The National Institute of Engineering

Mysuru – 570 008

Office of Dean (Academic Affairs)

No: NIE/Dean (AA)-102/2025-26/Odd/02 Date: 24.07.2025

List of Open Elective Courses – VII Semester B.E. (2022 Scheme)
Academic Year: 2025-26

Sl. No.	Course Code	Title of Open Elective	Offering Department	Max. No. of Students (NORTH CAMPUS)	Max. No. of Students (SOUTH CAMPUS)
1.	BCV754B	Conservation of Natural Resources	Civil Engineering	60	60
2.	BCV754C	Energy Efficiency, Acoustics and Day lighting In Building		60	-
3.	BCV754G	Air Pollution and Control		-	60
4.	BME754A	Automotive Electrical and Electronics System	Mechanical Engineering	-	60
5.	BME754B	Industrial Robotics		-	60
6.	BME754C	Waste Management Technologies		-	60
7.	BME754D	Total Quality Management		-	120
8.	BME754E	Introduction to Non-Destructive Testing		-	120
9.	BME754F	Technical Communication for Engineers		-	60
10.	BME754G	Fundamentals of Engineering Photography		60	60
11.	BME754I	Lean Manufacturing System		60	60
12.	BME754J	Supply Chain Management		60	60
13.	BEC754A	Introduction to Quantum Computing	Electronics & Communication Engineering	60	60
14.	BEC754B	Next-Gen Wireless: 5G Systems and Cross-Industry Use Cases		60	60
15.	BEC754C	Mobile Communication		60	60
16.	BEC754D	Neuromorphic Engineering		60	60
17.	BEE754A	Introduction to Smart grid	Electrical & Electronics Engineering	-	60
18.	BEE754C	Renewable Energy		-	60
19.	BEE754D	Agriculture Engineering		120	120

Sl. No.	Course Code	Title of Open Elective	Offering Department	Max. No. of Students (NORTH CAMPUS)	Max. No. of Students (SOUTH CAMPUS)
20.	BCI754B	Introduction to Algorithms	Computer Science & Engineering (AI&ML)	-	60
21.	BCI754D	Introduction to Machine Learning		-	60
22.	BIS754A	Introduction to DBMS	Information Science & Engineering	-	60
23.	BPH754A	Materials for Engineering Applications-2	Physics	-	90
24.	BMAT754A	Mathematics for Machine Learning	Mathematics	240	60

Note:

1. Students can opt for **ANY ONE Open Elective course** from the above mentioned list offered by other departments except their own/ allied department. **No multiple entry is permitted**.
2. The **maximum number** of students for an Open Elective Course will vary from department to department.
3. The **minimum number** of students for each course shall be **30**. If an open elective course has **less than 30 intake**, then such courses will not be offered and those students will be shifted to the other course based on the availability.
4. **Once the maximum number of students opting for a particular Open Elective Course is reached, the student has to opt for other Open Elective Course based on the availability**.
5. The Blownup Syllabus has been attached for reference.
6. **The Registration procedure and dates will be notified shortly.**

Dr. C. Vidyaraj
Dean (AA)

Copy to:

1. The Principal/ Vice Principal – for information
2. COE/ SDSC/ Head-IQAC – for information
3. HoDs of CIV / MEC / EEE / ECE / CSE / CSE (AIML)/ ISE / Time Table Committee Chairman

ESTD : 1946

Blownup Syllabus of Open Elective Courses:

Programme: B.E.

Scheme: 2022

Semester: VII

Academic Year: 2025-26

ESTD : 1946

Blownup Syllabus of Open Elective Courses Offered by the **Department of Civil Engineering**

for the students of:

B.E. VII Semester

Scheme: 2022

Academic Year: 2025-26

Code: BCV754B **Course: Conservation of Natural Resources**
Credits: 3 **L:T:P:S 3:0:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	Nil
Learning objectives	1. Learn types of land forms, soil conservation and sustainable land use planning. 2. Apprehend water resources, types, distribution, planning and conservation. Water pollution and types of uses. 3. Know the atmospheric composition of air, pollution and effects on human beings, animals and plants. Air pollution control. 4. Apprehend basics of biodiversity and ecosystems and know the current environmental issues

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Apprehend various components of land as a natural resource and availability and demand of water resources as applied to India.	Understand & Apply
CO2	Analyse the components of air as resource and its pollution.	Understand & Apply
CO3	Discuss biodiversity & its role in ecosystem functioning and critically appreciate the environmental concerns of today.	Understand

Mapping with POs and PSOs:

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

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	**Land:** Land as a resource, types of lands, conservation of land forms, deforestation, effect of land use changes.	3	-	-
1.2	Soil health, ecological and economic importance of soil, impact of soil degradation on agriculture and food security	3	-	-
1.3	Need for soil conservation, sustainable land use planning.	2	-	-
	Module – 2			
2.1	**Water:** Global water resources, Indian water resources, Resources system planning. Water use sectors- domestic, industrial, agriculture. Water deficit and water surplus basins in India.	3	-	-
2.2	Equitable distribution, Inter-basin water transfers, Interlinking of rivers – Himalayan component, peninsular component, issues involved.	3	-	-

2.3	Ground water its potential in India, conjunctive use, recharge of ground water. Contamination of ground water, sea water ingress, problems and solutions.	3	-	-
	Module – 3			
3.1	**Air:** Introduction, composition, sources and classification of air pollutants, National Ambient Air quality standards (NAAQS), Air quality index,	3	-	-
3.2	Effects of air pollution on human health. Economic effects of air pollution.	3	-	-
3.3	Control of air pollution by equipment, smoke and its control. Ozone depletion – impacts, photochemical changes.	3	-	-
	Module – 4			
4.1	**Biodiversity:** Introduction, Flora and Fauna, Importance of biodiversity, Economic values medicinal plants, drugs, fisheries biogeochemical cycling. Threat to biodiversity, natural & anthropogenic disturbance, habitat loss.	3	-	-
4.2	Conservation of biodiversity, National parks, wild life sanctuaries, zoological gardens, gene banks, pollen culture, ecological restoration, social forestry.	3	-	-
4.3	Ecosystem: Definition, Types: forest, grass land, marine, desert, wetlands, estuarine, lotic, lentic. Abiotic & biotic components of ecosystem	2	-	-
	Module – 5			
5.1	**Global warming:** concept, indicators, factor and effects. Global climate change-indicators, health impacts, effect on biodiversity, Introduction to global efforts in conservation of biodiversity,	3	-	-
5.2	Status of EIA in India. EIA regulations in India,	3	-	-
5.3	List of projects needing environmental clearance ,under EIA notifications. Case study power/ thermal power projects	2	-	-
	Total No. of Lecture Hours	42	-	-
	Total No. of Tutorial Hours		**-**	
	Total No. of Practical Hours			**-**

