”, New Age International Publisher, 2009 and onwards.
3	Louis.E.Frenzel, Communication Electronics – Principles and Application”, 3rd Editions, Tata McGraw-Hill, 2010.
4	G. Baura, “A Biosystems Approach to Industrial Patient Monitoring and Diagnostic Devices”, Morgan & Claypool, IEEE, 2008

<b>Reference Books / Web links:</b>	
1	B.R. Gupta and V. Singhal, “Consumer Electronics”, S.K. Kataria& Sons, 2013 and onwards.
2	A. Dhake, “Color Television”, McGraw Hill Education, 2004, 2nd Edition and onwards.

Subject Code	Subject Name	Category	L	T	P	C
OE1903	DIGITAL IMAGE PROCESSING AND ITS APPLICATIONS	OE	3	0	0	3

<b>Objectives:</b>	
●	To learn fundamentals of digital image processing.
●	To understand simple image enhancement techniques.
●	To get familiar with image restoration and segmentation techniques.
●	Be exposed to image compression and representation methods.
●	To know about the applications of image processing in various fields.

<b>UNIT-I</b>	<b>FUNDAMENTALS OF DIGITAL IMAGE PROCESSING</b>	<b>9</b>
Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationship between pixels.		
<b>UNIT-II</b>	<b>IMAGE ENHANCEMENT</b>	<b>9</b>
Spatial Domain: Gray level transformations, Histogram and Histogram Equalization – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering – Frequency Domain: Introduction to Fourier Transform – Smoothing and Sharpening frequency domain filters.		
<b>UNIT-III</b>	<b>IMAGE RESTORATION AND SEGMENTATION</b>	<b>9</b>
Noise models – Mean Filters – Adaptive filters-Inverse Filtering–Wiener filtering, Homomorphic filtering; Segmentation: Detection of Discontinuities–Lines, Points, Edges, Thresholding, Region based segmentation-Region growing, Region splitting and Merging.		
<b>UNIT-IV</b>	<b>IMAGE COMPRESSION AND REPRESENTATION</b>	<b>9</b>
Fundamentals – Image Compression models – Error Free Compression – Variable Length Coding – Bit Plane Coding – Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding – Transform Coding - Compression Standards-JPEG, Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments.		
<b>UNIT-V</b>	<b>OBJECT RECOGNITION AND IMAGE PROCESSING APPLICATIONS</b>	<b>9</b>
Introduction to pattern, pattern classes, pattern arrangements, object recognition based on matching – minimum distance classifier, correlation, Simple Matlab programs for histogram, histogram equalization, image enhancement, image restoration and image compression.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b> On completion of course students will be able to	
●	Describe digital image fundamentals.
●	Explain various image enhancement techniques.
●	Describe various image restoration and segmentation techniques.
●	Explain image compression and representation methods.
●	Describe object recognition and apply various image processing techniques in various applications.

<b>Text Books:</b>	
1	Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010.
2	Tinku Acharya, Ajoy K. Ray, "Image Processing: Principles and Applications", Wiley, 2005.

<b>Reference Books / Web links:</b>	
1	Anil Jain K., "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.
2	William K Pratt, "Digital Image Processing", John Wiley, 2002.
3	Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", First Edition, PHI Learning Pvt. Ltd., 2011.
4	Geoff Dougherty, "Digital Image Processing for medical applications", Cambridge University Press, 2009.
5	John R. Jensen, "Introductory Digital Image Processing- A remote sensing perspective", Fourth Edition, Pearson Education 2015.

Subject Code	Subject Name	Category	L	T	P	C
OEC1904	<b>PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE</b>	OE	3	0	0	3

<b>Objectives:</b>	
●	To understand the pattern recognition and its various approaches
●	To learn more about the different classifications in training set
●	To study the structure of various networks in pattern recognition
●	To learn the different search strategies in Artificial Intelligence
●	To know more about the various applications of Artificial Intelligence

<b>UNIT-I</b>	<b>PATTERN RECOGNITION OVERVIEW</b>	<b>9</b>
Overview of Pattern Recognition – Classification and description – Patterns and Feature Extraction- Training and Learning in Pattern Recognition Systems – Various Pattern Recognition approaches – Examples of Pattern Recognition Approaches		
<b>UNIT-II</b>	<b>TRAINING IN PATTERN RECOGNITION</b>	<b>9</b>
Parametric Estimation and Supervised Learning – Maximum Likely Hood Estimation – Bayesian Parameter Estimation Approach – Parzen Windows – Direct Classification using training set – Unsupervised learning and clustering – Clustering for Unsupervised Learning and Classification		
<b>UNIT-III</b>	<b>SYNTACTIC AND NEURAL PATTERN RECOGNITION</b>	<b>9</b>
Overview of Syntactic Pattern Recognition - Recognition by matching - Recognition by Parsing - CYK Parsing Algorithm- Neural Network Structure for Pattern Recognition Applications – Physical Neural Networks – Artificial Neural Network Model		
<b>UNIT-IV</b>	<b>INTRODUCTION TO ARTIFICIAL INTELLIGENCE</b>	<b>9</b>

Definition – Future of Artificial Intelligence– Characteristics of Intelligent Agents – Typical Intelligent Agents - Problem solving Methods – Search Strategies – Uninformed – Informed – Heuristics – Local Search Algorithms and Optimization Problems			
<b>UNIT-V</b>	<b>ARTIFICIAL INTELLIGENCE APPLICATIONS</b>		<b>9</b>
Natural Language Processing - Language Models – Information Retrieval- Information Extraction – Machine Translation – Speech Recognition – Robot – Hardware – Perception – Planning - Moving			
			<b>Total Contact Hours : 45</b>

<b>Course Outcomes:</b> On completion of course students will be able to	
●	Describe the various Pattern Recognition concerns
●	Analyze the different methods in statistical pattern recognition
●	Determine the patterns through structural and neural approaches
●	Make use of appropriate search algorithms for any Artificial Intelligence problem
●	Apply the concepts of Artificial Intelligence in various fields

<b>Text Books:</b>	
1	Robert J. Schalkoff, “Pattern Recognition: Statistical, Structural and Neural Approaches”, Wiley, Reprint 2007.
2	S. Russell and P. Norvig, “Artificial Intelligence: A Modern Approach”, Fourth Edition(Illustrated), Pearson Education 2019.

<b>Reference Books / Web links:</b>	
1	Richard O. Duda, Peter E. Hart, David G. Stork, “Pattern Classification”, Second Edition, John Wiley & Sons, 2012.
2	Gose, Earl, R. Johnsonbaugh, and Steve Jost, “Pattern Recognition and Image Analysis”, Prentice-Hall of India, New Delhi, 2015.
3	Rajjan Shinghal, Dr., “Pattern Recognition: Techniques and Applications”, OUP India, 2006.
4	J.T. Tou and R.C. Gonzalez, “Pattern Recognition Principles”, Second Edition, Addison-Wesley, 1977.
5	I. Bratko, Prolog: Programming for Artificial Intelligence”, Fourth Edition, Addison-Wesley Educational Publishers Inc., 2011.
6	M. Tim Jones, “Artificial Intelligence: A Systems Approach (Computer Science Series)”, First Edition, Jones and Bartlett Publishers, 2009.
7	Nils J. Nilsson, “The Quest for Artificial Intelligence: A History of Ideas and Achievements”, Cambridge University Press, 2010.
8	David L. Poole and Alan K. Mackworth, “Artificial Intelligence: Foundations of Computational Agents”, Second Edition, Cambridge University Press, 2017.
9	<a href="https://www.slideshare.net/Igustavomartins/introduction-to-pattern-recognition">https://www.slideshare.net/Igustavomartins/introduction-to-pattern-recognition</a>
10	<a href="https://www.slideshare.net/NashrahHabib/ai-introduction-140854467">https://www.slideshare.net/NashrahHabib/ai-introduction-140854467</a>

Sub code	Subject name	Category	L	T	P	C
OE1905	ELECTRONICS ENGINEERING	OE	3	0	0	3

<b>Objectives:</b>	
●	To understand broadly the basic electronic components and its characteristics.
●	To study the evolution and performance parameters of various electronic devices.
●	To know the concepts of digital electronics and study the A/D and D/A converters.
●	To learn about integrated circuits and surface mount devices (SMD).
●	To attain knowledge of applications of electronics in various systems.

<b>UNIT-I</b>	<b>ELECTRONIC COMPONENTS</b>	<b>9</b>
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 -LED, Alphanumeric, LCD, LASER.		
<b>UNIT-II</b>	<b>DEVICES AND APPLICATIONS</b>	<b>9</b>
History, Evolution and Inventors of Electronics Devices- PN Junction Diodes, Zener, Bipolar Junction Transistors, Field Effect Transistors, Uni Junction Transistors, Silicon Controlled Rectifier -Working and Simple Applications.		
<b>UNIT-III</b>	<b>DIGITAL ELECTRONICS</b>	<b>9</b>
Boolean algebra, Logic Gates, Half and Full adders, Decoder, Encoder, Multiplexer, Demultiplexer, Flip flops, Digital to Analog converters, Analog to Digital converters, Real Time Multi-Channel Data Acquisition System -Working and Demonstrations.		
<b>UNIT-IV</b>	<b>INTEGRATED CIRCUITS AND SMD</b>	<b>9</b>
Evolution and Inventors of Integrated Circuits - Structure, Scale/Level, Classification, Surface Mount Devices and Surface Mount Technology, Printed Circuit Boards, Semiconductor Manufacturing. Case Study and Industrial Visit.		
<b>UNIT-V</b>	<b>ELECTRONICS SYSTEMS</b>	<b>9</b>
Tsunami Warning System - Detection (Seismometer), Data processing Management, Alert Signal & Messaging, E Nose – Detection (Chemical Sensors), Data processing and Classification, Agriculture Robots (Navigation, Soil and Crop Sensors), Processing, and Actuation.		
		<b>Total Contact Hours : 45</b>
<b>Course Outcomes:</b> On completion of course students will be able to		
●	Analyse the various parameters of the electronic components based on their construction functionality.	
●	Demonstrate the working of various electronic devices and list out their applications.	
●	Realize logic circuits with different design styles and also to study about D/A and A/D converters.	
●	Acquire knowledge for the analysis of various parameters in integrated circuits and SMD.	
●	Apply the knowledge of electronics in various real time electronic systems.	

