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	Т	Р	С
1	OAE1001	Interduction to According Engineering	OE	2	0	0	2
	0AE1901	Enclosed to Aeronautical Engineering	OE	3	0	0	<u> </u>
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	OAI1901	Artificial Intelligence and Neural Network	OE	3	0	0	3
6	OAI1902	Introduction to Machine Learning	OE	2	0	2	3
7	OAI1903	Introduction to Robotic Process Automation	OE	0	0	6	3
8	OAT1901	Automotive Systems	OE	3	0	0	3
9	OAT1902	Automotive sensors and actuators	OE	3	0	0	3
10	OAT1903	Elements of Electric and Hybrid Vehicles	OE	3	0	0	3
11	OAT1904	Fundamentals of Automotive Electronics	OE	3	0	0	3
12	OBM1901	Introduction to Human Anatomy and Physiology	OE	3	0	0	3
13	OBM1902	Biomaterials and Artificial Organs	OE	3	0	0	3
14	OBM1903	Fundamentals of Medical Instrumentation	OE	3	0	0	3
15	OBM1904	Engineering Mechanics for Medical Applications	OE	3	0	0	3
16	OBT1901	Food and Healthy Living	OE	3	0	0	3
17	OBT1902	Man and Microbes	OE	3	0	0	3
18	OBT1903	Basic Bioinformatics	OE	3	0	0	3
19	OBT1904	Biotechnology in Product Development	OE	3	0	0	3
20	OBT1905	Medical Sciences for Engineers	OE	3	0	0	3
21	OBT1906	Application of Biotechnology for Environmental protection	OE	3	0	0	3
22	OBT1907	Fermentation Technology	OE	3	0	0	3
23	OBT1908	Essentials of Life Science for Engineers	OE	3	0	0	3
24	CH19O31	Introduction to Fertilizer Technology	OE	3	0	0	3
25	CH19O32	Introduction to Process Technology	OE	3	0	0	3
26	OCE1901	Natural Hazard & Disaster Management	OE	3	0	0	3
27	OCE1902	Green Building Design	OE	3	0	0	3
28	OCS1901	Data Structures Using C	OE	0	0	6	3

SL.NO.	COURSE	COURSE TITLE	CATGRY	L	Т	Р	С
	CODE						
29	0C\$1902	OOPS using IAVA	OF	0	0	6	3
30	OC\$1903	Programming using Python	OE	0	0	3	
31	OEC1901	MEMS and its applications	OE	3	0	0	3
31	OEC1902	Consumer Electronics	OE	3	0	0	3
32	OEC1902	Digital Image Processing and its applications	OE	3	0	0	3
34	OEC1904	Pattern Recognition and Artificial Intelligence	OE	3	0	0	3
35	OEC1905	Flectronics Engineering	OE	3	0	0	3
36	OFF1901	Electrical Safety and Quality Assurance	OE	3	0	0	3
37	OFF1902	Electric Power Utilization	OF	3	0	0	3
38	OFT1901	Emerging Techniques in Food Processing	OF	3	0	0	3
39	OFT1902	Food Safety	OF	3	0	0	3
40	OFT1902	Crop Process Engineering	OF	3	0	0	3
40	OFT1904	Food Supply Chain Management	OE	3	0	0	3
42	OIT1901	Business Intelligence	OE	3	0	0	3
43	OIT1902	Cyber Security	OE	3	0	0	3
44	OMT1901	Elements Of Automation	OE	2	0	2	3
45	OMT1902	CNC Systems -Design And Applications	OE	3	0	0	3
46	OMT1903	Mobile Robotics	OE	3	0	0	3
47	OMT1904	Medical Mechatronics	OE	3	0	0	3
48	OME1901	Supply Chain Management	OE	3	0	0	3
49	OME1902	Basics of 3D Printing and Additive	OE	3	0	0	3
50	O) (51000	Manufacturing	0.5		0	0	
50	OME1902	Industrial Safety Engineering	OE	3	0	0	3
51	OCY1901	Green Chemistry in Energy and Environment	OE	3	0	0	3
52	OGE1901	German Language	OE	3	0	0	3
53	OHS1901	Protessional Communication	OE	2	1	0	3
54	OMA1901	Computer Based Numerical Methods	OE	2	0	2	3
55	OPH1901	Materials Synthesis and Characterization	OE	3	0	0	3
55	5111701	Techniques		5	0		5

OPEN ELECTIVE OFFERED BY AERONATICAL ENGINEERING

LTPC OAE1901 INTRODUCTION TO AERONAUTICAL ENGINEERING 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

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

NIT II PROPERTIES OF ATMOSHPHERE

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**

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

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**

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

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; 11th edition.
- 2. Kermode, A.C., "Flight without Formula", Pearson Education; 5th edition.

TOTAL: 45 PERIODS

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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

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

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

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

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

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, 986.
- 4. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition, 2014.

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INTRODUCTION TO SPACE FLIGHT

UNIT I HISTORY OF INTERNATIONAL SPACE FLIGHT

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

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

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

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

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.

TEXT BOOKS

OAE1903

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).

INDUSTRIAL AERODYNAMICS

3. Web link: https://www.isro.gov.in/

OBJECTIVES

OAE1904

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

ATMOSPHERE UNIT I

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

WIND ENERGY COLLECTORS UNIT II

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory

UNIT III VEHICLE AERODYNAMICS

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TOTAL: 45 PERIODS

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Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of racing car, trains and Hovercraft

UNIT IV BUILDING AERODYNAMICS

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

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.

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OPEN ELECTIVE COURSES OFFERED BY AIML

SL. NO.	COURS E CODE	COURSE TITLE	Categor y	Contac t Period s	L	Т	Р	С
1.	OAI1901	Artificial Intelligence and Neural Network	OE	3	3	0	0	3
2.	OAI1902	Introduction to Machine Learning	OE	4	2	0	2	3
3.	OAI1903	Introduction to Robotic Process Automation	OE	3	0	0	6	3

OPEN ELECTIVE COURSES OFFERED BY AIML

Subject Code	Subject Name (Theory Courses)	Category	L	T	Р	C
OAI1901	ARTIFICIAL INTELLIGENCE AND NEURAL NETWORK	OE	3	0	0	3

Ob	Objectives:						
٠	Understand the various characteristic of a problem solving agent.						
•	Learn about the different strategies involved in problem solving.						
•	Learn about Knowledge Representation and reasoning.						
٠	To interpret the basic concepts of Neural Networks.						
٠	To learn various Neural Architecture Models.						

UNIT-I INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND PROBLEM SOLVING AGENT

Introduction : AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation CHAPTER -1, 2 & 3 (R1)

UNIT-II SEARCHING TECHNIQUES

Heuristic search techniques: Generate and test - hill climbing - Breadth first search - A* algorithm - problem reduction - AO* algorithm - constraint satisfaction - means-ends analysis CHAPTER - 3 (T1)

UNIT-III KNOWLEDGE REPRESENTATION AND REASONING

Knowledge Representation - Using Predicate logic: representing simple facts in logic - representing instance and ISA relationships - computable functions and predicates - resolutions. Representing knowledge using rules: procedural Versus declarative knowledge - logic programming - forward versus backward reasoning. CHAPTER -5 & 6 (T1)

UNIT-IV INTRODUCTION TO NEURAL NETWORKS

Introduction - Basic Architecture of Neural Networks: Single Computational Layer - Multilayer Neural Networks - Multilayer Network as a Computational Graph - Training a Neural Network with Backpropagation CHAPTER – 1 (T2)

UNIT-V NEURAL ARCHITECTURE MODELS

Common Neural Architectures - Advanced Topics: Reinforcement Learning - Separating Data Storage and Computations - Generative Adversarial Networks - Two Notable Benchmarks - The MNIST Database of Handwritten Digits - The ImageNet Database. Neural Architectures for Binary Classification Models: Revisiting the Perceptron - Least-Squares Regression - Logistic Regression - Support Vector Machines. CHAPTER – 1 & 2 (T2)

Contact Hours : 45

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Course Outcomes:

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

• Acquire the basic concepts of Artificial Intelligence and Problem solving agent.

• Apply various searching techniques.

- Understand the Knowledge Representation and Reasoning.
- Explain the basic concepts of Neural Networks.
- Apply various Neural Architecture Models.

Te	xt Books:
1	Artificial Intelligence, 2nd Edition, E.Rich and K.Knight (TMH).
2	CharuC.Aggarwal "Neural Networks and Deep learning" Springer International Publishing, 2018.

Re	Reference Books:							
1	Artificial Intelligence – A Modern Approach. Second Edition, Stuart Russel, Peter Norvig, PHI/ Pearson Education							
2	Neural networks and learning machines, simon haykin, 3rd edition, pearson, 2009.							

<u>CO - PO – PSO matrices of course</u>

PO/PSO	РО	РО	РО	РО	РО	РО	РО	РО	РО	РО	РО	РО	PSO	PSO	PSO
СО	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
OAI1901.1	2	1	1	1	2	-	-	-	-	-	-	-	3	2	1
OAI1901.2	2	1	1	1	2	-	-	-	-	-	-	-	3	2	1
OAI1901.3	2	2	3	1	2	-	-	-	-	1	-	-	2	2	2
OAI1901.4	2	3	3	1	2	2	-	-	2	1	2	2	1	2	3
OAI1901.5	2	3	3	1	2	2	-	-	2	1	2	2	1	2	3
Average	2	2	2.2	1	2	2	-	-	2	1	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 (Lab oriented Theory Courses)	Category	L	T	Р	C
OAI1902	INTRODUCTION TO MACHINE LEARNING	OE	2	0	2	3

Ob	Objectives:						
•	To know the fundamentals of machine learning.						
٠	Be exposed to regression models.						
•	Be familiar with basic supervised learning algorithms						
٠	To understand machine learning algorithms with tree model.						
٠	To learn and apply unsupervised learning techniques.						

UNIT-I INTRODUCTION

Components of learning – learning models – geometric models – probabilistic models – logical models – grouping and grading – learning versus design – types of learning – supervised – unsupervised – reinforcement – theory of learning – feasibility of learning – error and noise – training versus testing – theory of generalization – generalization bound – approximation generalization trade off – bias and variance – learning curve.

UNIT-II REGRESSION MODELS

Linear classification – univariate linear regression - bivariate regression – multivariate linear regression – regularized regression – Logistic regression. Naïve Baye's – Discriminant Functions -Probabilistic Generative Models - Probabilistic Discriminative Models – Bayesian Logistic Regression.

UNIT-III | SUPERVISED LEARNING

Perceptron: – multilayer neural networks – back propagation - learning neural networks structures – **support vector machines:** – soft margin SVM – going beyond linearity – generalization and over fitting – regularization – validation.

UNIT-IV TREE MODELS

Decision trees: Training and Visualizing a Decision Tree - Making Predictions - Estimating Class Probabilities - The CART Training Algorithm - Computational Complexity - Gini Impurity or Entropy -**Ensemble methods:** Bagging- Boosting- Boosting AdaBoost - Gradient Boosting – Xg boost.

UNIT-V UNSUPERVISED LEARNING

Clustering: Nearest neighbor models – K-means – clustering around Medoids. **Dimensionality Reduction:** – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis.

Contact Hours :

6

6

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List of	f Experiments
1.	A python program to implement univariate regression, bivariate regression and multivariate regression.
2.	A python program to implement logistic model.

3.	A python program to implement single layer perceptron.						
4.	4. A python program to implement multi layer perceptron with back propagation.						
5.	A python program to do face recognition using SVM classifier.						
6.	A python program to implement decision tree.						
7.	A python program to implement KNN and K-means.						
		Contact Hours	:	30			
		Total Contact Hours	:	60			

Co	Course Outcomes:					
On	On completion of the course, the students will be able to					
٠	Understand basics of machine learning.					
٠	Analyze the regression models for refining parameters.					
٠	Understand and explore the supervised learning algorithms.					
٠	Apply tree models for feature extraction.					
٠	Examine the supervised learning algorithms.					