Textbooks:

1. Asish Ghosh “Natural Resource Conservation and Environment Management” A.P.H. Publishing Corporation, 2003

Reference Books:

1. P.Jaya Rami Reddy, “A Textbook of Hydrology”, University Science Press, New Delhi, 2011.
2. Krishnamurthy K.V., “An advanced textbook of Biodiversity- principle & practices.” Oxford and IBH publications Co. Pvt ltd, New Delhi. 2004.
3. Odum, E.P., “Fundamentals of Ecology”, W.B sounders, Philadelphia, USA, 1971
4. Singh J.S, Singh S.P & Gupta, S.R., “Ecology, environment and resource conservation”, Anamaya publications, 2006

Online Resources:

1. NPTEL MOOC course on “Natural Resource Management” by Prof. Sudip Mitra IIT Guwahati.

Code: BCV754C **Course: Energy Efficiency, Acoustics And Daylighting In Building**
Credits: 3 **L:T:P 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks: 100**

Prerequisites if any	NA
Learning objectives	1. To facilitate learners to understand climatology, heating res in building and energy 2. To expose the learners to building acoustics, indoor air quality and day lighting. 3. To impart fundamental knowledge on Life cycle assessment and Energy efficiency in buildings

Course Outcomes:
On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Understand the climatology, heating in building and apply shading design concepts for building.	L1, L2
CO2	Comprehend concepts of building acoustics, indoor air quality and building lighting	L1, L2
CO3	Demonstrate the Life Cycle Assessment of Buildings and Green project management	L1, L2

Mapping with POs and PSOs:

COs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2		PSO 1	PSO 2	PSO 3
CO1	2		1			1	1					1		1		
CO2						1	1							1		
CO3	2					1	1					1		1		

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	**Introduction to Climatology and heating ress in building**: Basics of climatology, Earth	02	-	-
1.2	Sun relationship, Solar angles and sun path diagram, Design of shading systems. Basics of Thermodynamics, Convection/radiation heat transfer,	04	-	-
1.3	Heat gain through various elements of a building, Thermal Comfort models	03		

	and case studies			
	Module – 2			
2.1	**Building acoustics, Indoor air quality and Lighting in buildings**: Basics of sound and Building acoustics	02	-	-
2.2	Acoustic defects, prevention of sound transmission and acoustic measure for office building.	02	-	-
2.3	Indoor Air Quality – Effects, control of contaminants and moisture in indoor environment, Integrated approach for IAQ management. Fundamentals of lighting – Day lighting and its metrics	04	-	-
2.4	Strategies for day lighting and its control. Artificial lighting– Design and control strategies – Visual comfort enhancement.	03	-	-
	Module – 3			
3.1	Energy efficient buildings, Water and Waste management in buildings : Energy efficiency – Energy efficiency in building envelope and energy efficient HVAC and Lighting as per Energy conservation building code (ECBC) 2017	03	-	-
3.2	Energy simulation, Energy management system - Renewable energy and Energy Audit, (demand control ventilation)	02	-	-
3.3	Water Efficiency – Planning and design of water management system, Rainwater harvesting, Water efficient design and fixtures, Treatment and reuse and Water efficient landscape system.	02	-	-
3.4	Waste management – Types of waste and its treatment methods, Construction and demolition waste management, Waste management in residential, commercial buildings, health care facilities.	02	-	-
	Module – 4			
4.1	**Life Cycle Assessment of Buildings and Green project management**:	02	-	-
4.2	Materials – Green product certifications, features of sustainable building Materials and sustainable alternatives for structural, envelope and finishing materials.	02	-	-
4.3	Low carbon cement, Zero emission bricks and lean construction practices.	01	-	-

4.4	Life cycle assessment and its types – Modelling and Analysis, Green house Gas emission. Different phases of Green building project management.	02	-	-
Module – 5				
5.1	Energy efficiency in HVAC system–Variable Frequency Drive (VFD), Air volume drive. Rooftop solar installations and solar water heaters, Heat recovery system in buildings	02	-	-
5.2	Building Management System(BMS) – Occupancy sensors and energy efficient lighting controls, Smart Buildings.	02	-	-
	Total No. of Lecture Hours	**40**		
	Total No. of Tutorial Hours		**00**	
	Total No. of Practical Hours			**00**

Self-learning topics identified: (Maximum of 5 topics)

1. Building exterior and interior lighting
2. Landscape design
3. Seven LCA impact categories

Textbooks:

1. Harhara Iyer G, Green Building Fundamentals, Notion Press
2. Dr.Adv. Harshul Savla, Green Building: Principles & Practices
3. Arvind Kishan, Baker & Szokolay, Climate Responsive Architecture, Tata McGraw Hill, 2002.
4. Donald Watson and Kenneth Labs; Climatic Building Design - Energy-Efficient Building Principles and Practice; McGraw-Hill Book Company, 1983.