<b>Text Books:</b>	
1	Albert Malvino, David Bates, “Electronic Principles”, Eight Edition, McGraw Book Co., 2016

<b>Reference Books / Web links:</b>	
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, 2nd Edition.
5	V. R. Deo, “Electronic Components and Applications”, Ane Books Pvt. Ltd., 2012.
6	<a href="https://www.semiconductors.org/majn/resources">https://www.semiconductors.org/majn/resources</a>
7	technav.ieee.org/tagJ5783/ electronic-noses, www.tsunami.noaa.gov, www.e-booksdirectory.com
8	Make Electronics - Learning by Discovery by Charles Platt

## Open Electives offered by EEE

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
OEE1901	<b>ELECTRICAL SAFETY AND QUALITY ASSURANCE</b>	OE	3	0	0	3
<b>Objectives:</b>						
●	To understand the various electrical hazards in working environment and ensure the electrical safety.					
●	To provide knowledge on electrical standards and its requirements					
●	To create awareness on the methods for electrical safety and load protection.					
●	To inculcate knowledge on standardization to be followed in health care systems					
●	To understand the purpose of regulatory body and their requirements in health care systems					
<b>UNIT-I</b>	<b>ELECTRICAL HAZARDS</b>					<b>9</b>
Review of basic electrical concepts, Electrostatics – Electromagnetism – Electrical Hazards – Energy leakage – Clearance and insulation– Current surges – Electrical causes of fire and explosion – Human interface with electricity – Human resistance to electricity						
<b>UNIT-II</b>	<b>STANDARDS AND REQUIREMENTS</b>					<b>9</b>
National electrical Safety code - Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate. Hazardous area classification and classification of electrical equipment for hazardous areas (IS, NFPA, API and OSHA standards).						
<b>UNIT-III</b>	<b>ELECTRICAL PROTECTION AND MAINTENANCE</b>					<b>9</b>
Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance. First aid-cardio pulmonary resuscitation (CPR).						
<b>UNIT-IV</b>	<b>STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS</b>					<b>9</b>
Quality- Need for Standardization & Quality Management, QM in Health care organization Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services –Classification of equipment						
<b>UNIT-V</b>	<b>REGULATORY REQUIREMENT FOR HEALTH CARE</b>					<b>9</b>
CE and FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes.						
<b>Total Contact Hours</b>						<b>45</b>
<b>Course Outcomes:</b> On completion of the course, the students will be able to						
●	realize the effects of different electrical hazards and its causes					
●	analysed the significance of different electrical standards used in working environments					
●	develop knowledge and insight for the procedures used in quality control and assurance activities					
●	explain the process of standardization to be followed in hospitals.					
●	analyse the various governing bodies in health care system					
<b>Text Book (s):</b>						
1	B.M. Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd. 24					
2	K.Shridhara Bhat, Quality Management, Himalaya Publishing House Cesar A. Cacere & Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977.					
<b>Reference Books(s) / Web links:</b>						
1	Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1979.					
2	Karen Parsley, Karen Parsley Philomena Corrigan Quality improvement in Healthcare, 2 <sup>nd</sup> edition, Nelson Thrones Pub, 2002					
3	Sharon Myers —Patient Safety & Hospital Accreditation - A Model for Ensuring Success Springer Publishers 2012 7. Joseph F Dyro —Clinical Engineering Handbook— Elsevier Publishers, 2004					

COs/ Pos & PSOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	2	1	1	-	2	2	2	-	1	-	2	2			
CO 2	2	1	1	-	2	2	2	-	1	-	2	2			
CO 3	2	1	1	-	2	2	2	-	1	-	2	2			
CO 4	2	1	1	-	2	2	2	-	1	-	2	2			
CO 5	2	1	1	-	2	2	2	-	1	-	2	2			
<b>Average</b>	<b>2</b>	<b>1</b>	<b>1</b>	<b>-</b>	<b>2</b>	<b>2</b>	<b>2</b>	<b>-</b>	<b>1</b>	<b>-</b>	<b>2</b>	<b>2</b>			

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
<b>OEE1902</b>	<b>ELECTRIC POWER UTILIZATION</b>	<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Objectives:</b>						
●	To learn the energy saving concept by different ways of illumination.					
●	To understand the different methods of refrigeration.					
●	To impart knowledge on the fundamental's concepts of domestic appliances and earthing.					
●	To familiarize the concepts of heating and welding.					
●	To provide knowledge on electric drives and traction system.					
<b>UNIT-I</b>	<b>ILLUMINATION</b>					<b>9</b>
Illumination –Terminology, Laws of illumination, lighting calculation. Electric lamps-Different types of lamps, LED lighting and energy efficient lamps, Design of lighting schemes- indoor lighting schemes - factory lighting halls - outdoor lighting schemes - flood lighting - street lighting.						
<b>UNIT-II</b>	<b>REFRIGERATION</b>					<b>9</b>
Refrigeration- Domestic refrigerator and Air coolers, Air-Conditioners- Circuit Diagram, types and principle of operation.						
<b>UNIT-III</b>	<b>DOMESTIC UTILIZATION OF ELECTRICAL ENERGY</b>					<b>9</b>
Domestic utilization of electrical energy-House wiring, Induction based appliances, Online and OFF-line UPS, Earthing- Domestic, Industrial and sub-station.						
<b>UNIT-IV</b>	<b>ELECTRIC HEATING</b>					<b>9</b>
Electric heating- Types of heating and appliances- Electric furnaces- Resistance, Inductance and Arc Furnaces, Electric welding and sources of welding.						
<b>UNIT-V</b>	<b>ELECTRIC DRIVES AND TRACTION SYSTEM</b>					<b>9</b>
Electric Drives and Traction System- Types of drives and loads, Rating and heating of motors, Types of Traction, Speed-Time curves, Recent trends in traction						
						<b>Total Contact Hours</b>
						<b>: 45</b>
<b>Course Outcomes:</b>						
On completion of the course, the students will be able to						
●	realize the design of illumination systems with energy saving method.					
●	understand different methods of refrigeration.					
●	know fundamentals concepts of domestic appliances and earthing.					
●	understand the concepts of heating and welding.					
●	realize the various traction motor controls used in electric traction Hybrid Electric Vehicles.					

<b>Text Book (s):</b>	
<b>1</b>	Dr. Uppal S.L. and Prof. S.Rao, “Electric Power system “, Khanna Publishers, New Delhi, 2009.
<b>2</b>	R.K.Rajput, “Utilization of Electric Power”, Laxmi publications Private Limited., 2007.
<b>3</b>	N.V. Suryanarayana, “Utilization of Electric Power”, Wiley Eastern Limited, New Age International Limited, 2nd edition, Reprint 2017.
<b>Reference Books(s) / Web links:</b>	
<b>1</b>	C.L.Wadhwa, “Generation, Distribution and Utilisation of Electrical Energy”, New Age International Pvt. Ltd., 2003.
<b>2</b>	S. Sivanagaraju, M. Balasubba Reddy, D. Srilatha, “Generation and Utilization of Electrical Energy”, Pearson Education, 2010.
<b>3</b>	J.B.Gupta, “Utilization Electric power and Electric Traction”, S.K.Kataria and Sons, 2000.
<b>4</b>	C.L.Wadhwa, “Generation, Distribution and Utilisation of Electrical Energy”, New Age International Pvt. Ltd., 2003.

<b>COs/POs&amp;PSOs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>	<b>PO11</b>	<b>PO12</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>
<b>CO 1</b>	3	2	3	1	1	3	3	2	1	1	2	2			
<b>CO 2</b>	3	2	3	2	1	3	3	2	1	1	2	2			
<b>CO 3</b>	3	3	3	2	1	3	3	2	1	1	2	2			
<b>CO 4</b>	3	2	3	2	2	3	3	2	1	1	1	2			
<b>CO 5</b>	3	2	3	1	-	3	3	1	1	2	1	1			
<b>Average</b>	<b>3</b>	<b>2.2</b>	<b>3</b>	<b>1.6</b>	<b>1</b>	<b>3</b>	<b>3</b>	<b>1.8</b>	<b>1</b>	<b>1.2</b>	<b>1.6</b>	<b>1.8</b>			

## Open Electives offered by Food Technology

S. No	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1	OFT1901	Emerging Techniques in Food Processing	OEC	3	3	0	0	3
2	OFT1902	Food Safety	OEC	3	3	0	0	3
3	OFT1903	Crop Process Engineering	OEC	3	3	0	0	3
4	OFT1904	Food Supply Chain Management	OEC	3	3	0	0	3

Subject Code	Subject Name	Category	L	T	P	C
OFT1901	EMERGING TECHNIQUES IN FOOD PROCESSING	OEC	3	0	0	3

### Objectives:

- To understand the principles of high pressure treatment
- To gain knowledge on pulsed electric field & light technology
- To understand the applications of ohmic heating of foods.
- To analyse the effectiveness of ultrasound and ozone technology
- To gain knowledge on applications of non-ionizing radiations

<b>UNIT-I</b>	<b>HIGH PRESSURE TREATMENT</b>	<b>9</b>
Non-thermal technologies in preservation of foods – necessity and advantages – Status and trends of non-thermal technologies in preservation of foods - High pressure treatment of food – Governing Principles – Process equipment, processing and effect on microorganisms - Combined Pressure-Heat treatment on quality attributes of foods.		
<b>UNIT-II</b>	<b>PROCESSING USING SOUND, LIGHT AND MICROWAVE</b>	<b>9</b>
Ultrasound – Principle of operation – mechanism of inactivation of microorganisms and enzymes– UV light and pulsed light preservation – Principles of operation – microbial inactivation mechanism, Microwave Technology- principle – application – sterilization, tempering, drying, puffing, coagulation and other processing applications.		
<b>UNIT-III</b>	<b>PULSED ELECTRIC FIELD AND DIELECTRIC HEATING</b>	<b>9</b>
Pulsed Electric Field – Principles of operation – Equipment – processing - control parameters – Microbial Inactivation Mechanism – Effects on Fluid food nutritional and Quality parameters, Ohmic Heating – Principle – Equipment – Effect on Food quality and microbe’s inactivation.		
<b>UNIT-IV</b>	<b>PROCESSING USING MAGNETIC FIELD AND NON IONIZING RADIATION</b>	<b>9</b>
Introduction to irradiation technologies – general mode of action – Equipment and operational parameters – Food safety and shelf life of irradiated liquid foods - Oscillating Magnetic Fields-Magnetic fields- Generation – Mechanisms- Inactivation of Microorganisms – Magnetic fields in food preservation, Infra-red – Mechanism of IR absorption by food – IR emitters and spectral bands – applications, Radio wave Frequency – principle – factors influencing RF heating process – applications		
<b>UNIT-V</b>	<b>OZONE AND COLD PLASMA PROCESSING</b>	<b>9</b>
Generation of ozone – batch and continuous process of Ozone for inactivation – Factors affecting efficacy of ozone processing – Effect on food quality –Methods of generation of cold plasma – Control parameters – batch and continuous method of cold plasma treatment for decontamination.		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Understand the concepts and effects of high pressure processing
●	Apply the pulsed electric field and pulsed light technology for food processing
●	Comprehend the role of ultrasound and ozone techniques for foods
●	Apply ohmic heating principle in food processing
●	Utilize the non-ionizing radiations for food preservation.