Te	xt Books:
1	AurélienGéron - Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd
I	Edition. September 21019, O' Reilly Media, Inc., ISBN: 9781492032649.
2	Stephen Marsland,Machine Learning - An Algorithmic Perspectivel, Second Edition, Chapman and
4	Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

Re	ference Books:
1	Alex Smola and S.V.N. Vishwanathan," Introduction to Machine Learning", Cambridge University
L	Press 2008.
ſ	Andreas C. Müller and Sarah Guido," Introduction to Machine Learning with Python: A Guide for
2	Data Scientists", O'Reilly Media, Inc,2016.
2	S. Russel and P. Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Prentice Hall,
3	2009.
4	C. M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.

Web link:

1. https://www.coursera.org/lecture/python-machine-learning/introduction-4f2So

2. https://nptel.ac.in/courses/106/106/106106139/

<u>CO - PO – PSO matrices of course</u>

PO/PSO	РО	PSO	PSO	PSO											
СО	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3

OAI1902.1	2	1	1	1	2	-	-	-	-	-	-	-	1	2	1
OAI1902.2	2	1	1	1	2	-	-	-	-	-	-	-	1	2	1
OAI1902.3	2	1	3	1	3	-	-	-	-	1	-	-	1	2	2
OAI1902.4	2	1	3	2	3	2	-	-	2	1	2	2	1	2	3
OAI1902.5	2	1	3	2	3	2	-	-	2	1	2	2	1	2	3
Average	2	1	2.2	1.4	2.6	2	-	-	2	1	2	2	1	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 Courses)	Category	L	Τ	Р	С
OAI1903	INTRODUCTION TO ROBOTIC PROCESS AUTOMATION	OE	0	0	6	3

Ob	Objectives:					
•	Prepare to become Junior RPA Developers.					
•	Learn the basic concepts of Robotic Process Automation.					
•	Develop familiarity and deep understanding of UiPath tools.					
•	Develop the ability to design and create robots for business processes independently.					
•	Develop skills required to pass UiPath RPA Associate v1.0 Exam.					

UNIT-I	ROBOTIC PROCESS AUTOMATION (RPA) BASICS	9					
History of Automation, Story of Work, Introduction to RPA, RPA vs Automation, RPA and AI, RPA ar							
emerging ecosystem, Industries best-suited for RPA, Processes best-suited for automation.							
UNIT-II	INTRODUCTION TO UIPATH, VARIABLES AND ARGUMENTS	10					
UiPath and its Products, Robots and their Types, Studio Overview, Orchestrator, UiPath Studio Installation							
& Updating	The User Interface, Features of Studio, Building 'Hello World' Automation Project.						
Variables ar	nd their Types, Variables Panel, Scope of a Variable, Arguments, Arguments Panel, Argu	ment					
Directions, A	Arguments vs. Variables.						
UNIT-III	SELECTORS AND CONTROL FLOW	10					
UI interaction	ons, Input Actions and Input Methods, Containers, Recording and its types, Selectors and	their					
types, Anch	types, Anchors, Fine-tuning Selectors. Sequences, Control Flow and its Types, Decision Control, Loops,						
Other Control Flow Activities, Flowcharts, Error Handling							
UNIT-IV DATA MANIPULATION, AUTOMATION CONCEPTS AND TECHNIQUES 9							

Data Manipulation and Its importance, String Manipulations, DataTable Manipulations, Collection, J						
Types and Manipulations. Extraction and Its Techniques, Automation Techniques.						
UNIT-V UIPATH ORCHESTRATOR		7				
Orchestrator Overview, Publishing a Project to Orchestrator, Orchestrator Functionalities.						
Contact Hours	:	45				
Contact Hours	•	чJ				

Course Outcomes:

- Become Junior RPA Developers.
- Understand the basic concepts of Robotic Process Automation.
- Understand the UiPath tools.
 Design and create robots for business processes independently.
- Develop projects using UiPath.

Te	xt Books:
1	Learning Robotic Process Automation: Create Software Robots and Automate Business Processes with
T	the Leading RPA Tool – UiPath, Alok Mani Tripathi, Packt Publishing Ltd., 2018.
2	Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks &
4	Become An RPA Consultant Paperback, 2018.

Re	Reference Books:					
1	Robotic Process Automation Projects: Build real-world RPA solutions using UiPath and Automation					
L	Anywhere, Nandan Mullakara, Arun Kumar Asokan, Packt Publishing Ltd., 2020.					
r	Tom Tauli, "The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems" 1 st					
4	Edition, Kindle Edition.					

CO - PO – PSO matrices of course

PO/PSO	РО	РО	PO	РО	PO	РО	PSO	PSO	PSO						
СО	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
OAI1903.1	2	1	1	1	2	-	-	-	-	-	-	-	3	2	1
OAI1903.2	2	1	1	1	2	-	-	-	-	-	-	-	3	2	1
OAI1903.3	2	2	3	1	3	-	-	-	-	1	-	-	2	2	2
OAI1903.4	2	3	3	2	3	2	-	-	2	1	2	2	1	2	3
OAI1903.5	2	3	3	2	3	2	-	-	2	1	2	2	1	2	3

Average	2	2	2.2	1.4	2.6	2	-	-	2	1	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: "-"

Open Electives offered by Automobile Engineering

Subject Code	Subject Name	Category	L	T	Р	С
OAT1901	Automotive Systems	OE	3	0	0	3

Course Objective:

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.

UNIT-I ENGINE MOUNTING AND FRAME

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

UNIT-II SUSPENTION SYSTEM

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

UNIT-III CLUTCH, BRAKING SYSTEM

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

UNIT-IV TRANSMISSION SYSTEM

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

UNIT-V STEERING, TYRE AND FINAL DRIVE

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,

Total Contact Hours:45

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Course Outcomes:

- 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, 14th 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 steed

Subject Code	Subject Name	Category	L	Т	Р	С
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

UNIT-I INTRODUCTION

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.

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UNIT-II | POSITION, SPEED AND RPM SENSORS

Position sensors: Characteristics, measured variables, Potentiometer sensors, magnetically inductive type sensors, Wave-propagation sensors, GPS position and distance travelled measurement. **Speed and rpm sensors:** measured variables, measuring principles, relative rpm and speed measurement, Absolute rotating speed measurement.

Applications: Accelerator-pedal sensors: potentiometric accelerator pedal sensor, hall angular position sensors. **Engine speed sensors:** Inductive speed sensors, Active speed sensors, Hall phase sensors, Speed sensors for transmission control, Wheel speed sensors, Micromechanical yaw rate sensors, Piezoelectric-Tuning forkyaw rate sensor. **Position sensors for transmission control**: application, requirements, Linear position determination on the basis of Hall switches, Rotational position determination on the basis of eddy currents. **Steering angle sensors:** Application and operating principle of steering angle sensor. **Axle sensors:** Application and operating principle.

UNIT-IIIACCELERATION, PRESSURE, FORCE AND TORQUE SENSORS9Acceleration sensors:measured variables, measuring principles:displacement or travel measuring system,systems for measuring mechanical stress,Thermal acceleration sensors, packaging.Pressure sensors:measured variables,Measuring principles:Direct pressure measurement,Diaphragm type sensors, transferto a force sensor.Force and torque sensors:measured variables,measuring principles:Strain measuringforce sensors,Travel measuring force sensors.Torque sensor:strain measuring sensor, angle measuringsensors, eddy current sensors.

Applications: Acceleration sensors: Surface micromechanical (SMM) acceleration sensors,

Micromechanical bulk silicon acceleration sensors, piezoelectric acceleration sensors. Micro mechanical **pressure sensors**: application. Version with the reference vacuum on the component side, version with reference vacuum in a special chamber, High pressure sensors. Force sensor, Torque sensor, Piezoelectric knock sensors: application and operating principle, mounting.

UNIT-IV | TEMPERATURE, FLOW AND CLIMATE CONTROL SENSORS 9 Temperature sensors: 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. Flow meters: measured variables, Measuring principles. Gas sensors and concentration sensors: measured variables, Measuring principles

Applications: Temperature sensors: Application: engine temperature sensor, air temperature sensor, engine oil temperature sensor, fuel temperature sensor, exhaust gas temperature sensor, operating principles. Hot film air mass meters: application, HFM5 type, HFM6 type. Climate control sensor. 9

UNIT-V OTHER SENSORS AND ACTUATORS Optoelectronic sensors: 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.

Other Sensors: Working principle of Ultrasonic sensor, Rain/light sensor, Dirt sensor, Two step lambda oxygen sensors, Planar wide band lambda oxygen sensors, crash sensor.

Actuators: 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

> **Total Contact Hours** :

45

Course Outcomes: 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.

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

Re	ference Books / Web links:
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

OAT1903	Flements of Flectric and Hybrid Vehicles	Category	L	Τ	Р	С
	Elements of Electric and Hydrid Venicles	OE	3	0	0	3

OBJECTIVES:

- 1. To understand the need for alternative power train system
- 2. To provide adequate knowledge in high energy and power density batteries and fuel cells.
- 3. To give basic knowledge in power controls and motors used in EV and HEV applications.
- 4. To make the students understand the calculations involved in the basic design of electric vehicle
- 5. To understand the fundamentals of hybrid electric vehicle

UNIT I NEED FOR ALTERNATIVE SYSTEM

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

UNIT II ENERGY SOURCES : BATTERIES AND FUEL CELLS

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

UNIT III TRACTION MOTORS AND CONTROLLERS

Requirements of motors for EV and HEV application. Characteristic of permanent magnet and separately exited 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.

UNIT IV VEHICLE DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES

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

UNIT V HYBRID VEHICLES

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.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- 1. The students will be able to explain the need for alternative power trains for automobiles.
- 2. The students will be able to explain about high energy and power density batteries and fuel cells.
- 3. The students can suggest the type of motor that can be used for a particular type of EV.
- 4. The students can calculate the different resistance experienced by the automobile and suitability arrive at the power requirement need for EV propulsion.
- 5. The students will be able to discuss about the fundamentals of hybrid electric vehicles.

TEXT BOOKS: 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 REFERENCE BOOKS: 1 Ron HodKinson, "light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005 2 Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005

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OAT1004	FUNDAMENTALS OF AUTOMOTIVE	Category	L T		P	С				
OA11904	ELECTRONICS	OE	3	0	0	3				
OBJECTIVES:										
 To learn about the fundamental principles of automotive electronics To know about the various sensors used in automobiles To know about the electronic engine management systems for Petrol engines To know about the electronic engine management systems for diesel engines To understand the chassis management systems used in modern vehicles 										
UNIT I	FUNDAMENTALS OF AUTOMOTIVE ELECTI	RONICS			9					
Microprocessor and introduction to mo controlled in SI and	cchitecture, open and closed loop control strategies, PID odern control strategies like Fuzzy logic and adaptive co ad CI engines and in the other parts of the automobile.	control, Lool ntrol. Parame	k up ta eters t	ables o be	,					
	CENCODC				0					
UNIT II SENSORS 9 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.										
	SI ENGINE MANAGEMENT	L arrant and			9 .f. 61					
management syst Working of the fu full load enrichm closed loop lamb knock.	ems like Bosch L-Jetronic and LH-Jetronic. Group a tel system components. Cold start and warm up phases, ent, deceleration fuel cut off. Fuel control maps, oper da control. Electronic ignition systems and spark tim	idle speed con iop control	l inje ontrol of f Close	fing contraction , accontraction fuel i d loo	n tecl elera nject p co	tion and nirrol of				
UNIT IV	CI ENGINE MANAGEMENT				9					
Fuel injection sy advanced post injection the common rail limiter, flow limit	stem parameters affecting combustion, noise and em ection and retarded post injection. Electronically control fuel injection system. Working of components like fu er, EGR valves	issions in Cl led Unit Injec el injector, fu	l engi etion iel pu	ines. syster imp,	Pilo m. La rail	t, main, ayout of pressure				
	VIETICI E MANIA CEMENTE OVOTEMO				0					
UNII V Electric power s	VEHICLE MANAGEMENT SYSTEMS	system	rach	sons		aat balt				
tightening. Cruise Collision avoidan	e control. Vehicle security systems- alarms, vehicle trac ce Radar warning system	cking system.	On l	board	diag	gnostics.				
		Т	ОТА	I · A	5 PF	PIODS				
L		I	UIA	. 4		MODS				
COURSE OUTC	COMES:									
1. The student	 The student will be able to explain the various control strategies used in automotive electronics The student will be able to explain the working minimized of various concerns and its applications in 									