Reference Books:

1. The Sustainable Habitat Handbook (6VolumeSet), GRIHAVersion2019
2. National Building Code–2016,Volume1&2,BureauofIndianStandards
3. Energy Conservation Building Code–2017(withamendmentsupto2020), Bureau of Energy Efficiency

Online Resources;

1. Energy Efficiency Acoustics and Daylighting in Building – NPTEL Course

Code: BCV754G **Course: Air Pollution and Control**
Credits: 3 **L: T:P 3:0:0**
SEE: 50% **CIE: 50%**
SEE Hours: 3 **Max. Marks:100**

Prerequisites if any	
Learning objectives	• Understand the sources, classification, effects of air pollutants, and measurement of air pollutants, air pollution standards and control regulations. • Understand the basic concepts of various meteorological factors which influence the dispersion of air pollutants. • Gain Knowledge about the monitoring of particulate matter and Prediction of dispersion of air pollutants using models • Understand and analyze the basic mechanisms involved, working principles and design aspects of various air pollution controlling equipment.

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom's level
CO1	Identify the major sources of air pollution and understand their effects on health and environment.	Understand
CO2	Evaluate the dispersion of air pollutants in the atmosphere and to develop air quality models.	Understand Apply
CO3	Evaluate sampling techniques for atmospheric and stack pollutants and design control techniques for particulate and gaseous emissions.	Understand Analyze

Mapping with POs and PSOs:

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

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1				
1.1	Definition, Sources of air pollution, characterization and classification of atmospheric pollutants, air pollution episodes.	03		
1.2	Effects of air pollutants on human health, vegetation, animals, and materials and monuments	03		
1.3	Elemental properties of the atmosphere – scales of motion, heat, pressure, wind, moisture, relative humidity	02		
Module – 2				
2.1	Meteorology: Wind circulation, solar radiation, lapse rates, atmospheric stability	03		

	conditions, wind velocity profile			
2.2	Maximum Mixing Depth, Temperature Inversions, Wind rose diagram, heat island effect	03		
2.3	Stack emissions, plume behavior, estimation of effective stack height, heat island. effect.	03		
Module – 3				
3.1	Pollutants dispersion models: Point, line, and areal sources model	02		
3.2	Gaussian plume dispersion model – for point source (with and without reflection), Gaussian dispersion coefficient, Determination of ground level concentrations	03		
3.3	Air Quality Monitoring, Air Quality Index	02		
Module – 4				
4.1	Sampling of particulate and gaseous pollutants (Stack, Ambient & indoor air pollution)	03		
4.2	Monitoring and analysis of air pollutants (PM2.5, PM10, SO_X, NO_X, CO, NH_3)	03		
4.3	Air pollution emission standards, National and international policies, acts, rules, and regulations.	02		
Module – 5				
5.1	Air Pollution Control Equipment: Mechanisms, Control equipment for particulate matter – gravity settling chambers, centrifugal collectors, wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP)	03		
5.2	Control Equipment for gaseous pollutants – adsorption, absorption, condensation, and combustion.	03		
5.3	Indoor Air Pollution – sources, effects, and control.	02		
	Total No. of Lecture Hours	40		
	Total No. of Tutorial Hours		---	
	Total No. of Practical Hours			---

Textbooks:

1. Howard S Peavy, Donald R Rowe and George Tchobanoglous, “Environmental Engineering” , Tata Mc-G raw Hill Publication.
2. M. N. Rao and H V N Rao, “Air pollution”, Tata Mc-G raw Hill Publication.

Reference Books:

1. Noel De Nevers, “Air Pollution Control Engineering” , Waveland Pr Inc.
2. Anjaneyulu Y, “Text book of Air Pollution and Control Technologies”, Allied Publishers
3. H. C. Perkins, “Air pollution”. Tata McGraw Hill Publication41
4. Mackenzie Davis and David Cornwell, “Introduction to Environmental Engineering” McGraw-Hill Co.
5. Martin Crawford “Air Pollution Control Theory” Tata McGraw Hill Publication

Online Resources:

1. NPTEL course by By Prof. Alok Sinha, Prof. Bhola Ram Gurjar, IIT Roorkee titled “Air Pollution and Control”

ESTD : 1946

Blownup Syllabus of Open Elective Courses Offered by the **Department of Mechanical Engineering**

for the students of:

B.E. VII Semester

Scheme: 2022

Academic Year: 2025-26

Course Code: BME754A	Course: Automotive Electrical and Electronic systems
Credits: 3	L:T:P 3:0:0
SEE: 50 % Marks	CIE: 50 % Marks
SEE Hours: 3 hours	Max. Marks: 100

Prerequisites if any	None
Learning objectives	1. Deliver the knowledge of the principles behind automotive systems. 2. Impart information about the electrical and electronic technologies used in modern vehicles.

Course Outcomes:

On successful completion of the course, the student will be able to:

Course Outcomes		Bloom's level
CO1	Describe the foundations of the electrical and electronic systems in modern automobiles.	Understand
CO2	Discuss the electrical and electronic control systemin the automobiles.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	-	-	-	-	-	-	-	-	-		3	-	-	-
CO2	3	2	2	-	-	-	2	-	-	-	-	-		2	2	-	-

3 – Strong 2 – Medium 1 – Low

Course Content

	Module	No. of Lecture Hours	No. of Tutorial Sessions
	Module – 1 (Automotive Fundamentals Overview)		
1.1	Four Stroke Cycle, Engine Control, Drive Train	1	-
1.2	Transmission, Brakes, Steering System	1	-
1.3	Battery and Starting System	1	-
1.4	Air/Fuel Systems Fuel Handling, Air Intake System	1	-
	Module – 2 (Automotive Energy Storage Systems)		
2.1	***Introduction:*** Electrochemical Reactions, Specific Energy, Specific Power, Energy Efficiency.	2	-
2.2	***Battery Technologies:*** Lead-Acid Batteries, Lithium-Based Batteries such as Lithium-Polymer (Li-P) Battery and Lithium-Ion (Li-Ion) Battery, Sodium	5	-