<b>Text Books:</b>	
1	Cullen, P.J., Tiwari, B.K. and Valdramidis V.P. 2012. Novel thermal and non-thermal technologies for fluid foods. Academic press, 32 Jamestown Road, London NW1 7BY, UK.
2	Gustavo V. Barbosa-Cánovas, María S. Tapia and M. Pilar Cano, 2005. Novel Food Processing Technologies, CRC Press. ISBN: 0-8247-5333-X
3	Sun, D. Emerging Technologies for Food Processing, (Academic Press, 2005)
4	Ohlsson, T. and Bengtsson, N. Minimal Processing technologies in the food industry, (Wood head Publishing Limited, 2002)

<b>Reference Books / Web links:</b>	
1	Ioannis S. Boziaris, 2014. Novel Food Preservation and Microbial Assessment Techniques, CRC Press
2	Gaurav Tewari and Vijay K. Juneja, 2007. Advances in Thermal and Non-Thermal Food Preservation, Blackwell Publishing
3	Gustavo C Barbosa-Canovas, Q Howard Zhang, 1999. Pulsed Electric Fields in Food Processing Lancaster Pa: Technomic Publishing Co. ISBN 1566767830.
4	Gustavo V. Barbosa- Canovas, Usha R. Pothakamury, Enrique Palou and Barry G. Swanson. 1998. Nonthermal Preservation of Foods. Marcel Dekker Inc. New York.

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
FT19O31. 1	3	3	3	2	3	2	2	3	3	-	3	3	3	3	3	3
FT19O31. 2	3	3	3	2	3	2	2	3	3	-	3	3	3	3	3	3
FT19O31. 3	3	3	3	3	3	2	2	3	3	-	3	3	3	3	3	3
FT19O31. 4	3	3	3	3	3	2	2	3	3	-	3	3	3	3	3	3
FT19O31. 5	3	3	3	3	3	2	2	3	3	-	3	3	3	3	3	3
Average	3	3	3	2.6	3	2	2	3	3	-	3	3	3	3	3	3

Subject Code	Subject Name	Category	L	T	P	C
OFT1902	FOOD SAFETY	OEC	3	0	0	3

<b>Objectives:</b>						
●	To understand the principles of management systems in food safety					
●	To gain knowledge on risk assessment & management					
●	To understand the role of systems of food safety					
●	To analyse the effectiveness of food safety management system					
●	To apply gain knowledge on case studies					

<b>UNIT-I</b>	<b>INTRODUCTION TO MANAGEMENT SYSTEMS</b>	<b>9</b>
Introduction to Quality management systems 9001; 2000, ISO 14001 Environment Management Systems, Occupational Health and Safety Management systems, Safety and its importance		
<b>UNIT-II</b>	<b>RISK ASSESSMENT &amp; MANAGEMENT</b>	<b>9</b>
Hazards – Biological, Chemical and Physical, occurrence and its physiological, Hazard identification, characterization and significance assessment, Risk Analysis covering Risk Assessment, Risk Management and Risk Communication. Introduction to management of food safety hazards through Good Manufacturing Practices (GMP), Good Hygienic Practices (GHP), Good Retail Practices, Good Storage Practices.		
<b>UNIT-III</b>	<b>SYSTEMS OF FOOD SAFETY</b>	<b>9</b>
Introduction to different systems of food safety management including HACCP, ISO 22000, BRC, BRC, IFS, etc. 7 principles of establishing HACCP, ISO 22000 clause wise interpretation and implementation in a food establishment with case studies		
<b>UNIT-IV</b>	<b>FOOD SAFETY MANAGEMENT</b>	<b>9</b>
Global and India, Food Safety Management System certification process, Certifying and Accrediting body, Laboratory Quality Management System: Overview and requirements of ISO 17025, Requirements specific to food testing laboratories (Physical, Chemical and Biological parameters)		
<b>UNIT-V</b>	<b>CASE STUDIES</b>	<b>9</b>
Manufacturing, Food Service, Transportation and Retail – Preparation of check list for the implementation of GMP, preparation of quality policy, HACCP plan, Food safety management documentation and basic knowledge in auditing. Visits to ISO 22000 certified food units and ISO 17025 certified laboratories		
<b>Total Contact Hours</b>		<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Apply the safety management systems in food industry
●	Apply the risk analysis techniques to assess the food safety
●	Comprehend the role of systems of food safety
●	Apply the FSMS in food industry
●	Apply the gained knowledge in solving the case studies.

<b>Text Books:</b>	
1	Singal RS. 1992. Handbook of Indices of Food Quality and Authenticity; Woodhead Publ. Cambridge, UK.
2	Shapton D. A.1991. Principles and Practices of Safe Processing of Foods; Butterworth Publication, London.

<b>Reference Books / Web links:</b>	
1	ISO standards
2	Early R.1995.Guide to Quality Management Systems for Food Industries. Blackie Academic.
3	Furia T. E.1980. Regulatory status of Direct Food Additives. CRC Press

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
FT19O32. 1	3	3	2	2	2	3	3	3	3	-	3	3	3	3	3	3
FT19O32. 2	3	3	2	2	2	3	3	3	3	-	3	3	3	3	3	3
FT19O32. 3	3	3	2	2	2	3	3	3	3	-	3	3	3	3	3	3
FT19O32. 4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
FT19O32. 5	3	3	3	3	3	2	2	3	3	-	3	3	3	3	3	3
Average	3	3	2.4	2.4	2.4	3	3	3	3	-	3	3	3	3	3	3

Subject Code	Subject Name	Category	L	T	P	C
OFT1903	CROP PROCESS ENGINEERING	OEC	3	0	0	3

**Objectives:**

- To understand the principles of food processing
- To gain knowledge on cereal processing methods
- To understand the pulse processing methods
- To understand the pulse milling methods
- To gain knowledge on oil seed processing

<b>UNIT-I</b>	<b>IMPORTANCE OF FOOD PROCESSING</b>	<b>9</b>
Introduction, Food, Agriculture and Mechanization, Food Processing, Present status of Food processing, Importance of Food Processing, Scope of Food Processing, Key constraints for growth, Methods and Principles of Food Processing.		
<b>UNIT-II</b>	<b>PROCESSING OF CEREALS</b>	<b>9</b>
Processing of Rice: Method of Rice Milling, Modern rice milling processes, Parboiling Process- Methods, Advantages & Disadvantages. Processing of Wheat: Structure of wheat grain, Purpose of flour milling, Wheat milling process- Reception and storage of wheat, cleaning of wheat, Tempering or Conditioning, Wheat grinding, Component of Wheat mill- Break rolls, Brake sifting system, Reduction Rolls, Reduction sifting system, Scratch system. Processing of corn: Milling of corn- Dry milling method (Tempering- De-germing (T.D.) method)- Cleaning, Hydrothermal/conditioning treatment, De-germing, Drying and Cooling of degermer stock, Rolling and Grading; Wet Milling method of corn- Cleaning, Steeping, Germ recovery, milling and fibre recovery, Starch-Gluten separation.		
<b>UNIT-III</b>	<b>PROCESSING OF PULSES</b>	<b>9</b>
Introduction, Pulse milling process- Cleaning and grading, Pitting, Pre-treatments with oil, Conditioning of pulses, De-husking and Splitting, polishing; Equipment's required for pulse processing- Vibratory sieve separator, Cleaner with aspirator, Destoner, Auger Mixer/Screw conveyor, Pulse scourer, Pulse splitter, LSU Drier, Emery coated rollers, Rotating reel grader		
<b>UNIT-IV</b>	<b>MILLING METHODS FOR PULSES</b>	<b>9</b>

Dry milling method of pigeon pea, Wet milling method of pigeon pea, CFTRI method of Pigeon Pea milling, Pantnagar process of pigeon pea milling, CIAE method pigeon pea milling, Method of Black gram milling, Method of Bengal gram milling, Method of Lentil and peas milling, Method of Green gram milling.			
<b>UNIT-V</b>	<b>PROCESSING OF OIL SEEDS</b>	<b>9</b>	
Introduction, Raw material preparation, Oil Extraction methods- Mechanical expression, Solvent Extraction; Process of Oil Refining- De-odorising, Wintering, Neutralisation, Bleaching, De-gumming.			
<b>Total Contact Hours</b>			<b>: 45</b>

<b>Course Outcomes:</b>	
On completion of course students will be able to	
●	Explain the importance of crop processing technology
●	Apply the different technologies available to process cereals.
●	Comprehend the unit operations involved in processing of pulses
●	Demonstrate the milling technologies of pulses
●	Apply the methods learnt to process oil seeds.

<b>Text Books:</b>	
1	Chavan, U. D. (2012). Post-Harvest Management and Processing Technology: cereals, pulses, oilseeds, fruits and vegetables. Daya House Pub. , Rome.
2	Chakraverthy, A. (1995). Post-harvest technology of cereals, pulses and oilseeds. Oxford & IBH publishing Pvt. Ltd., New Delhi.