- 2. The student will be able to explain the working principle of various sensors and its applications in automobiles
- 3. The student will be able to explain various principles involved in electronic engine management systems for Petrol engines
- 4. The student will be able to explain various principles involved in electronic engine management systems for diesel engines

5. The student will be able to explain the control system operation behind the function of various chassis management systems

TEXT BOOKS:								
1	William B Ribbens"Understanding Automotive Electronics", SAE Publications, 1998							
2	Eric Chowanietz"Automobile Electronics" SAE Publications, 1994							
REFERENCE BOOKS/WEBLINK:								
1	Robert Bosch,"Diesel Engine Management", SAE Publications, 2006							
2	Robert Bosch, "Gasoline Engine Management" SAE Publications, 2006							
3	https://nptel.ac.in/courses/108/108/108108147/							

Open Electives offered by BioMedical Engineering

SI No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	Т	Р	С
1	OBM1901	Introduction to Human Anatomy and Physiology	OE	3	3	0	0	3
2	OBM1902	Biomaterials and Artificial Organs	OE	3	3	0	0	3
3	OBM1903	Fundamentals of Medical Instrumentation	OE	3	3	0	0	3
4	OBM1904	Engineering Mechanics for Medical Applications	OE	3	3	0	0	3

OBM1901 INTRODUCTION TO HUMAN ANATOMY AND PHYSIOLOGY L T P C 3 0 0 3

OBJECTIVES

- To identify all the organelles of an animal cell and their function.
- To understand structure and functions of skeletal and muscular systems of human body.
- To understand anatomy and functions of cardiovascular and respiration systems
- To know the significance of neural and special sensory systems
- To learn about the digestive and urinary systems.
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UNIT I BASICS OF HUMAN BODY

Cell: Different types of cell, Cell Structure and its organelles with functions. Cell Membrane –Transport across Cell Membrane -Membrane Potential – Origin and propagation of potential. Homeostasis. Tissues: Types and functions.

UNIT II SKELETAL AND MUSCULAR SYSTEM

Skeletal System: Structure and types of Bone and its functions – Types of joints and functions – Types of cartilage and functions – Introduction about implants. Muscular System: Types and functions of Muscles. Skin.

UNIT III CARDIOVASCULAR AND RESPIRATORY SYSTEM

Blood: Composition – Functions . Structure of heart – Conduction System of heart- ECG . Blood Vessels – Structure and types. Blood pressure and measurement. Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Types of respiration.

UNIT IV NERVOUS AND SPECIAL SENSORY SYSTEM

Nervous: Cells of Nervous systems – Types of Neuron and Synapses – Mechanisms of Nerve impulse – Brain: Parts of Brain –Reflex Mechanism –Autonomic Nervous systems and its functions-EEG. Sense Organs: Eye and Ear.

UNIT V DIGESTIVE AND URINARY SYSTEMS

Digestive: Organs of Digestive system – Digestion and Absorption. Urinary System: Structure of urinary system, Kidney and Nephron – Mechanisms of Urine formation – Micturition reflex.

OUTCOMES:

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

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TOTAL: 45 PERIODS

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- 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 LTP 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**

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

METALLIC AND CERAMIC MATERIALS UNIT II

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.

POLYMERIC IMPLANT MATERIALS UNIT III

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

TISSUE REPLACEMENT IMPLANTS UNIT IV

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

UNIT V **ARTIFICIAL ORGANS**

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

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TOTAL: 45 PERIODS

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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 L T P C

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, PO2, PCO2, PHCO3, Electrophoresis, colorimeter, photometer, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood cell counters.

UNIT III ASSIST DEVICES AND BIO-TELEMETRY

Cardiac pacemakers, DC Defibrillator, Telemetry principles, frequency selection, Biotelemetry, radio-pill and tele-stimulation.

UNIT IV RADIOLOGICAL EQUIPMENTS

Ionising radiation, Diagnostic x-ray equipments, use of Radio Isotope in diagnosis, Radiation Therapy.

UNIT V RECENT TRENDS IN MEDICAL INSTRUMENTATION

Thermograph, endoscopy unit, Laser in medicine, Diathermy units, Electrical safety in medical equipment.

TOTAL: 45 PERIODS

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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 helps to restore normal functioning of human.
- To identify the appropriate radio isotope in diagnosis.
- To apply electrical safety procedures in Hospitals.

TEXT BOOK:

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

REFERENCES:

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

OBM1904 ENGINEERING MECHANICS FOR MEDICAL APPLICATIONS L T P C 3 0 0 3

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.

UNIT I BIO-FLUID MECHANICS

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.

UNIT II CARDIAC MECHANICS

Cardiovascular system. Mechanical properties of blood vessels: arteries, arterioles, capillaries and veins. Blood flow: Laminar and Turbulent, Physics of cardiovascular diseases, Prosthetic heart valves and replacements. Respiratory Mechanics: Alveoli mechanics, Interaction of Blood and Lung P-V curve of Lung: Breathing mechanism, Airway resistance, Physics of Lung diseases.

UNIT III SOFT TISSUE MECHANICS

Pseudo elasticity, non-linear stress-strain relationship, Viscoelasticity, Structure, function and mechanical properties of Cartilage, Tendon, Ligament and skin.

UNIT IV MECHANICS OF JOINTS

Structure, composition and mechanical properties of bone, types of joints, kinetics and kinematics of joints, lubrication of joints.

UNIT V MODELLING

Introduction to Finite Element Analysis, Analysis of bio mechanical systems using Finite element methods, Graphical design. Mathematical models, blood vessel modeling – windkessel model, pulse wave velocities in arteries, determination of in-vivo elasticity of blood vessel.

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TOTAL: 45 PERIODS

OUTCOMES:

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

- Explain the mechanics of physiological systems.
- Solve the dynamics and fluid mechanics problems.
- Analyze the biomechanical systems.
- Design orthopaedic applications.

TEXT BOOKS:

- 1. Y.C Fung, "Biomechanics- Mechanical properties of living tissues", 2nd Edition, Springer-Verlag, 1993.
- 2. Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design", Springer Science+Business Media, 2004.

REFERENCES:

- 1. Susan J. Hall, "Basic Biomechanics" 6th edition, Mc Graw Hill Company, 1953.
- 2. C. Ross Ethier and Craig A. Simmons, Cambridge University Press, 2007.

Open Electives offered by Bio-Technology Engineering

S. No	Course Code	Course Title	Category	Contact Periods	L	Т	Р	С
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

OBT1901

FOOD AND HEALTHY LIVING

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

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

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

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

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.

APPLIED FOOD SCIENCE AND QUALITY MANAGEMENT UNIT-V

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,

Category LTPC OE 3 0 0 3

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FSMS, FSSAI, Entrepreneurial development- Business opportunity Identification, Assessment, development of entrepreneurial skills and become a successful entrepreneur.

Total Contact Hours : 45

LTPC

3 0 0 3

Category

OE

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

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

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

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

Principles of epidemiology (Epidemic, Endemic and Pandemic), Current Epidemics (AIDS, Nosocomical, 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

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

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:

- StanierRY, Ingrahm JI, Wheelis ML and PainterPR.—General Microbiology. 15th edition, McMillan Press. 1986.
- Ananthanarayanan, R. and C.K. JayaramPaniker, —Textbook of Microbiology^{||},4th Edition, Orient Longman, 1990.
- Schlegel, H.G.—GeneralMicrobiologyl, 7thEdition, CambridgeUniversityPress, 1993.
- Presscott, S.C. and Cecil G. Dunn, —Industrial Microbiologyl, Agrobios (India), 2005.

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OBT1903

BASIC BIOINFORMATICS

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

 $Basic \ UNIX \ commands - telnet - ftp - protocols - search \ engines - search \ algorithms - Introduction \ to \ R/Bioconductor.$

UNIT-II DATABASES

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

UNIT-III SEQUENCE ALIGNMENT, PATTERN MATICHING AND STATISTICAL METHODS

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

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

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.

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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.

OBT1904 BIOTECHNOLOGY IN PRODUCT DEVELOPMENT Category L T P C

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

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

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

UNIT-III PRODUCT DEVELOPMENT

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

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

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

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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.

OBT1905	MEDICAL SCIENCES FOR ENGINEERS	Category	L	Т	Р	С
		OE	3	0	0	3

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

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

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

UNIT-III HEALTHY LIVING

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

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

UNIT-V MOLECULAR MECHANISM

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

Total Contact Hours : 45

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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, 7th 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

OBT1906 APPLICATION OF BIOTECHNOLOGY FOR Category L T P C ENVIRONMENTAL PROTECTION OE 3 0 0 3

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

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

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

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

Molecular biology tools for Environmental management, rDNA technology in waste treatment, Genetically modified organisms in Waste management, Genetic Sensors, Metagenomics, Bioprospecting, Nanoscience

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in Environmental management, Phytoremediation for heavy metal pollution, Biosensors development to monitor pollution.

UNIT-V MODERN TECHNOLOGIES TO PROTECT ENVIRONMENT

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

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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.

OBT1907	FERMENTATION TECHNOLOGY	Category	L	Т	Р	С
		OE	3	0	0	3

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

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.

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

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

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

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

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 FikretKargi, "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.
- Irwin H.Segel, Biochemical Calculations, John Wiley & Sons, 2nd Edition, Wiley Publishers, New Delhi.

OBT1908 ESSENTIALS OF LIFE SCIENCE FOR ENGINEERS LTPC 300 3

OBJECTIVES:

The objectives of the course are

- To enable students learn about the fundamentals of life and biomolecules 1.
- 2. To impart knowledge on how metabolism and energy conversion happens in a biological system
- To develop an understanding of how genetic information are transferred 3.
- To create an awareness on life style disorders 4.
- 5. To impart a basic understanding of microbial action and host immunity.

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Unit 1 **CELL AND BIOMOLECULES**

Origin of life – cell and its organelles - biomolecules –water, carbohydrates, proteins, lipids, vitamins, minerals and enzymes -their role and importance in daily life.

Organ systems, oxidation of food stuffs and energy conversion, metabolism, storage food, starvation,

Unit II LIFE AND ENERGY

UNIT III GENETICS

balanced diet and healthy practices.

Law of inheritance – DNA, RNA - genetic material – central dogma of life – process of information transfer in biological system

Unit IV LIFE STYLE DISORDERS

Lifestyle disorders - obesity, diabetes, stroke, heart attack, ulcer, renal calculi, cancer, AIDS, hepatitisprevention and management.

Unit V **MICROBES AND IMMUNITY**

Role of microbes – non-pathogenic and pathogenic organisms –endemic, epidemic and pandemic – Immune system - innate and acquired immunity - host defense mechanisms, vaccine and immunisation.

Course Outcomes: The students will be able to

- Understand the importance of biomolecules and how a cell performs its role .
- Analyze how metabolism happens and energy is derived •
- Describe how information transfer happens in living organisms •
- Categorise the various life style disorders and recommend ways to manage them •
- Interpret microbial-host systems and their interactions •

Text Books:

- 1. Textbook of Biochemistry: With Clinical Correlations by Thomas M. Devlin, 7th edition, John Wiley &son inc.
- 2. Diseases of human body, Carol D Tamparo, Marcia A Lewis, Marcia A, Lewis, EdD, RN, CMA-AC, F.A Davis Company, 2011.
- 3. Microbiology, Michael Joseph Pelczar, Mcgraw-Hill College; 5th edition .2018
- 4. Reference Books(s) / Web links:
 - Biology for Engineers, Arthur.T., Johnson, CRC Press, Taylor and Francis, 2011 a.
 - Cell Biology and Genetics, Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, b. Cengage Learning, 2008.
 - c. Web link: https://nptel.ac.in/courses/122103039/

Open Electives offered by Chemical Engineering

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S. No	Course Code	Course Title	Category	Contact Periods	L	Т	Р	С
1	CH19O31	Introduction to Fertilizer Technology	OE	3	3	0	0	3
2	CH19O32	Introduction to Process Technology	OE	3	3	0	0	3

CH19O31 INTRODUCTION TO FERTILIZER TECHNOLOGY

OBJECTIVE:

To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.

UNIT I NITROGENOUS FERTILISERS

Introduction about fertilizers and uses, Methods of production of nitrogenous fertilizer-ammonium sulphate, urea and calcium ammonium nitrate, characteristics and specifications, storage and handling.