	based batteries and Metal Air Battery.		
2.3	Ultra-capacitors and Ultrahigh-Speed Flywheels Technologies	2	-
Module – 3 (Automobile Electrical)			
3.1	***Starting System:*** Principle & construction of starter motor in IC Engines. Types, Construction & working of battery coil and magneto ignition systems.	2	-
3.2	***Charging System:***Construction & Working of Charging System IC engines and EVs.	2	-
3.3	***Lighting Systems and accessories:*** Electrical fuel-pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper systems.	4	-
Module – 4 (Sensors and Actuators)			
4.1	***Sensors:***Basic sensor arrangement, working of oxygen Sensors, Throttle Position Sensor (TPS), Engine Crankshaft Angular Position sensor (CKP), Engine Speed Sensor, Ignition Timing Sensor, Hall effect Position Sensor, Manifold Absolute Pressure (MAP) Sensor, Engine Coolant Temperature (ECT) Sensor, Intake Air Temperature (IAT) Sensor, Knock Sensor, Airflow rate sensor.	6	-
4.2	***Actuators:*** Working of Fuel Metering, Fuel Injector and Ignition Actuator.	3	-
Module – 5 (Electronic systems)			
5.1	***Motion Control system:*** Principles of Cruise control, Power Brakes, Antilock Brake System (ABS), Electronic Steering Control, Traction Control, Electronically controlled suspension, Advanced Driver Assistance Systems (ADAS). Alternative Fuel Engines controls	7	-
5.2	***Automotive Diagnostics:*** On-board diagnostics, Off-board diagnostics,	3	-
	Total No. of Lecture Hours	**40**	**-**
	No. of Tutorial Sessions		**Nil**

Virtual Labs

Sl No	Experiment Name	Developed by	Link
1	Engine Health Monitoring by Vibration Analysis	IIIT Kharagpur	http://vlabs.iitkgp.ac.in/rtvlas/exp6/index.html
2	Ohm's Law	IIIT Kharagpur	http://vlabs.iitkgp.ac.in/be/exp4/index.html

Text Books:

1. **Understanding Automotive Electronics** by William B. Ribbens,7thEdition, SAMS-Elsevier Publishing, 2012.
2. **Modern Electric, Hybrid Electric, and Fuel Cell Vehicles - Fundamentals, Theory, and Design** by MehrdadEhsani, YiminGao and Ali Emadi, 3rdEdition, CRC Press, London, 2019.

Reference Books:

1. **Automobile Electrical and Electronic Systems** by Tom Denton, 5th Edition, Elsevier Butterworth-Heinemann, 2004.
2. **Automotive Electrics Automotive Electronics Systems and Components** by Robert Bosch Gambh, 5th Edition, John Wiley &Sons Ltd.,2007.

Online Resources:

1. Fundamentals of Automotive Systems - Web course in NPTEL (https://nptel.ac.in/courses/107106088)
2. Introduction to Hybrid and Electric Vehicles - Web course in NPTEL (https://nptel.ac.in/courses/108103009)

Course Code: BME754B	Course: Industrial Robotics
Credits: 3	L:T:P 3:0:0
SEE: 50 % Marks	CIE: 50 % Marks
SEE Hours: 3 hours	Total. Marks: 100 Marks

Prerequisites if any	None
Learning objectives	1. To gain knowledge in the field of Robotics and Control Systems. 2. To apply the concepts of Robotics for the development of automation solution.

Course Outcomes:

On successful completion of the course, the student will be able to:

Course Outcomes		Bloom's level
CO1	Understand the significance, social impact and future prospects of robotics and automation in various engineering applications.	Understand
CO2	Identify and describe the components and anatomy of robotic system.	Understand
CO3	Know about various path planning techniques and analyze different motions of robotics system.	Understand, Apply
CO4	Use the suitable drives and end-effectors for a given robotics application.	Apply
CO5	Apply robotics concept to automate the monotonous and hazardous tasks and categorize. various types of robots based on the design and applications in real world scenarios.	Understand

Mapping with POs and PSOs:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3	PSO4
CO1	3	2				2	1	1		1		3					
CO2	3	3	3	3	3	2	1	1	2	2		3					
CO3	3	3	3	3	3	2	1	1	2	2		3					
CO4	3	3	3	3	3	2	1	1	2	2		3					
CO5	3	3	3	3	3	2	1	1	2	2		3					

3 – Strong 2 – Medium 1 – Low

Course Content

	Module(s)	No. of Lecture Hours	No. of Tutorial Sessions
	Module – 1Introduction To Robotics		
1.1	Introduction to Robotics and Automation, laws of robot.	2	
1.2	Brief history of robotics, basic components of robot, robot specifications.	2	
1.3	Classification of robots, human system and robotics, safety measures in robotics, social impact.	2	
1.4	Robotics market and the future prospects, advantages and disadvantages of robots.	2	
	Module – 2Robot Anatomy And Motion Analysis		
2.1	Anatomy of a Robot, Robot configurations: polar, cylindrical, Cartesian, and jointed arm configurations.	2	
2.2	Robot links and joints	2	
2.3	Degrees of freedom: types of movements, vertical, radial and rotational traverse, roll, pitch and yaw.	2	
2.4	Wok volume/envelope, Robot kinematics: Introduction to direct and inverse kinematics, transformations and rotation matrix.	2	
	Module – 3Robot Drives And End Effectors		
3.1	Robot drive systems: Hydraulic, Pneumatic and Electric drive systems, classification of end effectors, mechanical grippers, vacuum grippers, magnetic grippers, adhesive gripper, gripper force analysis and gripper design, 1 DoF, 2 DoF, multiple degrees of freedom robot hand, tools as end effectors.	4	
3.2	Robot control types: limited sequence control, point-to-point control, playback with continuous path control, and intelligent control	4	
	Module – 4Path Planning		
4.1	Definition-Joint space technique, Use of P-degree polynomial-Cubic.	3	
4.2	Polynomial Cartesian space technique, parametric descriptions.	3	
4.3	Straight line and circular paths, position and orientation planning.	3	
	Module – 5Robotics Applications: Material Handling		
5.1	Pick and place, palletizing and depalletizing, machining loading and unloading, welding & assembly, Medical, agricultural and space applications.	2	
5.2	Unmanned vehicles: ground, ariel and underwater applications, robotic for computer integrated manufacturing.	2	
5.3	Types of robots: Manipulator, Legged robot, wheeled robot, aerial robots, Industrial robots.	2	
5.4	Humanoids, Cobots, Autonomous robots, and Swarm robots.	1	
	Total No. of Lecture Hours	**40**	**-**
	No. of Tutorial Sessions		**Nil**

Text Books:

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education,2009.
2. Mikell P. Groover et. al., "Industrial Robots - Technology, Programming andApplications", McGraw Hill, Special Edition, (2012).
3. Ganesh S Hegde, “A textbook on Industrial Robotics”, University science press, 3rd edition, 2017.