<b>Reference Books / Web links:</b>	
1	Pandey, P. H. (1998). Principles and Practices of Post-Harvest Technology. Kalyani publishing Pvt. Ltd., Ludhiana.
2	Sahay, K. M. and Singh, K. K. (1994). Unit operations of Agricultural Processing. Vikas Publishing House Pvt. Ltd., New Delhi.
3	Srivastava, P. K. and Kachru, R. P. (1995). Compendium of technologies for oil seed processing and utilization. Central Institute of Agricultural Engineering, Bhopal.

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
FT19O33. 1	3	3	2	2	2	3	3	3	3	-	3	3	3	3	3	3
FT19O33. 2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
FT19O33.3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
FT19O33. 4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
FT19O33. 5	3	3	3	3	3	2	2	3	3	-	3	3	3	3	3	3
Average	3	3	2.8	2.8	2.8	3	3	3	3	-	3	3	3	3	3	3

Subject Code	Subject Name	Category	L	T	P	C
OFT1904	FOOD SUPPLY CHAIN MANAGEMENT	OEC	3	0	0	3

Objectives:						
●	To understand the principles of supply chain management					
●	To gain knowledge on sourcing and procurement methods for food.					
●	To understand the role of risk management in food supply chain					
●	To analyse the factors to be considered for designing supply chain					
●	To gain knowledge on challenges in establishment of sustainable supply chain.					

UNIT-I	INTRODUCTION	9
Food Supply Chains & Food Logistics, Evolution of food supply chain, Relationship between Food & the economy, International Definition of Food Supply Chain, Significance & Drivers, the actors in Food Supply Chain (FSC) – Producers, Processors, Retailers & Distributors, Hospitality Sectors, Consumers, Types of Food Chains, Factors Influencing Food Supply Chain Food Logistics – Movement of Food, packaging in Logistics, Temperature Controlled Supply Chains		
UNIT-II	FOOD SOURCING AND PROCUREMENTS	9
Food Sourcing and procurements: Sourcing- Low cost sourcing, Outsourcing, In-sourcing, Single sourcing, Multiple sourcing, Partnerships; Procurement (Purchase)- Kraljic Matrix, Supplier Segmentation, Sustainable Procurement; A Traditional Food Industry Supply Chain (adapted from DTI-1995)- Diagram		
UNIT-III	RISK MANAGEMENT & TECHNOLOGY TRENDS	9
Managing supply chain risks, managing risks in Food Supply, Technology Trends in food supply chain, Traceability and use of technology- Traceability, RFID, Bar-coding, Food Processing & Food packaging in a technological context, Food Logistics.		
UNIT-IV	SUSTAINABILITY & FUTURE CHALLENGES	9
Attributes to consider when designing food supply chain. – Perishability, Seasonality in production, Edible nature of product, Heterogeneity- Info Asymmetry. Food Regulations & Safety. –Minimum Quality Standards, Regulations & Standards, Compatibility Standards- HACCP, ISO, FSSC, TACCP.		
UNIT-V	SUSTAINABILITY CHALLENGES IN FOOD SUPPLY CHAIN	9
Developing Sustainability within food supply chains- Production, Processing, Logistics & Retail, Sourcing; Food Sector & Economic Regeneration; Logistics Infrastructure; Food Cluster & Enterprise Zone; Food Parks & Hubs.		
		<b>Total Contact Hours : 45</b>

Course Outcomes:						
On completion of course students will be able to						
●	Apply the principles of supply chain management					
●	Utilize the sourcing and procurement methods for food.					
●	Carry out the risk management in food supply chain					
●	Analyse the factors to be considered for designing supply chain					
●	Find the challenges in establishment of sustainable supply chain.					

Text Books:						
1	Food Supply Chain Management & Logistics (From Farm to Fork) by Mr. Samir Dani, Published by KoganPage, New Delhi.					
2	Food Supply Management ( issues for the hospitality and retail sectors)- Edited by Jane F Eastham, Liz Sharples & Stephen D Ball, Published by Butterworth Heinemann, New Delhi.					

PO/PSO CO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
FT19O34. 1	3	3	2	2	2	3	3	3	3	-	3	3	3	3	3	3
FT19O34. 2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
FT19O34. 3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
FT19O34. 4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3
FT19O34. 5	3	3	3	3	3	2	2	3	3	-	3	3	3	3	3	3
Average	3	3	2.8	2.8	2.8	3	3	3	3	-	3	3	3	3	3	3

## Open Electives Offered by IT

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	OIT1901	Business Intelligence	OE	3	3	0	0	3
2.	OIT1902	Cyber Security	OE	3	3	0	0	3

Subject Code	Subject Name (Theory Course)	Category	L	T	P	C
OIT1901	BUSINESS INTELLIGENCE	OE	3	0	0	3

<b>Objectives:</b> Broad objective of this course is	
•	Be exposed with the basic rudiments of business intelligence system
•	understand the modeling aspects behind Business Intelligence
•	understand of the business intelligence life cycle and the techniques used in it
•	Be exposed with different data analysis tools and techniques

<b>UNIT-I</b>	<b>BUSINESS INTELLIGENCE</b>	<b>9</b>
Effective and timely decisions – Data, information and knowledge – Role of mathematical models – Business intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence.		
<b>UNIT-II</b>	<b>KNOWLEDGE DELIVERY</b>	<b>9</b>
The business intelligence user types, Standard reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, dimensional analysis, Alerts/Notifications, Visualization: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Visualization, Integrated Analytics, Considerations: Optimizing the Presentation for the Right Message.		
<b>UNIT-III</b>	<b>EFFICIENCY</b>	<b>9</b>
Efficiency measures – The CCR model: Definition of target objectives- Peer groups – Identification of good operating practices; cross efficiency analysis – virtual inputs and outputs – Other models. Pattern matching – cluster analysis, outlier analysis.		
<b>UNIT-IV</b>	<b>BUSINESS INTELLIGENCE APPLICATIONS</b>	<b>9</b>
Marketing models – Logistic and Production models –Telecommunication Industry & Banking Case studies.		
<b>UNIT-V</b>	<b>FUTURE OF BUSINESS INTELLIGENCE</b>	<b>9</b>
Future of business intelligence – Emerging Technologies, Machine Learning, Predicting the Future, BI Search & Text Analytics – Advanced Visualization – Rich Report, Future beyond Technology.		
		<b>Contact Hours : 45 Periods</b>

<b>Course Outcomes:</b>	
On completion of the course, the students will be able to	
•	Explain the fundamentals of business intelligence.
•	Link data mining with business intelligence.
•	Apply various modeling techniques.
•	Explain the data analysis and knowledge delivery stages.
•	Apply business intelligence methods to various situations and decide on appropriate technique.

<b>Text Books:</b>	
<b>1</b>	Efraim Turban, Ramesh Sharda, Dursun Delen, “Decision Support and Business Intelligence Systems”, 9 <sup>th</sup> Edition, Pearson 2013.

<b>Reference Books:</b>	
<b>1</b>	Larissa T. Moss, S. Atre, “Business Intelligence Roadmap: The Complete Project Lifecycle of Decision Making”, Addison Wesley, 2003.
<b>2</b>	Carlo Verzellis, “Business Intelligence: Data Mining and Optimization for Decision Making”, Wiley Publications, 2009.
<b>3</b>	David Loshin Morgan, Kaufman, “Business Intelligence: The Savvy Manager’s Guide”, Second Edition, 2012.
<b>4</b>	Cindi Howson, “Successful Business Intelligence: Secrets to Making BI a Killer App”, McGraw- Hill, 2007.
<b>5</b>	Ralph Kimball , Margy Ross , Warren Thornthwaite, Joy Mundy, Bob Becker, “The Data Warehouse Lifecycle Toolkit”, Wiley Publication Inc.,2007.
<b>6</b>	G. Shmueli, N.R. Patel, P.C. Bruce, “Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner”, 1 st Edition, Wiley India.

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
<b>CO1</b>	2	2	2	2	2	1	-	-	-	-	1	1	2	2	2	2
<b>CO2</b>	2	3	3	2	2	1	-	-	-	-	1	1	2	2	2	2
<b>CO3</b>	2	3	3	3	3	1	-	-	-	-	1	1	2	2	2	2
<b>CO4</b>	2	3	3	3	3	1	-	-	-	-	1	1	2	2	2	2
<b>CO5</b>	2	3	3	3	3	1	1	1	-	-	1	3	3	3	3	3
<b>CO (Avg)</b>	2	2.8	2.8	2.6	2.6	1	0.2	0.2	-	-	1	1.4	2.2	2.2	2.2	2.2

Correlation levels 1, 2 or 3 are as defined below:

1: Slight (Low) 2: Moderate (Medium) 3:

Substantial(High) No correlation : “-”

Subject Code	Subject Name (Theory Course)	Category	L	T	P	C
OIT1902	CYBER SECURITY	OE	3	0	0	3

<b>Objectives:</b> Broad objective of this course is to	
•	Learn the basics of Security Trends.
•	Know the operational and organizational security.
•	Study the fundamentals of cryptography.
•	Explore Authentication methods and Tools.
•	Identify the purpose of Intrusion Detection Systems.

<b>UNIT-I</b>	<b>INTRODUCTION TO SECURITY TRENDS AND CONCEPTS</b>	<b>9</b>
The Computer Security Problems - Targets and Attacks - Approaches to Computer Security – Ethics - Basic Security Terminologies – Security Models.		
<b>UNIT-II</b>	<b>OPERATIONAL AND ORGANIZATIONAL SECURITY</b>	<b>9</b>
Policies, Procedures, Standards and Guidelines – Security Awareness and Training – Interoperability Agreements – The security Perimeter – Physical Security – Environmental Issues – Wireless – Electromagnetic Eavesdropping – The Role of Security in People.		
<b>UNIT-III</b>	<b>CRYPTOGRAPHY</b>	<b>9</b>
Cryptography in Practice – Historical Perspectives – Algorithms – Hashing Functions – Symmetric Encryption – Asymmetric Encryption – Quantum Cryptography – Steganography – Cryptography Algorithm Use.		
<b>UNIT-IV</b>	<b>AUTHENTICATION AND REMOTE ACCESS</b>	<b>9</b>
User, Group and Role Management – Password Policies – Single Sign-On – Security Controls and Permissions – Preventing Data Loss or Theft – The Remote Access Process – Remote Access Methods.		
<b>UNIT-V</b>	<b>INTRUSION DETECTION SYSTEMS AND NETWORK SECURITY</b>	<b>9</b>
History of Intrusion Detection Systems – IDS Overview – Network-Based IDSs – Host-Based IDSs – Intrusion Prevention Systems – Honeypots and Honeynets – Tools.		
		<b>Contact Hours : 45 Periods</b>

<b>Course Outcomes:</b>	
On completion of the course, the students will be able to	
•	Learn the basics of Security Trends.
•	Know the operational and organizational security.
•	Explain the fundamentals of cryptography.
•	Apply Authentication methods and Tools.
•	Demonstrate the Intrusion Detection Systems.