UNIT II PHOSPHATIC FERTILISERS

Raw materials and processes for the production of sulphuric and phosphoric acids; phosphates fertilizers single superphosphate, triple superphosphate, and their methods of production, characteristics and specifications.

Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.

UNIT III POTASSIC FERTILISERS

UNIT IV COMPLEX AND NPK FERTILISERS

Methods of production of ammonium phosphate, mono-ammonium phosphate, diammonium phosphate, nitrophosphates, superphospates

UNIT V MISCELLANEOUS FERTILISERS

Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, control release fertlisers.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the students would know about the manufacturing techniques of fertilizers and design the equipments in fertilizer industry

TEXT BOOKS:

1. "Handbook of fertilizer technology", Association of India, New Delhi, 1977.

2. Menno, M.G.; "Fertilizer Industry - An Introductory Survey", Higginbothams Pvt. Ltd., 1973.

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.

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CH17O32 INTRODUCTION TO PROCESS TECHNOLOGY L

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

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

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

UNIT III FERTILIZER INDUSTRIES

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

UNIT IV ORGANIC INDUSTRIES

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

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).



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Open Electives offered by Civil Engineering

Course Code	Course Title		Pe	riods /V	Veek		
		L	Т	Р	Total	Credits	CAT
OCE1901	Natural Hazard & Disaster Management	3	0	0	3	3	OE
OCE1902	Green Building Design	3	0	0	3	3	OE

Subject	Subject Name (Theory course)	Category	L	Т	PC		
Code		0.7		_			
OCE1901	NATURAL HAZARD & DISASTER MANAGEMENT	OE	3	0	03		
Objectives:							
To gain kn	owledge on exposure to disasters, their significance and types.						
To underst	and the relationship between vulnerability, disasters, disaster preve	ention and risk r	edu	ctio	n.		
To gain a p	reliminary understanding of approaches of Disaster Risk Reduction	on (DRR).					
To acquire	knowledge on hazard and vulnerability profile of India, Scer	narios in the Ind	diar	i co	ontext,		
To develop	o rudimentary ability to respond to their surroundings with potent	ial disaster resp	ons	e in	areas		
	INTRODUCTION			<u> </u>	0		
UNII-I					•		
Landslide, Floc environmental, disability - Glol and Don'ts duri	d, Drought, Fire etc - Classification, Causes, Impacts including health, psychosocial, etc Differential impacts- in terms of caste bal trends in disasters: urban disasters, pandemics, complex emerging ng various types of Disasters.	g social, econom , class, gender, a gencies, Climate	nic, age, cha	pol loc inge	litical, ation, - Dos		
UNIT-II	APPROACHES TO DISASTER RISK REDUCTION (DRR)				9		
Disaster cycle	- Phases, Culture of safety, prevention, mitigation and preparedr	ness community	bas	sed	DRR,		
Structural- no	nstructural measures, Roles and responsibilities of- co	ommunity, Par	icha	iyat	Raj		
Institutions/Urb	an Local Bodies (PRIs/ULBs), States, Centre, and other stake-ho	Iders- Institution	nal	Pro	cesses		
and Framework	at State and Central Level- State Disaster Management Author	ity(SDMA) – E	arly	W	arning		
System – Advis	ories from Appropriate Agencies.			r			
UNIT-III	INTER-RELATIONSHIP BETWEEN DISASTERS AND DE	VELOPMENT			9		
Factors affectine mbankments, context of India	ng Vulnerabilities, differential impacts, impact of Developme changes in Land-use etc Climate Change Adaptation- IPCC Se - Relevance of indigenous knowledge, appropriate technology ar	ent projects succenario and Sce ad local resource	ch nari ×s.	as los	dams, in the		
UNIT-IV	DISASTER RISK MANAGEMENT IN INDIA			Т	9		
Hazard and Vu	Inerability profile of India. Components of Disaster Relief: Wate	er, Food, Sanita	tior	. S	helter.		
Health. Waste	Management. Institutional arrangements (Mitigation, Response	and Preparedn	ess.	, D	isaster		
Management A	ct and Policy - Other related policies, plans, programmes and le	egislation – Rol	e of	GI	S and		
Information Te	chnology Components in Preparedness, Risk Assessment and	Management, R	lesp	ons	e and		
Recovery Phase	es of Disaster – Disaster Damage Assessment.	6 ,	1				
UNIT-V	DISASTER MANAGEMENT: APPLICATIONS AND CA	SE STUDIES	Aľ	٧D	9		
Landslide Haz	ard Zonation: Case Studies, Earthquake Vulnerability Ass	essment of Bu	uild	ing	and		
Infrastructure: (Case Studies, Drought Assessment: Case Studies, Coastal Floodir	ng: Storm Surge	As	sess	ment,		
Floods: Fluvial	and Pluvial Flooding: Case Studies; Forest Fire: Case Studies	, Man Made di	sast	ers:	Case		
Studies, Space	Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster						

man	nagement.		
	Total Contact Hours	:	45
Co	ourse Outcomes		
	On completion the course, the students will be able to		
	Get familiarized with various disasters, causes and their impact on environment and society.		
	Assess vulnerability and various methods of risk reduction measures as well as mitigation.		
	Assess factors affecting vulnerabilities, differential impacts, impacts of major developmenta changes in land-use, climate change adaptation.	l pr	ojects,
	Get familiarized with hazard and vulnerability profile of India, Scenarios in the Indian contex damage assessment and management.	t, D	isaster
	Manage disaster, vulnerability assessment of buildings and infrastructure, case studies of flooding, landslides, floods, forest fire, Manmade disasters and its mitigation.	on c	coastal
Te	ext Book (s):		
1	Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 1 9380386423.	SBI	N-13: 9
2	Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education P ISBN-10: 1259007367, ISBN-13: 978-1259007361]	vt.	Ltd., 20
Re	eference Books(s) / Web links:		
1	Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NI Delhi, 2011.	DM	, New
2	Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, N 2010.	ew	Delhi,
3	Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005.		
4	Government of India, National Disaster Management Policy, 2009.		

Subject	Subject Name (Theory course)	Category	L	Т	P	С
Code						
OCE1902	GREEN BUILDING DESIGN	OE	3	0	0	3
Objectives:						
To compre	ehend the knowledge on environmental repercussions of the bui	lding materials	and	en	erg	зy
🗌 maintenan	ce.					
To underst	and the concepts of various types of sustainable construction and v	vaste recycling.				
To get acq	uainted with the knowledge on comforts of buildings.					
To appreh	end the usage of solar energy in buildings.					
To acquire	the perceptions on waste management and green cover.					
UNIT-I	ENVIRONMENTAL IMPLICATIONS OF BUILDINGS				9	
Energy use, car	bon emissions, water use, waste disposal; Building materials: sour	ces, methods of	pro	odu	ctic	on
and environme	and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for					
Building Materials; Maintenance Energy for Buildings.						
-						
UNIT-II	IMPLICATIONS OF BUILDING TECHNOLOGIES EMBO	DIED ENERG	Y)F	9	
	BUILDINGS					

Frar	ramed Construction, Masonry Construction. Resources for Building Materials, Alternative concepts.						
Rec	ycling of Industrial and Buildings Wastes. Biomass Resources for buildings.						
UN	NIT-III COMFORTS IN BUILDING	9					
The	ermal Comfort in Buildings- Issues; Heat Transfer Characteristic of Building Materials and Bui	lding					
Tecl	hniques. Incidence of Solar Heat on Buildings-Implications of Geographical Locations.						
UN	NIT-IV UTILITY OF SOLAR ENERGY IN BUILDINGS	9					
Utili	ity of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low En	nergy					
Coo	oling. Case studies of Solar Passive Cooled and Heated Buildings.						
UN	NIT-V GREEN COMPOSITES FOR BUILDINGS	9					
Con	ncepts of Green Composites. Water Utilisation in Buildings, Low Energy Approaches to V	Vater					
Mar	nagement. Management of Solid Wastes. Management of Sullage Water and Sewage. U	Jrban					
Env	vironment and Green Buildings. Green Cover and Built Environment.						
	Total Contact Hours :	45					
Co	ourse Outcomes						
	On completion the course, the students will be able to						
	Comprehend the environmental repercussions of the building materials and energy maintenance.						
	Understand the concepts of various types of sustainable construction and waste recycling.						
	Acquaint the knowledge on comforts of buildings.						
	Apprehend the usage of solar energy in buildings.						
	Perceive the ideas on waste management and green cover.						
	J						
Te	ext Book (s):						
1	K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials	and					
	Technologies. New Age International, 2007.						
2	Low Energy Cooling For Sustainable Buildings. John Wiley and Sons Ltd, 2009.						
Re	eference Books(s) / Web links:						
1	Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.						
2	Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010.						
3	Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009.						
4	Fundamentals of Integrated Design for Sustainable Building By Marian Keeler, Bill Burke.						

Open Electives offered by CSE

Subject		Subject Name (Laboratory Course)	Category	L	Т	Р	С
Co	de						
0	DCS1901	DATA STRUCTURES USING C	OE	0	0	6	3
Ob	jectives:						
٠	To apply the concepts of List ADT in the applications of various linear and nonlinear data structures.						
٠	To demonstrate the understanding of stacks, queues and their applications.						
٠	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 the		eir				
	application	S.					
•	To analyze	an algorithm and learn the fundamental algorithmic strategies.					

		List of Experiments
1	LINEA	R DATA STRUCTURES – LIST
	a.	Conceptual Understanding: LIST ADT - Arrays, and Linked List.
	b. 1	Problem solving using LIST concepts
	c. (Competitive Programming tips and techniques in LIST concepts.
2	LINEA	R DATA STRUCTURES – STACKS, QUEUES
	a.	Conceptual Understanding: Stack using Arrays and Linked List.
	b. (Conceptual Understanding: Queue using Arrays and Linked List.
	c	Problem solving using STACK and QUEUE concepts.
	d. (Competitive Programming tips and techniques in STACK and QUEUE concepts.
3	SEARC	HING AND SORTING
	a.	Conceptual Understanding: Linear Search and Binary Search.
	b. (Conceptual Understanding: Simple and optimized Sorting Technique
	c	Problem solving using Searching and sorting techniques.
	d. (Competitive Programming tips and techniques in Searching and sorting concepts.
4.	TREE A	AND GRAPHS
	a.	Conceptual understanding : Binary Search Tree
	b. (Conceptual understanding : Graph Traversal
	c	Problem solving using Searching and sorting techniques.
	d. (Competitive Programming tips and techniques in Tree and Graph
5.	ALGO	RITHM ANALYSIS AND DESIGN TECHNIQUES
	a.	Conceptual Understanding : Analysis of Algorithms
	b. 1	Problem solving using Brute Force.
	c	Problem solving using Divide and Conquer Technique.
	d. 1	Problem solving using Dynamic Programming.
	е.	Competitive Programming tips and techniques in algorithm optimization
		Total Contact Hours : 90

Co	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.				

Te	xt Book(s):
1	Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, PearsonEducation, 1997.
2	Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson

Referen	Reference Books(s) / Web links:					
1	Ellis Horowitz, SartajSahni and Susan Anderson-Freed, Fundamentals of Data Structures in C,					
1	2nd Edition, University Press, 2008.					
2	https://www.hackerrank.com/					
3	https://www.geeksforgeeks.org/					
4	https://leetcode.com/					

Subject Code	Subject Name (Lab Course)	Category	L	Т	Р	С
OCS1902	OOPS USING JAVA	OE	0	0	6	3

Ob	Objectives:				
●	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.				