Reference Books:

1. Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd., 2006.
2. Fu K S, Gonzalez R C, Lee C.S.G, "Robotics: Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987. https://www.robots.com/applications.

Course Code: BME754C	Course: Waste Management Technologies
Credits: 3	L:T:P 3:0:0
SEE: 50% Marks	CIE: 50% Marks
SEE Hours: 3 hours	Max. Marks: 100

Prerequisites if any	None
Learning objectives	1. To understand the source of waste generation and how it effects the environment. 2. To understand the management of solid waste and challenges involved in solid waste management. 3. To understand the management of hazardous waste and challenges involved in hazardous waste management. 4. To understand the innovative methods in handling waste and its effects. 5. To understand Laws governing the waste management.

Course Outcomes:

On successful completion of the course, the student will be able to:

	Course Outcomes	Bloom's level
CO1	Identify & segregate the waste	Understand
CO2	Formulate the appropriate waste segregation, collection & disposal system	Understand
CO3	Generate are porton waste management challenges	Understand
CO4	Select are medial measure for environmental & living being protection	Understand
CO5	Exercise the constitution laws as a citizen	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3	PSO4
CO1	1	2	3	1	-	3	3	3	2	2	1	1		-	3	-	-
CO2	1	2	3	1	-	3	3	3	2	2	1	1		-	3	-	-
CO3	-	-	1	-	-	2	2	1	-	1	2	1		-	1	-	-
CO4	1	2	3	1	-	3	3	3	2	2	1	1		-	3	-	-
CO5	-	-	-	-	-	2	1	2	1	-	-	-		-	-	-	-

3 – Strong 2 – Medium 1 – Low

Course Content

	Module – 1	No. of Lecture Hours	No. of Tutorial Sessions
1.1	Introduction to waste management: Importance, methods of logistics, human components.	2	-
1.2	Technological components- waste handling equipment and technology, steps in waste management logistics.	2	-
1.3	Waste collection system and organization: Environmental aspects of waste collection, role of public authority and private sector in waste collection	3	-
1.4	Organizing collection of residential waste, fee schemes, public awareness programs.	2	-
	Module – 2		
2.1	Engineering Systems for Solid Waste Management: Characteristics of solid waste, types of solid waste.	1	-
2.2	Processing and Treatment of Solid Waste; Mechanical Treatment Material Recovery Facility, Recycling and Recovery, Types of Material Recovery Facilities.	2	-
2.3	Biological Treatment & Biological methods for waste processing; Composting & methods. Bio-methanation, Bio-deisel, Bio-hydrogen, Mechanical Biological Stabilization.	2	-
2.4	Thermal Treatment Incineration, Residues and its utilisation, co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel, solid recovered fuel.	2	-
2.5	Engineering Disposal of SW: Dumping of solid waste; sanitary landfills – site selection.	1	
	Module – 3		
3.1	Hazardous Waste Management: Introduction, Hazardous waste definition, sources, identification and classification	1	-
3.2	Characteristics, Industrial waste & Plastic Waste; sources, environmental effects, challenges in handling Biomedical waste; Introduction to biomedical wastes, sources, classification, collection, segregation, treatment and disposal	3	-
3.3	E- waste; characteristics, generation, collection, transport, recycling and disposal, Effects on the society and environment, Transportation and Disposal, recycling and reuse	2	-
3.4	Nuclear waste; Characteristics, Types, Power reactors, Refinery and fuel fabrication wastes, Health and environmental effects,	3	-

	Decommissioning of Nuclear power reactors Hazardous waste landfills, Site selections.		
	Module – 4		
4.1	Innovations in waste management: Bio-waste management: composter, bio gas technologies, Global and Indian Context, recycling, reuse, energy production, land filling, remediation of hazardous waste contaminated sites	2	-
4.2	Revenue models, Developing Networks, Entrepreneurship activities, Best practices in India and Abroad- Case studies, Waste management and waste handling entrepreneurs in India and other countries	3	
4.3	Case studies of different municipalities waste handling techniques, domestic composting, medium & large scale composting, Centralised composting	2	-
	Module – 5		
5.1	Waste Management Laws in India: The Environmental Protection Act, The Hazardous Wastes (Management, Handling and Trans-boundary Movement) Rules, 2008.	3	-
5.2	The Plastic Waste (Management and Handling) Rules, 2011, Bio-Medical Waste (Management and Handling) Rules, 1998, The E-Waste (Management and Handling) Rules, 2011	2	-
5.3	The Batteries (Management and Handling) Rules, 2001. Duties of constitutional bodies and Ministries	2	-
	Total No. of Lecture Hours	**40**	**-**
	No. of Tutorial Sessions		**Nil**

Text Books:

1. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-HillEducation,2002,2ndEdition
2. Hazardous Wastes - Sources, Pathways, Receptors, Richard J. Watts, John Wiley and Sons,1998,1stEdition.
3. Strategic Management,Hitt, M.A.,Hoskisson, R.E., Ireland, R.D., (2016)., Cengage Learning,India.
4. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press,2014,2ndEdition
5. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-HillEducation,2002,2ndEdition

Reference Books:

1. WasteManagementPractices:Municipal,HazardousandIndustrial,JohnPichtel(2014).,2nd Ed.,CRCPress,USA.
2. Waste:AHandbookforManagement,Letcher,T.M.,Vallero,D.A.(2011).,1stEd,Academ icPress,USA.
3. Waste Management Strategy and Action Plan,IGES, UNEP, CCET. (2018), Phnom Penh 2018-2035.Phnom Penh,Cambodia.
4. NationalEnvironmentPolicy,2006,MinistryofEnvironmentandForests,Governmentof India,Approvedby theUnion Cabineton 18May,2006
5. Innovation and Entrepreneurship, Peter Drucker, (2012)., Routledge Publishers, England UK