<b>Reference Books:</b>	
1	W.A.Coklin, G.White, Principles of Computer Security: Fourth Edition, McGrawHill, 2016.
2	William Stallings, Cryptography and Network Security Principles and Practices, Seventh Edition, Pearson.
3	Achyut S. Godbole, Web Technologies: TCP/IP, Web/Java Programming, and Cloud Computing, Tata McGraw- Hill Education, 2013.

CO/PO	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PO13	PO14	PO15	PO16
CO1	1	-	2	-	-	-	-	1	-	-	-	-	1	-	-	-
CO2	2	-	-	2	-	-	-	-	-	-	-	-	1	3	-	-
CO3	2	-	-	3	-	-	-	-	-	-	-	-	2	-	-	2
CO4	-	-	-	-	2	1	-	-	-	-	-	-	-	2	2	-
CO5	-	2	-	-	-	-	-	-	-	-	-	-	1	-	2	3
CO (Avg)	1	0.4	0.4	1	0.4	0.2	-	0.2	-	-	-	-	1	1	0.8	1

Correlation levels 1, 2 or 3 are as defined below:

1: Slight (Low) 2: Moderate (Medium) 3:

Substantial(High) No correlation : “-”

## Open Electives Offered by MCT

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	OMT1901	Elements Of Automation	OE	3	3	0	0	3
2.	OMT1902	CNC Systems -Design And Applications	OE	3	3	0	0	3
3.	OMT1903	Mobile Robotics	OE	3	3	0	0	3
4.	OMT1904	Medical Mechatronics	OE	3	3	0	0	3

<b>OMT1901</b>	<b>ELEMENTS OF AUTOMATION</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

### OBJECTIVES:

- Understand the fundamental knowledge of various elements of automation.
- Understand the need for automation in process industries.
- To impart basic knowledge of sensors and actuators
- To apply the fundamental knowledge of hydraulic and pneumatic system
- To provide a clear view on Programmable Logic Controllers (PLC) and its application

### **UNIT I INTRODUCTION TO AUTOMATION 9**

Automated manufacturing systems - fixed /programmable /flexible automation - Need of automation, Basic elements of automated systems- power, program and control. Levels of automation; control systems: Continuous and discrete control; Low cost automation, Economic and social aspects of automation.

### **UNIT II SENSORS AND TRANSDUCERS 9**

Introduction to sensors and transducers - Static and dynamic characteristics-Types - Displacement, position and proximity  
Velocity and motion - force - fluid pressure - liquid flow and level - Temperature - Light - Selection of sensors.

### **UNIT III BASICS OF PNEUMATICS AND HYDRAULICS SYSTEM 9**

Operational principles and application, air compressors, Pneumatic cylinders and air motors, Pneumatic valves Principles of hydraulics, Hydraulic fluids, Hydraulic- pumps, valves, and actuators.

### **UNIT IV MECHANICAL AND ELECTRICAL ACTUATION SYSTEMS 9**

Mechanical actuation System: Mechanical system - types of motion - Kinematic chain - cams - Gear Trains Belt and chain drives  
Mechanical aspects of Motor selection. Electrical actuation system: Stepper motor, Servo motor, Solenoid switches

### **UNIT V PROGRAMMABLE LOGIC CONTROLLER 9**

Introduction - Basic structure - Input/output processing - programming  
Timers and counters - Analogue input/output - Selection of PLC - Simple problems

**TOTAL : 45 PERIODS**

## OUTCOMES:

After the completion of this course students will be able to

- Understand the fundamentals of automation system.
- Classify and infer various types of sensors and transducers
- Demonstrate various applications of hydraulic and pneumatic systems.
- Illustrate the operations of mechanical and electrical actuation systems.
- Acquire basic knowledge on PLC for various applications.

## TEXT BOOKS:

1. Bolton W., Mechatronics: electronic control systems in mechanical and electrical engineering, Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2013
2. Anthony Esposito, "Fluid Power with applications", Prentice Hall international, 2009.
3. Mikell P Groover, "Automation Production Systems and Computer- Integrated Manufacturing" Pearson Education, New Delhi, 2008.

## REFERENCES

1. Kuo .B.C, "Automatic control systems", Prentice Hall India, New Delhi, 2007.
2. Bagad V. S., Mechatronics, Technical Publication, Pune, 2009.
3. Devdas Shetty and Richard A. Kolk, Mechatronics System Design, Cengage Delmar Learning India Pvt Learning, 2012.

<b>OMT1902</b>	<b>CNC SYSTEMS- DESIGN AND APPLICATIONS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

## OBJECTIVES:

- Understand evolution and principle of CNC machine tools
- Describe constructional features of CNC machine tools
- Generate CNC programs for popular CNC controllers
- Describe machine tools and work holding devices for CNC machine tools

### **UNIT I INTRODUCTION 9**

Introduction to Automation – Goals of Automation, levels of automation, Hard Vs Soft Automation, Computer Aided manufacturing (CAM).

Evolution of CNC Technology - Numerical Control - Introduction, Role of NC / CNC in CAM, Applications of NC / CNC, Benefits of NC / CNC, Limitations of CNC.

### **UNIT II COMPONENTS OF CNC SYSTEM 9**

Basic Components of CNC system - Part programming, Machine control unit, Machine tool - Historical developments and their role in control of machine tools

Classification of NC / CNC systems - Based on type of Control (PTP\C\L), method of programming, type of architecture - Hardwired / Softwired / Open.

### **UNIT III INTERPOLATORS AND CONTROLLERS 9**

Machine Control Unit - Data processing Unit - elements and their functions - Interpolators and Sequential Controllers. Interpolators - Types and Stages of Interpolation, Principles of interpolation  
Programmable Logic Controllers - Elements of Hardware and Software, Methods of programming.

**UNIT IV PART PROGRAMMING****9**

Part programming - Introduction; Part Program and its elements, Methods of Programming - Manual and Computer Assisted Part programming - Concepts of CAM - Tool path generation and control methods.

**UNIT V MACHINE TOOLS****9**

Machine Tool - Components of CNC machine tool, Drives and controls, Automatic Tool Changers Automatic Pallet Changers, tool offsets and work offsets, high speed and precision machining concepts-work holding devices.

**TOTAL: 45 PERIODS****OUTCOMES:**

After the completion of this course students will be able to

- Explain the fundamentals of CNC machines, differentiate the advantages and disadvantages of different types of CNC machines
- Recognise the basic structure, construction, working and control of CNC machines
- Develop a CNC Part programming for the basic operations
- Classify different types of interpolators and controllers
- Be familiar with different machine tools and work holding devices of CNC

**TEXT BOOKS**

1. Koren Y, "Computer Control of Manufacturing systems", McGraw Hill, 2017.
2. Alan Overby "CNC Machining Handbook: Building, Programming, and Implementation" McGraw-Hill Education, 2010

**REFERENCES**

1. Reinbold U, Blume C and Dilmann R, "Computer Integrated Manufacturing Technology & Systems", Marcel Dekker, 1985.
2. John W, "Programmable Controllers - Principles and Applications" Merrill Publ.Co, New York, 1980.
3. Madison J, "CNC machining Handbook", Industrial Press Inc., 1996.
4. Barry Leatham - Jones, Introductions to Computer Numerical Control, Pitman, London - John Willey & Sons, 1986.
5. Roger S. Pressman & John E. Williams, Numerical Control and Computer Aided Manufacturing, John Willey.

**OMT1903****MOBILE ROBOTICS**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES:**

- To impart knowledge about the basics and constraints in Mobility for Robots
- To study about the different sensors integrated with mobile robots
- To observe about the Path determination and observance of the Robot environment
- To study about the different controlling strategies for Mobile Robots
- To expose the different application areas of Mobile Robotics

**UNIT I INTRODUCTION TO MOBILE ROBOTS****9**

Introduction – History – Configuration Space - Motion Constraints – Kinematics of wheeled Mobile Robots – Dynamics of Mobile Robots with Constraints – Mobile Robot Safety.

**UNIT II MOBILE ROBOT SENSORS 9**  
Position Sensor – Velocity Sensor – Distance Sensor – Robot Vision – Optical Gyroscope – Compass – GPS.

**UNIT III ROBOT LOCALIZATION AND MOTION PLANNING 9**  
Relative Localization – Absolute Localization – Simultaneous Localization and Mapping - Operation of Robot Navigation – Classification of Path Planning Methods – Model Based Robot Path Planning – Mobile Robot Motion Planning – Mobile Robot Task Planning.