	List of Experiments
1	JAVA FUNDAMENTALS
	Concepts and Programs to understand and apply the knowledge of java fundamentals through
	a. Implementing Data Types
ĺ	b. Using Variables to program simple java applications
	c. Implementing Arrays to access more number of input in single variable
	d. Using Operators to implement arithmetic, logical and relational expressions
	e. Implementing decision making strategy using Control Statements
	f. Getting Input to code with Command Line Arguments
2	CLASSES AND INHERITANCE
	Develop a java project by applying OOPS concepts
	a. Defining Classes : Methods, Constructors,
	b. Garbage Collection
	c. Access Specifiers
	d. Method Overloading
	e. Inheritance: Super keyword, this keyword, Method Overriding,
	f. Abstract Classes – Static Members -Final Method and Class
3	PACKAGES, EXCEPTION HANDLING AND STRINGS
	Programs to understand and develop concepts of Packages , Interfaces and Strings with Exception
	Handling
	a. Crate a java application to demonstrate java existing package
	b. Create a java project to create and use user defined packages
	c. Create a java application to include
	Interfaces
	Exceptions to understand and apply Exception Hierarchy – Throwing and Catching
	Exceptions
	Built-in Exceptions, User defined Exceptions and Stack Trace Elements
	d. Implement Strings - String Buffer concepts by solving case studies
4.	I/O AND COLLECTIONS

a) Implement Input / Output Basics with IO Streams – Byte streams and Character streams

b)	Create an java	application to	Read and	Write data	from Console
- /	- · · · · · J · · ·	TT T			

b) Create an java application to Read and Write data from filec) Create java application to read and write data from file

	0)	create juva apprearies to read and write data from the
	d)	Solve case studies to implement Collection Interfaces – Collection Classes.
5.	COM	PETITIVE PROGRAMMING USING JAVA
	a.	Conceptual Understanding : Analysis of Algorithms
	b.	Problem solving using Divide and Conquer Technique.
	с.	Problem solving using Dynamic Programming.
	d.	Competitive Programming tips and techniques in algorithm optimization
		Total Contact Hours : 90

Course Outcomes:				
•	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			

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

Reference Books(s) / Web links:

1	SCJP Sun Certified Programmer for Java 6 Study Guide. McGrawHill, 6 th edition,2008.
2	Steven Holzner, —Java 2 Black book, Dreamtech press, 2006.
3	Timothy Budd, —Understanding Object-oriented programming with Java, Updated Edition, Pearson Education, 1993.
4	Paul Deitel, Harvey Deitel, —Java SE 8 for programmers, 3rd Edition, Pearson, 2014.
5	https://www.javatpoint.com/java-tutorial

Su	bject Code	Subject Name (Laboratory Course)	Categor	L	Т	Р	С		
- (0051003	PROCRAMMING USING PVTHON	y OF	0	0	6	3		
,	JC51705	(Onen Elective – For 2019 and 2020 Batch only)	OE	U	U	U	5		
		Common to all branches of B E / B Tech programmes							
		(except – CSE, CSBS, CSD, IT, AI/ML)							
Cou	rse Objectiv	es:							
	To understa	nd the basics of Python Programming							
	To write, te	st, and debug simple Python programs with conditionals, and loops	and function	ons					
	To develop	Python programs with defining functions and calling them							
	To understa	nd and write python programs with compound data- lists, tuples, di	ictionaries						
	To lay the f	oundation for mathematical and statistical packages.							
		List of							
		Experiments							
1	Introduction	to Python Programming and Demo on Python IDLE / Anaconda d	listribution.						
2.	Experiment	s based on Variables, Datatypes and Operators in Python.							
<i>3</i> .	Coding Star	idards and Formatting Output.							
4.	Algorithmic	Approach: Selection control structures.							
э. 6	Algorithmic	s have don Strings and its operations							
0.	Experiment	s based on Lists and its operations.							
/. Q	Experiment	s based on Tuples and its operations.							
0.	Experiment	s based on Sets and its operations.							
9.	Experiment	s based on Dictionary and its operations.							
10.	Experiment Functions: I	Ruilt_in functions							
11.	Functions: I	Jer-defined functions							
12.	Functions: I	Recursive functions							
13.	Numpy Bas	ics · Arrays and Vectorized Computation							
15.	Getting star	ted with Pandas							
	8		Contact H	Iour	s	:	90		
						-			
Cou	rse Outcome	es:							
On c	ompletion of	the course, the students will be able to:							
	Use the basi	ics of Python Programming in problem solving							
	Write, test,	and debug simple Python programs with conditionals and loops							
	Develop Py	thon programs step-wise by defining functions and calling them							
	Use Python	lists, tuples, dictionaries for representing compound data.							
	Apply Num	py and Pandas for numerical and statistical data.							
Text	Books:	• •							
1.	Allen B. Do Python 3,	owney, Think Python: How to Think Like a Computer Scientist,	Second edi	tion,	Upd	ated	for		
	Shroff/O'Re	eilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)							
2.	Guido Van	Rossum and Fred L. Drake Jr, An Introduction to Python - Revise	d and upda	ted f	or Py	thon	3.2,		
	Network Theory Ltd	2011	-						
3.	Wes McKi	nney, Python for Data Analysis - Data wrangling with pandas.	Numpy. an	d in	ythor	, Se	cond		
	Edition,	, , , , , , , , , , , , , , , , , , ,	r <i>J</i> , 541	r.	,	,	- 54		
	O'Reilly M	edia Inc, 2017.							
Refe	rence Books	:							
1.	John V Gut Edition, MI	tag, Introduction to Computation and Programming Using Pythor T	n, Revised	and	expai	nded			
	D								
1	Press, 2013).	 2. Robert Sedgewick, Kevin Wayne, Robert Dondero, Introduction to Programming inPython: An Inter- 						
2.	Press, 2013 Robert Sed disciplinary	8. gewick, Kevin Wayne, Robert Dondero, Introduction to Program	nming inPy	thor	: An	Inte	er-		
2.	Press, 2013 Robert Sed disciplinary Approach, I	3. gewick, Kevin Wayne, Robert Dondero, Introduction to Program Pearson India Education Services Pvt. Ltd., 2016.	nming inPy	thor	: An	Inte	er-		
2.	Press, 2013 Robert Sed disciplinary Approach, I Timothy A.	B. gewick, Kevin Wayne, Robert Dondero, Introduction to Program Pearson India Education Services Pvt. Ltd., 2016. Budd, Exploring Python, Mc-Graw Hill Education (India) Private	nming inPy <u>Ltd., 2</u> 015.	thor	: An	Inte	er-		

5.	Charles Dierbach, Introduction to Computer Science using Python: A Computational ProblemSolving
	Focus, Wiley
	India Edition, 2013.
6.	Paul Gries, Jennifer Campbell and Jason Montojo, Practical Programming: An Introduction to Computer
	Science usingPython 3, Second edition, Pragmatic Programmers, LLC, 2013.

Platform Needed:

Python 3 interpreter for Windows/Linux

<u>CO - PO – PSO matrices of course</u>

PO/PS O CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P O 10	P O 11	P O 12	PS O1	PS O2	PS O3
OCS1903. 1	2	2	2	2	1	-	-	-	1	1	1	1	3	3	-
OCS1903. 2	2	1	1	1	1	-	-	-	-	-	1	1	3	2	-
OCS1903. 3	2	1	2	1	2	-	-	-	-	-	1	1	2	3	2
OCS1903. 4	2	2	3	2	2	-	-	-	-	-	2	1	2	2	2
OCS1903. 5	2	2	3	2	3	-	-	-	-	-	2	1	2	2	2
Average	2	1.6	2.2	1.6	1.8	0.0	0.0	0.0	0.2	0.2	1.4	1	2.4	2.4	2

Note: Enter correlation levels 1, 2 or 3 as defined below:

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

3: Substantial (High)If

there is no correlation, put "-"

Open Electives offered by ECE

S.NO	COURSE CODE	COURSE TITLE	CATE GORY	CONTAC T	L	Т	Р	С
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	Т	Р	С
OEC1901	MEMS AND ITS APPLICATIONS	OE	3	0	0	3

Ob	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.				

UNIT-I INTRODUCTION TO MEMS

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.

UNIT-II MEMS SENSOR

Case Study 01: Gyroscope, Accelerometer, Case Study 02: Pressure Sensors, tactical sensor.

UNIT-III RF MEMS

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

UNIT-IV GAS SENSOR

Chemical Sensor, Metal Oxides Based Sensor, SAW Sensor, VOC sensor Oxygen sensor Humidity sensor, H₂S Sensor, Hydrogen sensor, Nitrogen oxide sensor, Breath analysers, Case Study: Humidity sensor, Volatile organic sensor for Aliphatic gases.

UNIT-V BIOMEMS SENSOR

<u>Blood Pressure Sensors</u>, <u>Micro</u> 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 (µTAS), Lab-On-Chip, Case study: Biosensors for estimation of blood glucose, urea and uric acid.

Total Contact Hours :

Co	Course Outcomes: On completion of course students will be able to		
٠	Design the micro devices, micro systems using the MEMS fabrication process		
٠	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		

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Te	Text Books:		
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		

Reference Books / Web links:

Mark Madou, Fundamentals of Microfabrication, CRC Press, New York, 2002, eBook Published 8th Oct 2018. 1 DOIhttps://doi.org/10.1201/9781482274004.

2 Chang Liu, Foundations of MEMS, Pearson Education India, 2012.

- NadimMaluf, KirtWillams, 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.
- Stephen Beeby, Graham Ensell, Michael Kraft, Neil White, "MEMS Mechanical Sensors" 2004, Artech House, 5 Inc.

Subject Code	Subject Name	Category	L	Т	Р	С
OEC1902	CONSUMER ELECTRONICS	OE	3	0	0	3

Ob	Objectives:		
•	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 an denote of the model in the initial of an internet of the state o		

• To understand the working principles of various consumer electronic devices.

UNIT-I AUDIO SYSTEM

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

UNIT-II **TELEVISION**

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.

UNIT-III **TELECOMMUNICATION SYSTEMS:**

Basics of Telephone system, Caller ID Telephone, Intercoms, Cordless Telephones, Cellular mobile systems, Fiber Optics Communication, Satellite Radio, Integrated services Digital Networks (ISDN). 9

HOME ELECTRONICS: UNIT-IV

Digital Camera system, Microwave ovens, Washing Machines, Air Conditioners and Refrigerators, WiFi Routers, Smart Surveillance system

UNIT-V MISCELLANEOUS DEVICES:

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.

> **Total Contact Hours** 45 :

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Co	Course Outcomes: On completion of course students will be able to		
٠	List technical specification of electronics Audio system (microphone and speaker).		
•	Trouble shoots consumer electronics products like TV, washing machine and AC.		
٠	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.		

Text Books:

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,
5	2010.
4	G. Baura, "A Biosystems Approach to Industrial Patient Monitoring and Diagnostic Devices", Morgan &
4	Claypool, IEEE, 2008

R	Reference Books / Web links:		
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	Т	Ρ	С
OEC1903	DIGITAL IMAGE PROCESSING AND ITS APPLICATIONS	OE	3	0	0	3

Objectives:

- 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.

UNIT-I FUNDAMENTALS OF DIGITAL IMAGE PROCESSING

Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationship between pixels.

UNIT-II IMAGE ENHANCEMENT

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.

UNIT-III IMAGE RESTORATION AND SEGMENTATION

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.

UNIT-IV IMAGE COMPRESSION AND REPRESENTATION

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.

UNIT-V	OBJECT RECOGNITION AND IMAGE PROCESSING APPLICATIONS	9
Introduction to patte	ern, pattern classes, pattern arrangements, object recognition based on matching – minimum	m
distance classifier, correlation, Simple Matlab programs for histogram, histogram equalization, image		
enhancement, image	e restoration and image compression.	

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Cou	Course Outcomes: 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.	

Тех	Text Books:		
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.		