Online Resources:

https://nptel.ac.in/content/storage2/courses/105106056/Introduction.pdf
https://nptel.ac.in/courses/105/103/105103205/
http://cpheeo.gov.in/cms/manual-on-municipal-solid-waste-management-2016.php
https://nptel.ac.in/courses/105/103/105103205/
https://nptel.ac.in/courses/120/108/120108005/
https://nptel.ac.in/courses/105/106/105106056/
https://nptel.ac.in/courses/105/105/105105160/
https://nptel.ac.in/courses/103/107/103107125/

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ActivityBasedLearning(SuggestedActivitiesinClass)/PracticalBasedlearning

- Preparationofamodelforwastemanagementforahostel,apartment,institution,
- Speechesbystudentsaboutbestpracticesfollowedfordomesticwastehandling
- Preparecompostusingmachines
- Visitnearbywastedumpyardandpreparereportcoveringchallenges&remedies
- Visitindustriesandobservelarge-scaleindustrywastedisposalpracticesandchallenges
- Visitnearbyhospitalsandobservelarge-scalebio-medicalwastedisposalpracticesandchallenges
- Displayeverydayone/twoconstitutionrulesonclassnoticeboard Posterpreparationbystudents

Course Code: BME754D	Course : Total Quality Management
Credits: 3	L:T:P 3:0:0
SEE Marks: 50 % Marks	CIE Marks: 50 % Marks
SEE Hours: 3 hours	Total Marks: 100

Prerequisites if any	None
Learning objectives	To improve the quality of an organization's outputs, including goods and services, through the continual improvement of internal practices.

Course Outcomes:

On successful completion of the course, the student will be able to:

Course Outcomes		Bloom's level
CO1	Understand various approaches to TQM	Understand
CO2	Understand the characteristics of quality leader and his role.	Apply
CO3	Develop feedback and suggestion systems for quality management.	Apply
CO4	Enhance the knowledge in Tools and Techniques of quality management	Understand

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3	PSO4
CO1	3		2	1	2	3	-	2				2		3	-	-	2
CO2	3	3	2	-	-	-	-	2	2	2	2			2	-	-	2
CO3	3	3	2		-		-	2	3	1	2			2	-		2
CO4	3	3	3					2	2	2	2						

3 – Strong 2 – Medium 1 – Low

Course Content

	Module – 1	No. of Lecture Hours	No. of Tutorial Sessions
1.1	Principles and Practice: Definition, basic approach, gurus of TQM,	2	-
1.2	TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM.	2	-
1.3	Quality Management Systems: Introduction, benefits of ISO registration,	2	
1.4	ISO 9000 series of standards, ISO 9001 requirements.	2	-
	Module – 2		
2.1	Leadership: Definition, characteristics of quality leaders,	2	-

2.2	Leadership concept, characteristics of effective people, ethics,	1	-
2.3	Deming philosophy, role of TQM leaders, implementation,	2	
2.4	Core values, concepts and framework,	1	
2.5	Strategic planning communication, decision making.	2	
Module – 3			
3.1	Customer Satisfaction and Customer Involvement: Customer Satisfaction: customer and customer perception of quality,	1	
3.2	Feedback, using customer complaints, service quality, translating needs into Requirements, customer retention, case studies.	2	-
3.3	Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing,	3	-
3.4	Performance appraisal, unions and employee involvement, case study	2	-
Module – 4			
4.1	Continuous Process Improvement: process, the Juran trilogy, improvement strategies,	1	
4.2	Types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.	3	-
4.3	Statistical Process Control : Pareto diagram, process flow diagram, cause and effect diagram,	1	
4.4	Check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process,	2	
4.5	Control charts for variables, control charts for attributes, scatter diagrams, case studies.	1	
Module – 5			
5.1	Tools and Techniques: Benching marking, information technology, Theory of Inventive Problem Solving	2	
5.2	Quality management systems, environmental management system,	2	-
5.3	Quality function deployment, quality by design, failure mode and effect analysis,	2	-
5.4	Product liability, total productive maintenance.	2	
	Total No. of Lecture Hours	**40**	**-**
	No. of Tutorial Sessions		

Books:

1. Total Quality Management Dale H. Besterfield, Pearson Education India ISBN: 8129702606, Edition 0
2. Total Quality Management, Engineers, M. Zairi head, Publishing.

3. Managing for Quality and Performance Excellence, James R. Evans and W M, Cengage Learning, 9th edition,
4. A New American TQM, four revolutions in management, Shoji Shiba, Alan Graham, Productivity press,Oregon, 1990.
5. Engineering Optimization Methods and Applications
6. Organizational Excellence through TQM, H. Lal, New age Publications, 2008.
7. Introduction to Operations Research- Concepts and Cases, F.S. Hillier. G.J. Lieberman, Tata McGrawHill, 9th Edition, 2010

Web links and Video Lectures (e-Resources):

- https://www.investopedia.com/terms/t/total-quality-management-tqm.asp
- https://www.youtube.com/watch?v=VD6tXadibk0
- https://aboutthree.com/blog/five-important-factors-in-total-quality-management/
- https://www.youtube.com/watch?v=renlXcpK9sk
- https://www.youtube.com/watch?v=umqtSNPp5Dk
- https://study.com/academy/lesson/five-principles-of-total-quality-management-tqm.html
- https://www.greenlight.guru/blog/total-quality-management-principles

Course Code: BME754E	**Course: Introduction to Non-Destructive Testing**
Credits: 3	**L:T:P:3:0:0**
SEE: 50 % Marks	**CIE: 50 % Marks**
SEE Hours: 3 hours	**Total. Marks: 100 Marks**

Prerequisites if any	None
Learning objectives	1. To introduce the basic principles, techniques, equipment, applications and limitations of Non-Destructive Testing (NDT) methods such as Visual, Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Eddy Current. 2. To enable selection of appropriate NDT methods 3. To make aware the developments and future trends in NDT.