**UNIT IV MOBILE ROBOT CONTROLLERS 9**  
General Robot Controllers - Sliding Mode Control of Mobile Robot – Fuzzy Control for Mobile Robot – Position Based Vision Control – Image Based Vision Control

**UNIT V APPLICATIONS OF MOBILE ROBOTS 9**  
Mobile Robot in Factory Automation – Mobile Telerobots – Micro Mobile Robots - Research Robots – War Robots – Assistive Mobile Robots in Walking Rehabilitation Therapy – Mobile Robots for Home Services.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

After the completion of this course students will be able to

- Understand the basics of Mobility in Robots along with its constraints
- Compare the sensor performances and able to choose appropriate sensor based upon the requirement
- Perform Localization of Mobile Robot and its Path Planning.
- Analyze the performances of different Controllers in Mobile Robots
- Understand the different areas of Applications of Mobile Robots

**TEXT BOOKS**

1. Spyros G Tzafestas, “Introduction to Mobile Robot Control”, Elsevier, 2014
2. Gregor Klancar, Andrej Zdesar, Saso Blazic, Igor Skrjanc, “Wheeled Mobile Robotics: From Fundamentals Towards Autonomous Systems”, Butterworth Heinemann, 2017

**REFERENCES**

1. Kevin M. Lynch, Frank C. Park, “Modern Robotics”, Cambridge University Press, 2017
2. Everett H.R., “Sensors for Mobile Robots”, CRC Press, 2010
3. Carlotta A. Berry, “Mobile Robotics for Multidisciplinary Study”, Morgan and Claypool, 2012

<b>OMT1904</b>	<b>Medical Mechatronics</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**OBJECTIVES:**

- To study the basics, scopes and importance of Biomechatronics
- To understand the sensors used in the field of medical sciences
- To understand the concept of mobility assistance in medical field
- To study the working of bioinspired robots in medical field
- To understand the concepts and applications of robotics in Medicine

<b>UNIT-I Introduction to Biomechatronics</b>	<b>9</b>
Introduction – Scope of Biomechatronics – Overview of Neuromusculoskeletal System – Role of Biomechatronics – CPM – Importance of Mechatronics in Medical Applications	<b>9</b>
<b>UNIT-II Biosensors</b>	
Bio MEMS Sensors – Optical Sensors for Medical Care – Biosensors for Glucose Monitoring – Sensors for Respiratory Monitoring - Feedback Sensors - – Home Health Care and Telecare	<b>9</b>
<b>UNIT-III Mobility Assistance</b>	
Introduction – Manual Wheelchairs – Electric Wheelchairs – Wheelchairs with Low-Throughput HMIs – Stair-Climbing Wheelchairs – Assisted Walking – Challenge of Innovation in Semi- Autonomous Wheelchair Design	<b>9</b>
<b>UNIT-IV Bioinspired Robotics</b>	
Introduction to Bioinspiration – Bioinspired Locomotion – Bioinspired Manipulation – Bioinspired Soft-Robotic Systems – Algorithmic Bioinspiration	<b>9</b>
<b>UNIT-V Applications of Mechatronics in Medicine</b>	
Robotics in Medicine – Smart Instruments and Probs – Smart Probe for Detecting Kidney Stones – Breast Cancer – Smart System for Cardiovascular Plaque Detection	
<b>Total Contact Hours</b>	<b>: 45</b>

**Course Outcomes:**

On completion of course students will be able to

- Explain the concepts of mechatronics in medical field.
- Analyze the working of biosensors for medical applications
- Predict the different working methods of wheelchair for mobility assistance
- Explain the working of Robotics in Medical Field
- Discover the components used in smart medical systems

**Text Books:**

- 1 Marko B. Popovic, “Biomechatronics” Elsevier Science, March 2019

**Reference Books / Web links:**

- 1 Jyotismita Chaki, Nilanjan Dey, Debashis De, “Smart Biosensors in Medical Care”,2020
- 2 Siamak Najarian, Javad Dargahi, Goldis Darbemamieh, Siamak Hajizadeh Farkoush, “Mechatronics in Medicine A Biomedical Engineering Approach”, 2011
- 3 Dawson D and Right, “Introduction to Bio-mechanics of Joints and Joint Replacement”, Mechanical Engineering Publications Ltd., 1989.

## Open Electives Offered by MECH

Subject Code	Subject Name (Theory course)	Category	L	T	P	C
OME1901	SUPPLY CHAIN MANAGEMENT	OE	3	0	0	3

Objectives: The students can						
●	Describe the role and drivers of supply chain management in achieving competitiveness.					
●	Understand about Supply Chain Network Design.					
●	Illustrate the issues related to Logistics in Supply Chain.					
●	Appraise about Sourcing and Coordination in Supply Chain.					
●	Understand the application of Information Technology and Emerging Concepts in Supply Chain					

<b>UNIT-I</b>	<b>INTRODUCTION TO SUPPLY CHAIN MANAGEMENT</b>	<b>9</b>
Supply chain Management: Scope and Importance - Evolution of Supply Chain – Examples of supply Chains - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.		
<b>UNIT-II</b>	<b>SUPPLY CHAIN NETWORK DESIGN</b>	<b>9</b>
Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network- Distribution Network in Practice - Role of network Design in Supply Chain – Framework for network Decisions – Impact of uncertainty on Network Design – Network design decisions – Network design decisions using Decision Tress.		
<b>UNIT-III</b>	<b>LOGISTICS IN SUPPLY CHAIN</b>	<b>9</b>
Role of transportation in supply chain – Factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation - 3PL- 4PL- Global Logistics - Reverse Logistics: Reasons, Activities and issues.		
<b>UNIT-IV</b>	<b>SOURCING AND COORDINATION IN SUPPLY CHAIN</b>	<b>9</b>
Role of Sourcing in supply chain - Supplier selection, assessment and contracts - Design Collaboration – Sourcing, Planning and Analysis - Supply chain co-ordination - Bull whip effect – Effect of lack of coordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.		
<b>UNIT-V</b>	<b>IT AND EMERGING CONCEPTS IN SUPPLY CHAIN</b>	<b>9</b>
The role IT in supply chain - The supply chain IT framework - Customer Relationship Management - Internal Supply Chain Management – Supplier Relationship Management – Future of IT in supply chain – E-Business in supply chain - Risks in Supply Chain - Lean supply Chains - Sustainable supply Chains.		
<b>Total Contact Hours</b>		<b>: 45</b>

Course Outcomes: Upon completion of this course, students will acquire	
●	Ability to understand the scope of Supply Chain Management and the drivers of Supply Chain performance.
●	Ability to design suitable Supply Chain network for a given situation.
●	Ability to analyze and solve the issues related to Logistics in SCM.
●	Ability to understand Sourcing, Coordination and current issues in SCM.
●	Ability to appraise about the applications of IT in SCM and apply SCM concepts in selected enterprises.

Text Books:	
1	Sunil Chopra, Peter Meindl and D.V. Kalra, “Supply Chain Management: Strategy, Planning and Operation”, Pearson Education, 2016.

<b>Reference Books(s) / Web links:</b>	
1	Ravi Ravindran A, Donald P. Warsing, Jr, "Supply Chain Engineering: Models and Applications", "CRC Press, 2012.
2	Srinivasan G.S, "Quantitative models in Operations and Supply Chain Management", PHI, 2010.
3	Janat Shah, "Supply Chain Management: Text and Cases", Pearson Education India, 2016.

<b>Subject Code</b>	<b>Subject Name (Theory course)</b>	<b>Category</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>OME1902</b>	<b>BASICS OF 3D PRINTING AND ADDITIVE MANUFACTURING</b>	<b>OE</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

<b>Objectives:</b>	
●	To familiarize the development of Additive Manufacturing, various business opportunities and applications.
●	To understand various software tools, techniques and file formats to create 3D models that helps in product development / prototyping requirements using AM.
●	To be familiar with Liquid and Solid based AM processes.
●	To be familiar with Powder and Wax based processes.
●	To understand the use of Bio Additive manufacturing and 4D printing.

<b>UNIT-I</b>	<b>INTRODUCTION</b>	<b>9</b>
Need, Fundamentals of Additive and digital Manufacturing, Advantages and Applications, Comparison of Additive Manufacturing with traditional Manufacturing, Additive Manufacturing (AM) process chain: 3D model, converting into STL file, transfer to system, checking, machine setup and building, Post process. Classification of AM process. Materials used in Additive Manufacturing Processes, Need for AM in product development and rapid tooling.		
<b>UNIT-II</b>	<b>REVERSE ENGINEERING AND DESIGN FOR ADDITIVE MANUFACTURING (DFAM)</b>	<b>9</b>
Introduction to Reverse Engineering: Applications, Steps in reverse Engineering. Design for additive manufacturing: CAD model preparation, Part orientation and support generation and removal, Model slicing and software's – Tool path generation. File formats in AM. Data Processing and Controllers.		
<b>UNIT-III</b>	<b>LIQUID AND SOLID BASED ADDITIVE MANUFACTURING PROCESSES</b>	<b>9</b>
Guidelines for process selection, Liquid based AM process - Stereo lithography apparatus, Polyjet printing, Digital Light Processing - Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies. Solid Based AM process - Fused Deposition Modeling (FDM), Solid Ground Curing (SGC), Laminated Object Manufacturing (LOM) - Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies.		
<b>UNIT-IV</b>	<b>POWDER BASED AND OTHER ADDITIVE MANUFACTURING PROCESSES</b>	<b>9</b>
Selective Laser Sintering (SLS), Selective Laser Melting (SLM) and Electron Beam Melting (EBM), Laser Engineered Net Shaping (LENS): Principle, Process, Machine parameters, Process parameters, Materials used, Strength and weakness, Applications, Case studies. Wax printing – Principle, Process, materials used and applications.		
<b>UNIT-V</b>	<b>BIO ADDITIVE MANUFACTURING AND 4D PRINTING</b>	<b>9</b>

Bio-Additive Manufacturing, Computer Aided Tissue Engineering (CATE) – Processing Steps and Case Studies. Customized Implants and Prosthesis, Materials used in bio printing and limitations. Design and Production of Medical devices. Sustainability in AM processes – Introduction to 4D printing and Smart materials used.

**Total Contact Hours** : **45**

**Course Outcomes:** At the end of this course, students can have the

- Ability to explain the development of AM technology and how AM technology propagated into various businesses and developing opportunities.
- Ability to explain the process of transforming a concept / existing product into 3D model used in AM technology.
- Ability to explain Liquid and Solid based AM processes.
- Ability to explain Powder and Wax based processes.
- Ability to evaluate the advantages, limitations, applications and use of Bio Additive manufacturing and 4D printing.

**Text Books:**

1. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015.
2. Ian Gibson, David W. Rosen and Brent Stucker “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”, 2nd edition, Springer., United States, 2015.

**Reference Books(s) / Web links:**

1. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015.
2. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011
3. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States, 2006.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011.
5. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies, and Applications”, Woodhead Publishing., United Kingdom, 2016.

## Open Electives Offered by S & H

Subject Code	Subject Name	Category	L	T	P	C
OCY1901	GREEN CHEMISTRY IN ENERGY AND ENVIRONMENT	OE	3	0	0	3

Objectives:	
●	To understand the principles of green chemistry
●	To acquire knowledge on different approaches of green chemical reactions
●	To know the synthesis and applications of bio-inspired green nanomaterials.
●	To obtain knowledge on microbial fuel cells.
●	To understand the production and storage of hydrogen energy.