Re	Reference Books / Web links:			
1	Anil Jain K., "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.			
2	Willliam 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	Т	Р	С
OEC1904	PATTERN RECOGNITION AND ARTIFICIAL INTELLIGENCE	OE	3	0	0	3

Ob	Objectives:				
•	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				

UNIT-I PATTERN RECOGNITION OVERVIEW

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** 9

TRAINING IN PATTERN RECOGNITION UNIT-II

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

SYNTACTIC AND NEURAL PATTERN RECOGNITION UNIT-III

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 9

UNIT-IV INTRODUCTION TO ARTIFICIAL INTELLIGENCE 9

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 9

UNIT-V ARTIFICIAL INTELLIGENCE APPLICATIONS

Natural Language Processing - Language Models - Information Retrieval- Information Extraction - Machine Translation - Speech Recognition - Robot - Hardware - Perception - Planning - Moving

> **Total Contact Hours** : 45

Course Outcomes: 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 •

Text Books:

1	Robert J. Schalkoff, "Pattern Recognition: Statistical, Structural and Neural Approaches", Wiley, Reprint 2007.
C	S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Fourth Edition(Illustrated), Pearson
2	Education 2019

Ref	erence Books / Web links:
1	Richard O. Duda, Peter E. Hart, David G. Stork, "Pattern Classification", Second Edition, John Wiley & Sons,
1	2012.
2	Gose, Earl, R. Johnsonbaugh, and Steve Jost, "Pattern Recognition and Image Analysis", Prentice-Hall of
2	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
5	Publishers Inc., 2011.
6	M. Tim Jones, "Artificial Intelligence: A Systems Approach (Computer Science Series)", First Edition, Jones
0	and Bartlett Publishers, 2009.
7	Nils J. Nilsson, "The Quest for Artificial Intelligence: A History of Ideas and Achievements", Cambridge
/	University Press, 2010.
Q	David L. Poole and Alan K. Mackworth, "Artificial Intelligence: Foundations of Computational Agents",
0	Second Edition, Cambridge University Press, 2017.
9	https://www.slideshare.net/lgustavomartins/introduction-to-pattern-recognition
10	https://www.slideshare.net/NashrahHabib/ai-introduction-140854467

Sub code	Subject name	Categor	L	Т	Р	С
		У				
OEC1905	ELECTRONICS ENGINEERING	OE	3	0	0	3

Obj	Objectives:			
•	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.			

UNIT-I ELECTRONIC COMPONENETS	9
History, Evolution and Inventors of Electronic Components - Resistors, Capacitors and	Inductors -
Types, Construction and Functions, Cables - Construction, Characteristics, Types- High Impedan	ce, Low
Impedance, Ribbon, High Temperature, Flat Twin, RF, Telephone, Optical Fiber, Connectors,	Switches,
Relays, Displays -LED, Alphanumeric, LCD, LASER.	
UNIT-II DEVICES AND APPLICATIONS	9
History, Evolution and Inventors of Electronics Devices- PN Junction Diodes, Zener, Bipolar Juncti	on
Transistors, Field Effect Transistors, Uni Junction Transistors, Silicon Controlled Rectifier -Wo	rking
and Simple Applications.	
UNIT-III DIGITAL ELECTRONICS	9
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.	
UNIT-IV INTEGRATED CIRCUITS AND SMD	9
Evolution and Inventors of Integrated Circuits - Structure, Scale/Level, Classification, Surface Mount	
Devices and Surface Mount Technology, Printed Circuit Boards, Semiconductor Manufacturing. Case	
Study and Industrial Visit.	
UNIT-V ELECTRONICS SYSTEMS	9
Tsunami Warning System - Detection (Seismometer), Data processing Management, Alert Signal &	
Messaging, E Nose – Detection (Chemical Sensors), Data processing and Classification, Agriculture Ro	bots
(Navigation, Soil and Crop Sensors), Processing, and Actuation.	
Total Contact Hours	: 45
Course Outcomes: On completion of course students will be able to	
• Analyse the various parameters of the electronic components based on their construction functional	ity.
• 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.	
Text Books:	
1 Albert Malvino, David Bates, "Electronic Principles", Eight Edition, McGraw Book Co., 2016	

Ref	erence Books / Web links:
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	https://www.semiconductors.org/majn/resources
7	technav.ieee.orgltagJ5783/ electronic-noses, www.tsunarni.noaa.gov, www.e-booksdirectory.com
8	Make Electronics - Learning by Discovery by Charles Platt

Open Electives offered by EEE

Su Co	bject do	Subject Name (Theory course)	Category	L	Т	Р	С
	EE1901	ELECTRICAL SAFETY AND OUALITY	OE	3	0	0	3
		ASSURANCE	UL	2	v	v	5
Oł	iectives:						
•	To unders	tand the various electrical hazards in working environment and	d ensure the el	ectri	cal s	afety	7.
•	To provid	e knowledge on electrical standards and its requirements					
•	To create	awareness on the methods for electrical safety and load protec	tion.				
•	 To inculcate knowledge on standardization to be followed in health care systems 						
•	To unders	tand the purpose of regulatory body and their requirements in	health care sys	tem	s		
UN	IT-I I	ELECTRICAL HAZARDS	J			9	
Re	view of bas	ic electrical concepts, Electrostatics – Electromagnetism – Electro	rical Hazards –	Ene	rgy	leaka	ge –
Cle	earance and	insulation- Current surges - Electrical causes of fire and exp	plosion – Hum	nan i	nter	face	with
ele	ctricity – H	uman resistance to electricity					
UN	NIT-II S	STANDARDS AND REQUIREMENTS				9	
Na	tional elect	rical Safety code - Standards and statutory requirements - In-	dian electricity	act	s an	d rul	es –
sta	tutory requ	irements from Electrical inspectorate. Hazardous area clas	sification and	clas	ssific	catior	n of
ele	ctrical equip	oment for hazardous areas (IS, NFPA, API and OSHA standards).				
UN	IT-III I	ELECTRICAL PROTECTION AND MAINTENANCE				9	
Sel	ection of E	nvironment, Protection and Interlock – Discharge rods and earth	ing device – S	afety	in t	the us	se of
por	table tools	- Preventive maintenance. First aid-cardio pulmonary resuscitation	on (CPR).				
UN	NIT-IV S	STANDARDIZATION OF QUALITY MEDICAL CARE IN	HOSPITAL	5		9	
Qu	ality- Need	for Standardization & Quality Management, QM in Health car	e organization	Qual	lity a	assura	ance
me	thods, QA 1	n (Medical Imaging & Nuclear medicine) Diagnostic services –	Classification of	of equ	uıpn	nent	
UN		REGULATORY REQUIREMENT FOR HEALTH CARE	<u></u>			9	
CE	and FDA r	egulations, Accreditation for hospitals - JCI, NABH and NABL,	Other regulate	ory C	code	s.	-
0	0.1		tact Hours		:	4	5
Co	urse Outco	omes: On completion of the course, the students will be able to)				
•	realize the	effects of different electrical hazards and its causes	•				
	analysed t	he significance of different electrical standards used in workin	g environment	IS			
•	develop k	nowledge and insight for the procedures used in quality contro	and assurance	e aci	1V1t1	es	
	explain th	e process of standardization to be followed in hospitals.					
•	analyse th	e various governing bodies in health care system					
le	Xt BOOK (S)	:				Mad	Lasl
1	1 B.M. Saknarkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd. 24						ncai
2	2 K.Shridhara Bhat, Quality Management, Himalaya Publishing House Cesar A. Cacere & Albert Zana,						ia,
4	The Practice of Clinical Engg. Academic press, New York, 1977.						
Re	ference Bo	oks(s) / Web links:					
1	Webster J Cliffs, Ne	.G and Albert M.Cook, Clinical Engg, Principles & Practices w Jersy, 1979.	, Prentice Hall	Inc.	, En	glew	rood
2	Karen Par Nelson Th	rsley, Karen Parsley Philomena Corrigan Quality improven arones Pub, 2002	nent in Health	care	, 2 nd	¹ edit	tion,
3	Sharon M Publishers	yers —Patient Safety & Hospital Accreditation - A Model 2012 7. Joseph F Dyro —Clinical Engineering Handbook—	for Ensuring S Elsevier Publis	Succ	ess , 20	Sprin 04	nger

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			
Average	2	1	1	-	2	2	2	-	1	-	2	2			

Su Co	bject de	Category	L	P	C	
0	EE1902	ELECTRIC POWER UTILIZATION	OE	3 0	0	3
Ob	jectives:					1
•	To learn th	he energy saving concept by different ways of illumination.				
•	To unders	tand the different methods of refrigeration.				
۲	To impart	knowledge on the fundamental's concepts of domestic appliances an	d earthing.			
٠	To familia	rize the concepts of heating and welding.				
٠	To provid	e knowledge on electric drives and traction system.				
UN	II I-TI	LUMINATION			9	
Illu lan fac	mination – nps, LED li tory lighting	Terminology, Laws of illumination, lighting calculation. Electric le ghting and energy efficient lamps, Design of lighting schemes- in g halls - outdoor lighting schemes - flood lighting - street lighting.	amps-Differen door lighting	it tyj sche	pes mes	of s -
UN	VIT-II R	EFRIGERATION			9	
Ret prin	frigeration- nciple of op	Domestic refrigerator and Air coolers, Air-Conditioners- Circu eration.	it Diagram,	type	s a	nd
UN	IT-III D	OMESTIC UTILIZATION OF ELECTRICAL ENERGY			9	
Do UP	mestic utili S, Earthing	zation of electrical energy-House wiring, Induction based appliance - Domestic, Industrial and sub-station.	es, Online and	1 OF	F-li	ne
UN	IT-IV E	LECTRIC HEATING			9	
Ele	ectric heatir	ng- Types of heating and appliances- Electric furnaces- Resistance	ce, Inductanc	e an	d A	rc
Fu	rnaces, Elec	tric welding and sources of welding.				
UN	IT-V E	LECTRIC DRIVES AND TRACTION SYSTEM			9	
Ele	ectric Drive	s and Traction System- Types of drives and loads, Rating and heat	ing of motors	, Ty	pes	of
Tra	action, Spee	d-Time curves, Recent trends in traction				
		Total C	ontact Hour	5 :	4	5
Co	urse Outco	mes:				
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 fund	lamentals concepts of domestic appliances and earthing.				
•	understand	the concepts of heating and welding.				
	realize the	various traction motor controls used in electric traction Hybrid Elect	ric Vehicles.			

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

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

Open Electives offered by Food Technology

S. No	Course Code	Course Title	Category	Contact Periods	L	Т	Р	С
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	Subject Name	Category	L	Τ	Р	С
Code						
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

UNIT-I HIGH PRESSURE TREATMENT

Non-thermal technologies in preservation of foods – necessity and advantages – Status and trends of nonthermal 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.

UNIT-II | PROCESSING USING SOUND, LIGHT AND MICROWAVE

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. 9

UNIT-III | PULSED ELECTRIC FIELD AND DIELECTRIC HEATING

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.

UNIT-IV PROCESSING USING MAGENTIC FIELD AND NON IONIZING RADIATION

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 files-Generation - Mechanisms- Inactivation of Microorganisms - Magnetic fields in food preservation, Infrared – Mechanism of IR absorption by food – IR emitters and spectral bands – applications, Radio wave Frequency – principle – factors influencing RF heating process – applications

UNIT-V OZONE AND COLD PLASMA PROCESSING

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.

Total Contact Hours : 45

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Course Outcomes:

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.

Text Books:

- 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.
 Curture W. Buckerse Official Science and M. Piller Cores. 2005. Neural Faced Proceedings.
- 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)

Reference Books / Web links:

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
2	Gustavo C Barbosa-Canovas, Q Howard Zhang, 1999. Pulsed Electric Fields in Food Processing
3	Lancaster Pa: Techonomic Publishing Co. ISBN 1566767830.
4	Gustavo V. Barbosa- Canovas, Usha R. Pothakamury, Enrique Palou and Barry G. Swanson. 1998.
4	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	Р	С
OFT1902	FOOD SAFETY	OEC	3	0	0	3

	Ob	jectives:
	•	To understand the principles of management systems in food safety
I	•	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
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To apply gain knowledge on case studies

UNIT-I **INTRODUCTION TO MANAGEMENT SYSTEMS**

Introduction to Quality management systems 9001; 2000, ISO 14001 Environment Management Systems, Occupational Health and Safety Management systems, Safety and its importance

UNIT-II RISK ASSESSMENT & MANAGEMENT

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. 9

UNIT-III SYSTEMS OF FOOD SAFETY

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

UNIT-IV | FOOD SAFETY MANAGEMENT

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)

UNIT-V CASE STUDIES

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

		Total Contact Hours	:	45					
Co	urse Outcomes:								
On	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.								

Text Books

-	
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.

Re	ference Books / Web links:
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

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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	Т	Р	C
OFT1903	CROP PROCESS ENGINEERING	OEC	3	0	0	3

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()hi	ectives:
<u> </u>	0000000

- 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

UNIT-I IMPORTANCE OF FOOD PROCESSING

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.

UNIT-II PROCESSING OF CEREALS

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.