Course Outcomes:

On successful completion of the course, the student will be able to:

	Course Outcomes	Bloom's level
CO1	Check different metals and alloys by visual inspection method.	Understand
CO2	Explain and perform non-destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonictest, X- ray and Gamma ray radiography	Understand

Mapping with POs and PSOs:

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3	PSO4
CO1	3	2	1	-	3	-	-	-	-	-	-	-		2	-	3	-
CO2	3	2	1	-	3	-	-	-	-	-	-	-		2	-	3	-

3 – Strong 2 – Medium 1 – Low

Course Content

	Module(s)	No. of Lecture Hours	No. of Tutorial Sessions
	Module – 1		
1.1	**Overview of NDT**: NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods forthe detection of manufacturing defects as well as material characterisation. Relative merits and limitations,Various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.	8	-
	Module – 2		
2.1	**Surface NDT Methods**: Liquid Penetrant Testing – Principles, types and properties of liquid penetrants,	4	-

	developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results.		
2.2	**Magnetic Particle Testing-** Theory of magnetism, inspection materials, magnetization methods, Interpretationand evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.	4	-
	Module – 3		
3.1	**Thermography**- Principles, Contact and non -contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation andinfrared detectors, Instrumentations and methods, applications.	8	-
	Module – 4		
4.1	**Ultrasonic Testing**-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction.	8	-
	Module – 5		
5.1	**Radiography**: Principle, interaction of X-Ray with matter, imaging, film and film less techniques, typesand use of filters and screens, geometric factors, Inverse square, law, characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence.	8	-
	Total No. of Lecture Hours	**40**	**-**
	No. of Tutorial Sessions		**Nil**

Text Books:

1. Practical Non-Destructive Testing by Baldev Raj, T.Jayakumar, M.Thavasimuthu, Narosa Publishing House, 2009.
2. Non-Destructive Testing Techniques by Ravi Prakash New Age International Publishers 1st revised edition, 2010.

Reference Books:

1. ASM Metals Handbook, “Non-Destructive Evaluation and Quality Control”, Volume-17 American Society of Metals, Metals Park, Ohio, USA, 2000.
2. Introduction to Non-destructive testing: a training guide Paul E Mix, Wiley 2nd Edition New Jersey, 2005.

Online Resources:

1. Theory and Practice of Non-Destructive Testing by IIT Madras – NPTEL(Ranjit Bauri)

Course Code: BME754F	Course: Technical Communication for Engineers
Credits: 3	L:T:P: 2:2:0
SEE: 50 % Marks	CIE: 50 % Marks
SEE Hours: 3 hours	Total. Marks: 100 Marks

Prerequisites if any	None
Learning objectives	• Understand the fundamentals of Technical Communication for Engineers • Develop skills required to become effective communicators of scientific information

Course Outcomes:

On the successful completion of the course, the student will be able to

Course Outcomes		Bloom's level
CO1	Describe the communication process.	Understand
CO2	Demonstrate skill in technical writing, comprehension, and condensation.	Apply
CO3	Exhibit competence in delivering technical presentations, active listening & speaking	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3	PSO4
CO1	1	-	-	-	-	3	-	-	-	3	-	3		-	-	-	3
CO2	1	-	-	-	-	3	-	-	-	3	-	3		-	-	-	3
CO3	1	-	-	-	-	3	-	-	-	3	-	3		-	-	-	3

Strong: 3 Medium: 2 Low: 1

Course Content

	Module – 1	No. of Lecture Hours	No. of Tutorial Hours
1.1	Principles of communication: Introduction to Communication.	3	-
1.2	Barriers to Communication, Communication Media and Technology, Communication Process,	4	-
1.3	Demonstration of Communication Process & Barriers through role play.	-	2
	Module – 2		
2.1	Channels of Communication: Direction of Communication: Upward, Downward, Horizontal and Interpersonal), Organizational communication, Choice of communication. Verbal vs. Non Verbal	5	-

	Communication.		
2.2	Demonstration of Channels and Direction of Communication through role play.	-	2
	Module – 3		
3.1	Listening and Speaking: Active listening; Effective Speaking; Effective Presentations; Interviews	4	-
3.2	Demonstration of Listening Skills though role play	-	2
	Module – 4		
4.1	Reading and Writing: Reading, Technical writing, Art of condensation, Letters, Memos and emails	4	-
4.2	Demonstration of Reading Skills through individual & group activities	-	2
	Module – 5		
5.1	Demonstration of Speaking Skills through Presentations & role play	-	6
5.2	Demonstration of Writing Skills through Report preparation and precis writing.	-	6
	Total No. of Lecture Hours	20	-
	Total No. of Tutorial Hours		20

Text Books:

1. Business Communication, Lesikar and Pettit, Irwin. 6th Edition
2. Technical Communication, Meenakshi Raman, Second Edition, Oxford Higher Education

Reference Books:

1. Technical Communication for Engineers, Shalini Verma, Vikas Publishing House, 2015
2. The Oxford Guide to Effective Writing and Speaking, John Seely, Oxford University Press, 2nd Edition, 2005

Online Resources:

1. Technical English for Engineers, IIT Madras, NPTEL (https://onlinecourses.nptel.ac.in/noc19_hs31)

Course Code: BME754G	**Course: Fundamentals of Engineering Photography**
Credits: 3	**L:T:P: 2:0:2**
SEE: 50 % Marks	**CIE: 50 % Marks**
SEE Hours: 3 hours	**Total. Marks: 100 Marks**

Prerequisites if any	None
Learning objectives	This course is designed to introduce engineering students to the art and science of photography, providing them with essential skills and knowledge to explore the world through the lens of a camera. Students will learn not only the technical aspects of photography but also how to use their creativity to capture and communicate engineering concepts, designs, and innovations effectively.