<b>UNIT-I</b>	<b>INTRODUCTION TO GREEN CHEMISTRY</b>	<b>9</b>
Green chemistry–definition–principles of green chemistry–green chemistry metrics– atom economy- E factor- reaction mass efficiency and other green chemistry metrics–application of green metrics analysis to synthetic plans– Waste: Production-problems-prevention.		
<b>UNIT-II</b>	<b>GREEN CHEMICAL REACTIONS</b>	<b>9</b>
Environmentally benign processes–solvent free reactions-alternate solvents–supercritical solvents–ionic liquids– water as a reaction medium–energy efficient design of processes–photo- electro- sono chemical methods– microwave assisted reactions. Green reagents and catalysis in green synthesis.		
<b>UNIT-III</b>	<b>BIO-INSPIRED GREEN NANOMATERIALS</b>	<b>9</b>
Bio-inspired green nanomaterials –biosynthesis of nanoparticles by bacteria and fungi – biosynthesis of nanoparticles using plant extracts – advantages - applications.		
<b>UNIT-IV</b>	<b>MICROBIAL FUEL CELLS</b>	<b>9</b>
Introduction – materials for microbial fuel cells –principles, working and applications – wastewater treatment – energy generation – sensors.		
<b>UNIT-V</b>	<b>HYDROGEN ENERGY</b>	<b>9</b>
Hydrogen – physical and chemical properties- characteristics–production of hydrogen –Electrochemical: electrolysis, photo electro chemical. Biological: photo biological, anaerobic digestion. Hydrogen storage options – compressed gas –chemical hydride–cryogenic storage–Nanostructures for efficient solar hydrogen production– metal nano clusters in hydrogen storage applications.		
		<b>Total Contact Hours : 45</b>

Course Outcomes:	
On completion of the course students will be able to	
●	Familiarize with the principles of green chemistry.
●	Apply green chemical approaches in the manufacture of materials.
●	Synthesize biogenic nanomaterials.
●	Develop microbial fuel cells.
●	Acquaint with the production of hydrogen energy.

<b>Text Books:</b>	
1	Ahluwalia, V. K., Kidwai M. New trends in green chemistry, Anamaya Publishers, New Delhi, India (2004).
2	Basu, S. (Ed) Recent Trends in Fuel Cell Science and Technology, Springer-Verlag New York (2007).

<b>Reference Books / Web links:</b>	
1	Mike Lancaster, Green Chemistry: An Introductory Text: Edition 3, RSC (2016).
2	Albert S. Matlack, "Introduction to Green Chemistry", CRC press (2010).
3	Alexi Lapkin and David Constable (Eds), Green chemistry metrics, Wiley, John & Sons, Incorporated (2008).
4	Ahluwalia. V.K, Green Chemistry, Environmentally Benign Reactions, CRC Press, Boca, Raton, 2 <sup>nd</sup> Edition (2012).
5	Vladimir A. Basiuk, Elena V. Basiuk, Green Processes for Nanotechnology: From Inorganic to Bioinspired Nanomaterials, Springer International Publishing Switzerland, (2015).
6	Keith Scott and Eileen Hao Yu (Eds), Microbial Electrochemical and Fuel Cells, Fundamentals and Applications, 1 <sup>st</sup> Edition, Woodhead Publishing (2016).
7	B. Sorensen, G. Spazzafumo, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier, Academic Press (2018).

Subject Code	Subject Name	Category	L	T	P	C
OGE1901	GERMAN LANGUAGE	OE	3	0	0	3

<b>Objectives:</b>	
●	To learn the basic vocabulary in German language.
●	To learn to speak simple sentences in German language.
●	To learn to make request over telephone and answer using telephone etiquettes.
●	To learn to write a formal or informal letter and respond.
●	To understand a conversation as spoken by the natives in their accent.

<b>UNIT-I</b>	<b>Grüßen, vorstellen und überHobbyssprechen</b>	<b>9</b>
grüßen und verabschieden – sich und andere vorstellen – übersich und anderesprechen - Zahlen bis 20 - Telefonnummer und E-Mail-Adressen sagen – buchstabieren - über Länder und Sprachensprechen – <b>Grammatik:</b> W Frage – Aussagesatz - Verben und Personal pronomen. – überHobbyssprechen – sich verabreden, Wochentage benennen - über Arbeit, Berufe und Arbeitszeiten sprechen - ein Profil im Internet erstellen. <b>Grammatik:</b> Artikel – der, das, die – Verben und Personal Pronomen – II - Ja- / Nein Frage - Plural der Substantive - die Verben 'haben' und 'sein'		
<b>UNIT-II</b>	<b>Reise in einer Stadt, das Essen und Zeitangaben</b>	<b>9</b>
Plätze und Gebäude benennen – Fragen zu Orten stellen - Texte einer Bildgeschichte zuordnen Dinge erfragen – Verkehrsmittel benennen - nach dem Weg fragen und einen Weg beschreiben – Texte mit internationalen Wörtern verstehen – Artikel lernen. <b>Grammatik:</b> bestimmter Artikel – der, das, die – unbestimmter Artikel – ein, eine – Negations Artikel – kein, keine - Imperativ mit 'Sie' - über Essen sprechen – einen Einkauf planen – Gespräche beim Einkauf führen – mit 'w' fragen Texte verstehen – Wörter ordnen und lernen. <b>Grammatik:</b> Positionen im Satz – Akkusativ – Verben mit Akkusativ.		
<b>UNIT-III</b>	<b>Zeit mit Freunden, Eine Einladung schreiben und beantworten</b>	<b>9</b>

Die Uhrzeit verstehen und nennen – Zeitangaben machen – über die Familie sprechen – sich verabreden – sich für eine Verspätung entschuldigen und darauf reagieren – einen Termin telefonisch vereinbaren. <b>Grammatik:</b> Zeitangaben mit am, um, von, bis – Possessivartikel: mein, dein – Modalverben im Satz - Modalverben – müssen, können, wollen - etwas gemeinsam planen – über Geburtstage sprechen – eine Einladung verstehen und schreiben – im Restaurant bestellen und bezahlen – über ein Ereignis sprechen – bestimmte Informationen in Texten finden – Veranstaltungstipps in Radio verstehen. <b>Grammatik:</b> Datumsangaben; am – trennbare Verben – Präposition für + Akkusativ – Personalpronomen im Akkusativ mich, dich. - Präteritum von 'haben' und 'sein'.		
<b>UNIT-IV</b>	Kontakte, Wohnung	<b>9</b>
Termine absprechen – Anleitungen verstehen und geben – Briefe verstehen und beantworten – über Sprachen lernen sprechen – Informationen in Texten finden – Gesprächssituationen erkennen, Gespräche verstehen. <b>Grammatik:</b> Präpositionen mit Dativ - Artikel im Dativ – Possessivartikel: Akkusativ. Wohnungsanzeigen verstehen – eine Wohnung beschreiben – eine Einladung schriftlich beantworten – über eine Wohnungseinrichtung sprechen – Gefallen und Missfallen ausdrücken – Farben nennen – über Wohnformen sprechen – einen Text über eine Wohnung schreiben. <b>Grammatik:</b> Adjektiv mit sein – Adjektiv + sehr/zu – 'in' mit Akkusativ – Wechsel Präpositionen mit Dativ.		
<b>UNIT-V</b>	Arbeit, Kleidung und Mode	<b>9</b>
Tagesablauf beschreiben – über vergangene Ereignisse sprechen – über Stellenanzeigen verstehen – Meinung über Jobs äußern – Blogs über Jobs verstehen – ein Telefongespräch vorbereiten – telefonieren und nachfragen – über Jobs sprechen. <b>Grammatik:</b> Perfekt/Partizip II regelmäßige und unregelmäßige Verben – Sätze verbinden: 'und', 'oder', 'aber'. - über Kleidung und Mode sprechen – Chat über einen Einkauf verstehen – über vergangenes berichten (to report about the past) – Gespräche beim Kleiderkauf führen – sich im Kaufhaus orientieren – Informationen über Berlin verstehen und recherchieren. <b>Grammatik:</b> Interrogativartikel: Welcher? Welches? Welche? – Demonstrativartikel: dieser, dieses, diese – Partizip II: trennbare und nichttrennbare Verben – Personalpronomen im Dativ – Verben mit Dativ.		
		<b>Total Contact Hours : 45</b>

<b>Course Outcomes:</b>	
On Completion of the course, the student will be able to:	
●	Do Self-introduction, to greet someone, say telephone number, Email Address and frame questions using "W" question words.
●	Converse in German like, Frame questions related to place names, say the means of transport, ask for the way and to describe a way, speak about food, lead a conversation in a shop.
●	Respond to requests and Queries like, the Time and Date in German, ask excuse for late coming, speak about Birthdays, place an order in a Restaurant and make payment.
●	Write simple text like, Letter writing and answering a letter, understand the conversation situation, describe an Apartment, write a text about an Apartment.
●	Say the actions that happened in the past, to orientate oneself in a Department store, speak about Dress.

<b>Text Books:</b>	
1	Lehrbuch: 'Netzwerk A1 Deutsch als Fremdsprache A1' published in India by: Goyal Publishers & Distributors Pvt. Ltd., 86, U.S. Jawahar Nagar, Kamla Nagar, Delhi – 110 007.
2	Referenz: 'Studio d A1 Deutsch als Fremdsprache' published in India by: Goyal Publishers & Distributors Pvt. Ltd., 86, U.S. Jawahar Nagar, Kamla Nagar, Delhi – 110 007.

<b>Reference Books / Web links:</b>	
1	<a href="https://www.lingoni.com">https://www.lingoni.com</a>
2	<a href="https://learngermanwithanja.com">https://learngermanwithanja.com</a>
3	<a href="https://youtu.be/RuGmc662HDg">https://youtu.be/RuGmc662HDg</a>

Subject Code	Subject Name	Category	L	T	P	C
OHS1901	PROFESSIONAL COMMUNICATION AND LIFE SKILLS	OE	2	1	0	3

Objectives:	
●	To introduce the need for professional communication in the workplace
●	To improve personal and oral communication and professional presentation skills
●	To prepare an effective resume, and to attend interviews
●	To enhance official communication and Team Skills
●	To comprehend personal values and principles to improve professional competency.