UNIT-III PROCESSING OF PULSES

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

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UNIT-IV | MILLING METHODS FOR PULSES

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. 9

UNIT-V PROCESSING OF OIL SEEDS

Introduction, Raw material preparation, Oil Extraction methods- Mechanical expression, Solvent Extraction; Process of Oil Refining- De-odorising, Wintering, Neutralisation, Bleaching, De-gumming. **Total Contact Hours** 45 :

Course	Outcomes	:
~	1	

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. •

Text Books:

- 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.

Reference Books / Web links:

- Pandey, P. H. (1998). Principles and Practices of Post-Harvest Technology. Kalyani publishing Pvt. 1 Ltd., Ludhiana.
- Sahay, K. M. and Singh, K. K. (1994). Unit operations of Agricultural Processing. Vikas Publishing 2 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
FT19033.3	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	Subject Name	Category	L	Т	P	С
Code						
OFT1904	FOOD SUPPLY CHAIN MANAGEMENT	OEC	3	0	0	3

Objectives:

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٠	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

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

Food Sourcing and procurements: Sourcing- Low cost sourcing, Outsourcing, In-sourcing, Single sourcing, Multiple sourcing, Partnerships; Procurement (Purchase)- Kralgic Matrix, Supplier Segmentation, Sustainable Procurement; A Traditional Food Industry Supply Chain (adapted from DTI-1995)- Diagram 0

UNIT-III RISK MANAGEMENT & TECHNOLOGY TRENDS

Managing supply chain risks, managing risks in Food Supply, Technology Trends in food supply chain, Traceability and use of technology- Traceability, RIFD, Bar-coding, Food Processing & Food packaging in a technological context, Food Logistics.

SUSTAINABILITY & FUTURE CHALLENGES UNIT-IV

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

Developing Sustainability within food supply chains- Production, Processing, Logistics & Retail, Sourcing; Food Sector & Economic Regeneration; Logistics Infrastructure; Food Cluster & Enterprise Zone; Food Parks & Hubs.

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.

Te	xt 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,

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45

Total Contact Hours

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	CATEGOR Y	CONTACT PERIODS	L	Т	Р	С
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	Т	Р	С
OIT1901	BUSINESS INTELLIGENCE	OE	3	0	0	3

Object	ives: 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				

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. 9 UNIT-II KNOWLEDGE DELIVERY 9 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. 9 UNIT-III EFFICIENCY 9 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. 9 Marketing models – Logistic and Production models –Telecommunication Industry & Banking Case studies. UNIT-V FUTURE OF BUSINESS INTELLIGENCE 9 Future of business intelligence – Emerging Technologies, Machine Learning, Predicting the Future, BI Search & Text Analytics – Advanced Visualization – Rich Report, Future beyond Technology.	UNIT-I	BUSINESS INTELLIGENCE	9						
intelligence architectures: Cycle of a business intelligence analysis – Enabling factors in business intelligence projects – Development of a business intelligence system – Ethics and business intelligence. UNIT-II KNOWLEDGE DELIVERY 9 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. UNIT-III EFFICIENCY 9 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. UNIT-IV BUSINESS INTELLIGENCE APPLICATIONS 9 Marketing models – Logistic and Production models –Telecommunication Industry & Banking Case studies. UNIT-V FUTURE OF BUSINESS INTELLIGENCE 9 Future of business intelligence – Emerging Technologies, Machine Learning, Predicting the Future, BI Search & Text Analytics – Advanced Visualization – Rich Report, Future beyond Technology. Contact Hours : 45 Periods	Effective and timely of	decisions – Data, information and knowledge – Role of mathematical models – Business							
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Analytics – Advanced Visualization – Rich Report, Future beyond Technology. Contact Hours : 45 Periods	Future of business intelligence - Emerging Technologies, Machine Learning, Predicting the Future, BI Search & Text								
Contact Hours : 45 Periods	Analytics – Advanced	Analytics – Advanced Visualization – Rich Report, Future beyond Technology.							
		Contact Hours : 45 Pe	riods						

Course Outcomes:								
On completion	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.							

Text	Books:
1	Efraim Turban, Ramesh Sharda, Dursun Delen, "Decision Support and Business Intelligence Systems", 9th
	Edition, Pearson 2013.
Refer	rence Books:
1	Larissa T. Moss, S. Atre, "Business Intelligence Roadmap: The Complete Project Lifecycle of Decision
	Making", Addison Wesley, 2003.
2	Carlo Vercellis, "Business Intelligence: Data Mining and Optimization for Decision Making", Wiley
	Publications, 2009.
3	David Loshin Morgan, Kaufman, "Business Intelligence: The Savvy Manager"s Guide", Second Edition, 2012.
4	Cindi Howson, "Successful Business Intelligence: Secrets to Making BI a Killer App", McGraw-Hill, 2007.
5	Ralph Kimball, Margy Ross, Warren Thornthwaite, Joy Mundy, Bob Becker, "The Data Warehouse
	Lifecycle Toolkit", Wiley Publication Inc.,2007.
6	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/P O	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PO	PSO 1	PSO 2	PSO 3	PSO 4
	1	2	3	4	5	6	7	8	9	10	11	12				
CO1	2	2	2	2	2	1	-	-	-	-	1	1	2	2	2	2
CO2	2	3	3	2	2	1	-	-	-	-	1	1	2	2	2	2
CO3	2	3	3	3	3	1	-	-	-	-	1	1	2	2	2	2
CO4	2	3	3	3	3	1	-	-	-	-	1	1	2	2	2	2
CO5	2	3	3	3	3	1	1	1	-	-	1	3	3	3	3	3
CO (Avg)	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	Т	Р	С
OIT1902	CYBER SECURITY	OE	3	0	0	3

Objectiv	Objectives: 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.						

UNIT-I	IT-I INTRODUCTION TO SECURITY TRENDS AND CONCEPTS 9							
The Comput	The Computer Security Problems - Targets and Attacks - Approaches to Computer Security – Ethics - Basic Security							
Terminologi	es – Security Models.							
UNIT-II	VIT-IIOPERATIONAL AND ORGANIZATIONAL SECURITY9							
Policies, Pro	cedures, Standards and Guidelines - Security Awareness and Train	ing – Interoperability A	Agreements –					
The security	Perimeter - Physical Security - Environmental Issues - Wireless -	- Electromagnetic Eave	sdropping – The					
Role of Secu	rity in People.							
UNIT-III	CRYPTOGRAPHY		9					
Cryptograph	y in Practice – Historical Perspectives – Algorithms – Hashing Fur	ctions – Symmetric En	cryption –					
Asymmetric	Encryption - Quantum Cryptography - Steganography - Cryptogr	aphy Algorithm Use.						
UNIT-IV	AUTHENTICATION AND REMOTE ACCESS		9					
User, Group	and Role Management - Password Policies - Single Sign-On - Sec	curity Controls and Per	missions –					
Preventing I	Data Loss or Theft – The Remote Access Process – Remote Access	Methods.						
UNIT-V INTRUSION DETECTION SYSTEMS AND NETWORK SECURITY 9								
History of Intrusion Detection Systems - IDS Overview - Network-Based IDSs - Host-Based IDSs - Intrusion								
Prevention Systems – Honeypots and Honeynets – Tools.								
		Contact Hours :	45 Periods					

Course (Course Outcomes:						
On comp	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.						

Refe	Reference Books:							
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/P	PO1	PO2	PO3	PO 4	P O	P	P O7	PO	P	PO1	PO1	PO1	PS	PSO	PS	PSO
0					05	Uo	07	ð	09	U	1	2	1	2	3	4
C01	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 ELECTIVE

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	Т	Р	С
1.	OMT1901	Elements Of OE OE		3	2	0	2	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

Offered by the Department of Mechatronics Engineering to other branch students

OMT1901	ELEMENTS OF AUTOMATION	

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

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

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

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

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

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UNIT V **PROGRAMMABLE LOGIC CONTROLLER**

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

TOTAL : 30 PERIODS

LIST OF EXPERIMENTS

- 1. Displacement measurement using potentiometer and LVDT and plotting the characteristic curves.
- 2. Study of Characteristics and calibration of strain gauge and Load Cell
- 3. Temperature measurement using Thermocouple, Thermistor and RTD and comparing the characteristics.
- 4. Speed control of DC motor.
- 5. Study of various types of transducers.
- 6. Study of hydraulic, pneumatic and electro-pneumatic circuits.
- 7. Modeling and analysis of basic hydraulic, pneumatic and electrical circuits using software.
- 8. Study of PLC and its applications.

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:

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

REFERENCES

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

OMT1902 CN	NC SYSTEMS- DESIGN AND APPLICATIONS
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L	Т	Р	C
3	0	0	3

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

Total: 30 Periods

UNIT I **INTRODUCTION**

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

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

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

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**

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

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

- Reinbold U, Blume C and Dilmann R, "Computer Integrated Manufacturing Technology & Systems", 1. 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.

TOTAL: 45 PERIODS

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OMT1903 MOBILE ROBOTICS

L T P C 3 0 0 3

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

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

Position Sensor – Velocity Sensor – Distance Sensor – Robot Vision – Optical Gyroscope – Compass – GPS.

UNIT III ROBOT LOCALIZATION AND MOTION PLANNING

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

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.

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

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TOTAL: 45 PERIODS

OMT1904	Medical Mechatronics	_	_	_	~
		L 3	T O	P	C 3
OBJECTIVE	ES:	5	0	0	5
 To str To ur To ur To str To ur 	idy the basics, scopes and importance of Biomechatronics iderstand the sensors used in the field of medical sciences iderstand the concept of mobility assistance in medical field idy the working of bioinspired robots in medical field iderstand the concepts and applications of robotics in Medicine				
UNIT-I I	ntroduction to Biomechatronics				9
Introduction -	- Scope of Biomechatronics – Overview of Neuromusculoskele	tal System	– Role o	f	
Diomeenation	ites – et m – importance of meenatories in meetear Apprear	0115			9
UNIT-II B	biosensors			G	c
BIO MEMS S Respiratory N	ensors – Optical Sensors for Medical Care – Biosensors for Giu Ionitoring - Feedback Sensors - – Home Health Care and Telec	are	toring –	Sensors	for
itespineory it					9
UNIT-III M Introduction - Stair-Climbin Wheelchair D	Iobility Assistance - Manual Wheelchairs – Electric Wheelchairs – Wheelchairs wi g Wheelchairs – Assisted Walking – Challenge of Innovation is resign. Exoskeleton.	ith Low-Th n Semi- Au	roughpu tonomoເ	t HMIs 15	_
					9
UNIT-IV E Introduction t	ioinspired Robotics o Bioinspiration – Bioinspired Locomotion – Bioinspired Mani	pulation –	Bioinspi	red Soft	:-
Kobolic Syste	nis – Algoriunnie Bionspiration				9
UNIT-V A Robotics in M Cancer – Sma	pplications of Mechatronics in Medicine ledicine – Smart Instruments and Probs – Smart Probe for Dete art System for Cardiovascular Plaque Detection	cting Kidne	ey Stone	s – Brea	ıst
]	Fotal Cont	act Hou	rs :	45
Course Outc On completio • Expl • Ana • Pred • Expl	omes: n of course students will be able to ain the concepts of mechatronics in medical field. lyze the working of biosensors for medical applications ict the different working methods of wheelchair for mobility as ain the working of Robotics in Medical Field	sistance			

• 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
- Bawson 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	Т	Р	С
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

UNIT-I INTRODUCTION TO SUPPLY CHAIN MANAGEMENT

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.

UNIT-II SUPPLY CHAIN NETWORK DESIGN

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.

UNIT-III | LOGISTICS IN SUPPLY CHAIN

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.

UNIT-IV SOURCING AND COORDINATION IN SUPPLY CHAIN 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. UNIT-V IT AND EMERGING CONCEPTS IN SUPPLY CHAIN

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.

Total Contact Hours : 45

C	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.				
lacksquare	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:

Sunil Chopra, Peter Meindl and D.V. Kalra, "Supply Chain Management: Strategy, Planning and

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Operation", Pearson Education, 2016.

Re	Reference Books(s) / Web links:			
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.			

Subject Code	Subject Name (Theory course)	Category	L	T	Р	C
OME1902	BASICS OF 3D PRINTING AND ADDITIVE MANUFACTURING	OE	3	0	0	3

Ob	Objectives:				
	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.				
٠	To understand the use of Bio Additive manufacturing and 4D printing.				

UNIT-I INTRODUCTION

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.

UNIT-IIREVERSE ENGINEERING AND DESIGN FOR ADDITIVE MANUFACTURING9(DFAM)

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.

UNIT-III | LIQUID AND SOLID BASED ADDITIVE MANUFACTRING PROCESSES

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.

UNIT-IV POWDER BASED AND OTHER ADDITIVE MANUFACTRING PROCESSES

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.

UNIT-V BIO ADDITIVE MANUFACTURING AND 4D PRINTING

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

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

Re	ference 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.

Subject Code	Subject Name (Theory course)	Category	L	Т	Р	С
OME1903	INDUSTRIAL SAFETY ENGINEERING	OE	3	0	0	3

Objectives:	
	To understand the Fundamental concept and Principle of Industrial Safety
	To understand various chemical hazards in industries and its preventions

To Study about the occurrence and control of noise
To know about various hazard analysis tools
To understand various safety regulations

UNIT-I	Introduction	12		
Evolution of modern safety concepts - Fire prevention - Mechanical hazards - Boilers, Press				
vessels, Electrical	Exposure.			
UNIT-II	Chemical Hazards	10		
Chemical exposur	re – Toxic materials – Ionizing Radiation and Non-ionizing Radiation -	Industrial		
Hygiene – Industr	rial Toxicology.			
UNIT-III	Environmental Control	10		
Industrial Health	Hazards - `Environmental Control - Industrial Noise - Noise m	easuring		
instruments, Cont	instruments, Control of Noise, Vibration, - Personal Protection.			
UNIT-IV	Hazard Analysis	14		
System Safety A	System Safety Analysis – Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects			
Analysis (FMEA), HAZOP analysis and Risk Assessment.				
UNIT-V	Safety Regulations	14		
Explosions - Disaster management - catastrophe control, hazard control, Safety education and				
training - Factories Act, Safety regulations Product safety – case studies.				

Cour	Course Outcomes: At the end of this course, the student can		
	Explain the fundamental concept and principles of industrial safety		
	Understand the measures to safeguarding the health and safety of individuals in various		
	settings, from workplaces to the general environment		
	Able to understand the importance of maintaining the environment for workplace.		
	Able to provide hazard analysis for the given environment.		
	Able to know and maintain the various safety regulations and norms.		

Text Books:

1. John V.Grimaldi, "Safety Management", AITB S Publishers, 2003.

2. David L.Goetsch, "Occupational Safety and Health for Technologists", 5th Edition, Engineers and Managers, Pearson Education Ltd., 2005.of Asia, Springer,2017

References:

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.

2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.

Open Electives Offered by S & H

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

Obje	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.	

UNIT-I INTRODUCTION TO GREEN CHEMISTRY 9 Green chemistry-definition-principles of green chemistry-green chemistry metrics- atom economy- E factorreaction mass efficiency and other green chemistry metrics-application of green metrics analysis to synthetic plans-Waste: Production-problems-prevention. 9 UNIT-II GREEN CHEMICAL REACTIONS 9 Environmentally benign processes-solvent free reactions-alternate solvents-supercritical solvents-ionic liquids

Environmentally benign processes-solvent free reactions-alternate solvents-supercritical solvents-ionic liquidswater as a reaction medium-energy efficient design of processes-photo- electro- sono chemical methodsmicrowave assisted reactions. Green reagents and catalysis in green synthesis.

UNIT-III BIO-INSPIRED GREEN NANOMATERIALS

Bio-inspired green nanomaterials –biosynthesis of nanoparticles by bacteria and fungi – biosynthesis of nanoparticles using plant extracts – advantages - applications.

UNIT-IV MICROBIAL FUEL CELLS

Introduction – materials for microbial fuel cells –principles, working and applications – wastewater treatment – energy generation – sensors.

UNIT-V HYDROGEN ENERGY

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.

Total Contact Hours :

Cour	Course Outcomes:	
On co	ompletion 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.	

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Text Books:			
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).		

Refe	rence Books / Web links:
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
5	(2008).
1	Ahluwalia. V.K, Green Chemistry, Environmentally Benign Reactions, CRC Press, Boca, Raton,
4	2^{nd} Edition(2012).
5	Vladimir A. Basiuk, Elena V. Basiuk, Green Processes for Nanotechnology: From Inorganic to Bioinspired
3	Nanomaterials, Springer International Publishing Switzerland, (2015).
6	Keith Scott and Eileen Hao Yu(Eds), Microbial Electrochemical and Fuel Cells, Fundamentals and
	Applications, 1 st Edition, Woodhead Publishing (2016).
	B. Sorensen, G. Spazzafumo, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Elsevier,
7	Academic Press (2018).

Subject Code	Subject Name	Category	L	Т	Р	С
OGE1901	GERMAN LANGUAGE	OE	3	0	0	3

Obje	Objectives:		
٠	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.		

UNIT-I	Grüßen, vorstellen und überHobbyssprechen	9
grüßen und verabso	chieden - sich und anderevorstellen - übersich und anderesprechen - Zahlen bis	20 -
Telefonnummer und	E-Mail-Adressesagen - buchstabieren - über Länder und Sprachensprechen - Grammati	k: W
Frage – Aussages	atz - Verben und Personal pronomen. – überHobbyssprechen – sichverabr	eden,
Wochentagebenenne	n - über Arbeit, Berufe und Arbeitszeitensprechen - einProfilim Internet erste	ellen.
Grammatik: Artikel - der, das, die - Verben und Personal Pronomen - II - Ja- / NeinFrage - Plural de		
Substantive - die Ver	rben 'haben' und 'sein'	

UNIT-II Reise in einer Stadt, das Essen und Zeitangaben 9	
Plätze und Gebauedebennen – FragenzuOrtenstellen - TexteeinerBildgeschichtezuordnen Dinge erfragen	_
Verkehrsmittelbenennen - nachdemWegfragen und einenWegbeschreiben - Textemit Internationalen Wörter	rn
verstehen - Artikellernen. Grammatik: bestimmter Artikel - der, das, die - unbestimmter Artikel - ein, ein, ein	ne
- Negations Artikel - kein, kein, keine - Imperativmit 'Sie' - über Essen sprechen- einen Einkaufplanen	_
GesprächebeimEinkaufführen - mit 'w' fragenTexte verstehen - Wörterordnen und lernen. Grammatil	k:

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PositionenimSatz – Akk	xusativ – VerbenmitAkkusativ.				
UNIT-III Zeit	it mitFreunden, Eine Einladungschreiben und beantworten	9			
Die Uhrzeit verstehen u	und nennen – Zeitangabenmachen – über die Familiesprechen – sichverabrede	en –			
sichfüreineVerspätungen	ntschuldigen und daraufreagieren – einenTermintelefonischvereinbaren. Gramm	atik:			
Zeitangabenmit am, um,	, von, bis - Possessivartikel: mein, dein - ModalverbenImSatz - Modal verben - mi	issen,			
können, wollen - etwasg	gemeinsamplanen – überGeburtstagesprechen – eineEinladung verstehen und schreib	en –			
im Restaurant bestellen	und bezahlen - übereinEreignissprechen - bestimmteInformationen in Textenfind	en –			
Veranstaltungstipps in Ra	Radio verstehen. Grammatik: Datumsangaben; am - trennbareverben - Praposition	nfür +			
Akkusativ – Personal pro	ronomenimAkkusativmich, dich Prateritum von 'haben' und 'sein'.				
UNIT-IV Kor	ntake, Wohnung	9			
Termineabsprechen –	Anleitungen verstehen und geben - Briefe verstehen und beantworte	en –			
überSprachenlernensprechen – Informationen in Textenfinden – Gesprächsituationenerkennen, Gespräche					
verstehen. Grammatik: PräpositionenmitDativ - ArtikelimDativ – Possessivartikel: Akkusativ.					
Wohnungsanzeigen ver	Wohnungsanzeigen verstehen – eineWohnungbeschreiben – eineEinladungschriftlichbeantworten –				
übereineWohnungseinrichtungsprechen – Gefallen und Missfallenausdrücken – Farbennennen –					
überWohnformenspreche	en – einen Text übereineWohnungschreiben. Grammatik: Adjektivmit sein – Ad	jektiv			
+ sehr/zu - 'in' mitAkkus	sativ – WechselPräpositionenmitDativ.				
•					
UNIT-V Arb	beit, Kleidung und Mode	9			
Tagesablaufbeschreiben -	- überverganganessprechen - überStellenanzeigen verstehen - Meinungüber Jobs ä	ußern			
		x 1			

- Blogs ueber Jobs verstehen – einTelefongesprächvorbereiten – telefonieren und nachfragen – über Jobs sprechen. **Grammatik:** Perfekt/Partizip II regelmaßige und unregelmaßigeverben – Sätzeverbinden: 'und', 'oder', 'aber'. - überKleidung und Mode sprechen – Chat übereinenEinkauf verstehen – überVergangenesberichten (to report about the past) – GesprächebeimKleiderkaufführen – sichimKaufhasorientieren – Informationenüber Berlin verstehen und recherchieren.**Grammatik:**Interrogativartikel: Welcher? Welches? Welche? – Demonstrativartikel: dieser, dieses, diese – Partizip II: trennbare und nichttrennbareverben – Personal pronomenimDativ – VerbenmitDativ.

Total Contact Hours :

Course Outcomes:

On Completion of the course, the student will be able to:

On C	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.

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

Refe	Reference Books / Web links:		
1	https://www.lingoni.com		
2	https://learngermanwithanja.com		
3	https://youtu.be/RuGmc662HDg		

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

Obje	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		
٠	To enhance official communication and Team Skills		
٠	To comprehend personal values and principles to improve professional competency.		

UNIT-I PROFESSIONAL COMMUNICATION

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

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

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

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

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

Total Contact Hours

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Cou	arse 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.		
Ref	Reference Books / Weblinks:		
1	Thomas Hackin, and Leslie Olsen. Technical Writing and Professional Communication for non-native		
1	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)		
On	line Resources		
1	https://www.coursera.org/specializations/effective-business-communication		
2	https://www.youtube.com/watch?v=srn5jgr9TZo&t=6s		

- 3 https://www.youtube.com/watch?v=CZx4DTglHJc&t=329s
- 4 <u>https://www.coursera.org/learn/learning-how-to-learn</u>
 5 <u>https://www.youtube.com/watch?v=2wPeC4CLkLU</u>

Subject Code	Subject Name	Category	L	Т	Р	C
OMA1901	COMPUTER BASED NUMERICAL METHODS	OE	2	0	2	3

Obj	jectives:
	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.

UNIT-ISOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS9Solution 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.9

UNIT-II	INTERPOLATION AND APPROXIMATION	9
Interpolation with unequal intervals - Lagrange's interpolation - Newton's divided difference interpolation -		

Interpolation with equal intervals - Newton's forward and backward difference formulae- algorithms.

UNIT-III NUMERICAL DIFFERENTIATION AND INTEGRATION

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.

UNIT-IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIALEQUATIONS

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.

UNIT-V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

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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.

Total Contact Hours

45

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.
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• 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:

1 Veerarajan. T, "Numerical methods with programs in C,"Tata McGraw Hill, New Delhi, 2007.

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

Subject Code	Subject Name	Category	L	Т	Р	С
OPH1901	MATERIALS SYNTHESIS AND	OE	3	0	0	3
	CHARACTERIZATION TECHNIQUES					

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 .

UNIT-I **Crystal Growth Techniques**

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

UNIT-II **Nanomaterials Preparation Techniques**

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 -Nanostructures - quantum wires, quantum wells, quantum dots, quantum clusters - Carbon nano-tubes -Applications

UNIT-III Ceramic Materials Preparation Techniques

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. 9

UNIT-IV Introduction to Structural Analysis

X-ray Diffraction - Single crystal and Powder diffraction - Electron microscopy - SEM - TEM - AFM -Advantages and limitations

UNIT-V Thermal and Spectroscopic Studies

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

> **Total Contact Hours** 45

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:

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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

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Reference Books / Web links:		
1	Willard HH, Merritt LL, Dean JA and Settle FA, "Instrumental Methods of Analysis", CBS Publishers	
1	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 th 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.	