UNIT-I	PROFESSIONAL COMMUNICATION	9
Basics of Communication - Purpose of Professional Communication - Effective Communication-Communication Techniques - Types of Communication – Process of communication - Tools for communication- Barriers to Communication - Communication at Workplace –Verbal Communication –Non-verbal Communication - General Conversation.		
UNIT-II	PERSONAL COMMUNICATION	9
Self-Introduction - Personal Communication - Oral Communication – Extempore - Impromptu Speaking-Public Speaking – Listening practice for Public speaking – Presentation Skills – Visual Presentation - Personal Appearance and Etiquettes - Body Language – Postures - Facial Expression - Eye Contacts - Demonstrative speech - Pick and Talk- Telephonic Etiquettes.		
UNIT-III	PREPARATORY SKILLS	9
Recruitment process - Cover letter - Resume writing – Digital Resume - Exploring Career Opportunities - Identifying the Core Domains - Applying and Following the responses - Call letters – Interview Skills - Interpersonal Skills - Mock Interview - Aptitude and Reasoning Skills - Facing the Personal Interview -Building Social Profile and Identity - Critical Thinking-Entrepreneurial Skills- Negotiation Skills		
UNIT-IV	OFFICIAL COMMUNICATION	9
Email Writing Etiquettes - Requesting and responding to requests – follow up emails – Documentation-Agenda - Minutes of the Meeting - Official and Business Correspondence – Memorandum – Notices - Policies and Circulars – Structured communication – Role play based on real-time issues - Brainstorming - Group Discussion Skills - Team Building		
UNIT-V	LIFE SKILLS	9
Definition - Strategies and Techniques - Components of Life skills - Self-awareness - Applying life skills - Human Values - Problem Solving - Stress Management - Emotional Intelligence - Work and life balance - Self Discipline - Decision Making Skills – Values and Ethics - Code of Conduct - Professional Ethics - Critical and Analytical thinking - Time management -Overcoming Failures - Case studies		
<b>Total Contact Hours</b>		<b>45</b>

Course Outcomes:
------------------

On completion of the course, students will be able to	
●	Initiate communication, compete and make effective presentations.
●	Communicate with colleagues and employers with confidence.
●	Prepare for interviews and achieve their dream job.
●	Build written communication and become competitive in the workplace.
●	Adopt life skills and human values.

<b>Reference Books / Weblinks:</b>	
1	Thomas Hackin, and Leslie Olsen. Technical Writing and Professional Communication for non-native speakers of English, McGraw- Hill
2	Clyne, M. Inter-cultural communication at work. , Cambridge University Press, Cambridge, 1994
3	Adair, John. Effective Communication. London: Pan Macmillan Ltd., 2003.
4	Meenakshi, Raman, and Sangeeta Sharma. Communication Skills. Oxford: University Press.India, 2011.
5	Ajmani, J. C. Good English: Getting it Right. New Delhi: Rupa Publications, 2012.
6	Shikha, Seetha. Communication Skills for Engineers in Global arena, IJAMH(1): 1-6 (2012)
<b>Online Resources</b>	
1	<a href="https://www.coursera.org/specializations/effective-business-communication">https://www.coursera.org/specializations/effective-business-communication</a>
2	<a href="https://www.youtube.com/watch?v=srn5jgr9TZo&amp;t=6s">https://www.youtube.com/watch?v=srn5jgr9TZo&amp;t=6s</a>
3	<a href="https://www.youtube.com/watch?v=CZx4DTglHJc&amp;t=329s">https://www.youtube.com/watch?v=CZx4DTglHJc&amp;t=329s</a>
4	<a href="https://www.coursera.org/learn/learning-how-to-learn">https://www.coursera.org/learn/learning-how-to-learn</a>
5	<a href="https://www.youtube.com/watch?v=2wPeC4CLkLU">https://www.youtube.com/watch?v=2wPeC4CLkLU</a>

Subject Code	Subject Name	Category	L	T	P	C
OMA1901	COMPUTER BASED NUMERICAL METHODS	OE	2	0	2	3

<b>Objectives:</b>	
●	This course aims at providing the necessary basic concepts of a few numerical methods for solution of algebraic equations.
●	To develop interpolating polynomials in both equal and unequal intervals
●	To provide for solving numerically, the different kinds of problems involving differentiation and integration.
●	This course aims at providing the necessary procedures for solving initial value problems and ordinary differential equations numerically.
●	This course aims at providing the necessary procedures for solving boundary value problems and partial differential equations numerically.

<b>UNIT-I</b>	<b>SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS</b>	<b>9</b>
Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations: Iterative method - Gauss Seidel - Eigen values of a matrix by Power method – algorithms.		
<b>UNIT-II</b>	<b>INTERPOLATION AND APPROXIMATION</b>	<b>9</b>
Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation - Interpolation with equal intervals - Newton's forward and backward difference formulae- algorithms.		

<b>UNIT-III</b>	<b>NUMERICAL DIFFERENTIATION AND INTEGRATION</b>	<b>9</b>
Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules –algorithms.		
<b>UNIT-IV</b>	<b>INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS</b>	<b>9</b>
Single Step methods - Taylor's series method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multi step method - Milne's predictor corrector methods for solving first order equations – algorithms.		
<b>UNIT-V</b>	<b>BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS</b>	<b>9</b>
Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method – algorithms.		
		<b>Total Contact Hours</b>
		<b>45</b>

**Course Outcomes:**

On completion of the course, students will be able to

●	solve algebraic equations and eigen value problems that arise during the study of Engineering problems.
●	use various interpolation techniques for solving problems in Engineering.
●	use numerical methods to solve problems involving numerical differentiation and integration.
●	solve initial value problems numerically that arise in Science and Engineering.
●	solve boundary value problems that encounter in different fields of Engineering study.

**Text Books:**

<b>1</b>	Veerarajan. T, “ Numerical methods with programs in C,”Tata McGraw Hill, New Delhi, 2007.
----------	---

**Reference Books / Web links:**

<b>1</b>	Chapra. S.C., and Canale.R.P., "Numerical Methods for Engineers, Tata McGraw Hill, 5 th Edition, New Delhi, 2007.
<b>2</b>	Brian Bradie. "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.
<b>3</b>	SankaraRao. K., "Numerical methods for Scientists and Engineers", Prentice Hall of India Private, 3 rd Edition, New Delhi, 2007.
<b>4</b>	Grewal. B.S., and Grewal. J.S., "Numerical methods in Engineering and Science", Khanna Publishers, 9th Edition, New Delhi, 2007.
<b>5</b>	Gerald. C. F., and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 6th Edition, New Delhi, 2006.
<b>6</b>	Goyal, M, “Computer Based Numerical and Statistical Techniques”, Firewall Media, New Delhi

Subject Code	Subject Name	Category	L	T	P	C
OPH1901	MATERIALS SYNTHESIS AND CHARACTERIZATION TECHNIQUES	OE	3	0	0	3

Objectives:						
•	To understand the techniques to grow quality single crystals by solution and melt growth.					
•	To learn various preparation methods to synthesis nanostructured materials.					
•	To study various preparation methods to synthesis ceramic materials.					
•	To learn different methods of structural analysis for material synthesized.					
•	To learn different methods for analysing thermal and microscopic properties of materials					

<b>UNIT-I</b>	<b>Crystal Growth Techniques</b>	<b>9</b>
Solution growth – low temperature -Supersaturation – Nucleation – Seeding – dopants – Melt growth – Czochralski method – Bridgman method – S-R Method of growing bulk single crystals–NLO crystals - Applications		
<b>UNIT-II</b>	<b>Nanomaterials Preparation Techniques</b>	<b>9</b>
Two main approaches in nanotechnology -Bottom up technique and top down technique - Ball milling, Sputtering, Vapour deposition - pulsed laser deposition – chemical vapour deposition, sol-gel -Nano-structures – quantum wires, quantum wells, quantum dots, quantum clusters - Carbon nano-tubes - Applications		
<b>UNIT-III</b>	<b>Ceramic Materials Preparation Techniques</b>	<b>9</b>
Types and applications of ceramics - Synthesis of ceramic powders - Forming of ceramics: Uniaxial and Isostatic pressing , Slip casting, Tape casting, Extrusion and Injection molding - Sintering - Porosity measurement.		
<b>UNIT-IV</b>	<b>Introduction to Structural Analysis</b>	<b>9</b>
X-ray Diffraction – Single crystal and Powder diffraction – Electron microscopy - SEM – TEM– AFM – Advantages and limitations		
<b>UNIT-V</b>	<b>Thermal and Spectroscopic Studies</b>	<b>9</b>
Thermal studies - Thermo Gravimetry – Differential Thermal Analysis – Differential Scanning Calorimetry – Specific Heat Capacity Analysis – UV-Vis Spectroscopy - FTIR Spectroscopy – FT-Raman Spectroscopy - Interpretation of results - Advantages and limitations		
<b>Total Contact Hours</b>		<b>45</b>

Course Outcomes:	
On completion of the course, students will be able to	
•	use various techniques for growing crystals of different materials
•	identify suitable methods for synthesizing nanomaterials for various applications
•	classify ceramics based on their properties and identify suitable preparation techniques and applications
•	apply the knowledge of various structural analysis techniques
•	utilize thermal and spectroscopic techniques to characterize materials

Text Books:	
1	T. Pradeep, “A Textbook of Nanoscience and Nanotechnology”, McGraw Hill, 2016
2	Budinski, K.G. & Budinski, M.K. “Engineering Materials Properties and Selection”, Prentice Hall, 2009
3	Skoog DA, Holler FJ and Nieman TA, “Principles of Instrumental Analysis”, Barace College Publishing, DC, 2006

<b>Reference Books / Web links:</b>	
1	Willard HH, Merritt LL, Dean JA and Settle FA, "Instrumental Methods of Analysis", CBS Publishers and Distributors, New Delhi, 2004.
2	M.N. Rahaman, "Ceramic Processing", CRC Taylor & Francis, 2007
3	B.D. Cullity, "Elements of X-ray diffraction", 4 <sup>th</sup> edition, Addison Wiley, 1978.
4	M.H. Loretto, "Electron Beam Analysis of Materials", Chapman and Hall, 1984.
5	P. Santhanaragavan and P. Ramasamy "Crystal growth Process and Methods", Kru Publications, 2000.
6	Michel Barsoum, "Fundamentals of Ceramics", CRC Press, 2002.