Course Outcomes:

On the successful completion of the course, the student will be able to

	Course Outcomes	Bloom's level
CO1	Explain the fundamental principles of photography, including exposure, composition, and lighting.	Understand
CO2	Apply technical skills to capture high-quality images in different engineering contexts, such as documenting engineering projects, creating instructional materials, and illustrating technical reports.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3	PSO4
CO1	1	-	-	-	-	3	-	-	-	3	-	3		-	-	-	3
CO2	1	-	-	-	-	3	-	-	-	3	-	3		-	-	-	3

Strong: 3 Medium: 2 Low: 1

Course Content

	Module – 1	No. of Lecture Hours	Lab Hours
1.1	History and evolution of photography	1	
1.2	Basic principles of photography: exposure, composition, focus, and lighting	1	
1.3	Introduction to different types of cameras and their functionalities	1	
1.4	Understanding camera settings: aperture, shutter speed, ISO	1	

1.5	Depth of field and its implications in engineering photography	1	
1.	*Practical Session on camera settings and implication of depth of field.*		4
	Module – 2		
2.1	Principles of composition: rule of thirds, leading lines, framing, symmetry.	2	
2.2	Framing engineering subjects: capturing structures, machines, and designs creatively	2	
2.	*Visual storytelling: using photography to convey engineering narratives*		4
	Module – 3		
3.1	Techniques for capturing architectural marvels, bridges, and infrastructure.	2	
3.2	Photography of industrial processes and machinery	2	
3.3	Safety considerations and precautions while photographing in engineering environments	2	
3.	*Techniques to capture architectural structures and machinery*		4
	Module – 4		
4.1	Macro photography for capturing intricate engineering details	2	
4.2	High-speed photography for capturing fast-moving objects and phenomena.	2	
4.3	Aerial photography and its applications in engineering projects	2	
4.	*Practical sessions on specialized photographic techniques (Macro, High-Speed and Aerial)*		4
	Module – 5		
5.1	Colour theory and its application in engineering photography	1	
5.2	Introduction to photo editing software (Commercial and Free Softwares)	2	
5.3	Basic editing techniques: cropping, colour correction, retouching	2	
5.	*Editing Photos using professional photo editing software.*		4
	Total No. of Lecture Hours	26	-
		Total No. of Practical Hours	20

Text Books:

1. "Understanding Exposure" by Bryan Peterson - This book provides a comprehensive guide to mastering exposure in photography, which is crucial for engineering students to capture technical subjects effectively.
2. "The Photographer's Eye: Composition and Design for Better Digital Photos" by Michael Freeman - Focuses on the principles of composition and design, helping students understand how to frame engineering subjects creatively and aesthetically.
3. "Light: Science and Magic: An Introduction to Photographic Lighting" by Fil Hunter, Steven Biver, and Paul Fuqua - Offers in-depth insights into the science of light and techniques for controlling and manipulating light in photography, which is essential for capturing engineering subjects in different lighting conditions.
4. "Architectural Photography" by Adrian Schulz - Specifically focuses on techniques for photographing architecture, infrastructure, and urban landscapes, providing valuable insights for engineering students interested in capturing built environments.
5. "Photographing Machinery: A Practical Guide to Lighting, Composition, and Visual Storytelling" by Jeffrey Friedl - Offers practical advice and techniques for photographing machinery and industrial subjects, making it relevant for engineering students interested in documenting engineering processes and equipment.

Online Resources:

1. Cameras, Exposure, and Photography, Michigan State University, Coursera (https://www.coursera.org/learn/exposure-photography?specialization=photography-basics).
2. Camera Control, Michigan State University, Coursera (https://www.coursera.org/learn/camera-control?specialization=photography-basics)
3. Principles of Photo Composition and Digital Image Post-Production, Michigan State University, Coursera. (https://www.coursera.org/learn/photo-composition?specialization=photography-basics)
4. Photography Techniques: Light, Content, and Sharing, Michigan State University, Coursera. (https://www.coursera.org/learn/photography-techniques?specialization=photography-basics)

Course Code: BME754I **Credits: 03** **SEE: 50 Marks** **SEE Hours: 3 Hrs**	**Course Name : Lean Manufacturing System** **L: T:P:S :3:0:0:0** **CIE : 50 Marks** **Total Marks : 100**

Prerequisites if any	Nil
Learning objectives	1. To discover management philosophy, a way of thinking andoperation for an entire organization to maximize customer value. 2. Embark on a path of continuous improvement and lifelong learning. 3. Understand to translate a corporate operation vision into an action plan.

Course Outcomes:

On the successful completion of the course, the student will be able to

	Course Outcomes	**Bloom's level**
CO1	To discover elimination of waste, improvement in quality, reducingcost, reducingtime in manufacturing system.	Remember Understand
CO2	Choose an appropriate sequence in scheduling for parts and product deliveryeffectively.	Remember Understand
CO3	Analyze the lean tools such as 5S, Kaizen, Hoshin planning, Kanban in manufacturing system.	Apply Analyze
CO4	To learn the ability to draw a value stream mapping of an actual manufacturing process.	Apply Analyze

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	3	2	-	2	2	2	2	2	2	2		3	3	2
CO2	3	2	3	3	-	3	3	2	2	2	2	3		3	3	2
CO3	3	3	3	3	2	2	2	2	2	2	-	2		3	3	2
CO4	3	3	3	3	-	2	2	2	2	2	-	2		3	3	2

Strong: 3 Medium: 2 Low: 1

Module 1		No. of Lecture Hours	No. of Tutorial Hours	self-Learning Hours
1.1	**Introduction to Lean Concept:** The philosophy of TPS, Basic framework of TPS,	02	-	-
1.2	Mass production, craft product, origin of lean production system, System and system thinking,	02	-	-
1.3	Basic image of lean production system, customer focus and MUDA,	02	-	-
1.4	Profit through cost reduction, Elimination of overproduction,	02	-	-
Module 2				
2.1	**Stability and Standardization of Operations and TPS** Standardized work, Elements of standardized work, Charts to define standardized work, Manpower reduction, Standardized work and kaizen, Standardization of operation,	04	-	-
2.2	Total Productive Maintenance, Visual Management,	02	-	-
2.3	**Worker Involvement:** Involvement, activities to support involvement, Quality circle activity, Kaizen training,	02	-	-
Module 3				
3.1	**Primary Tools used in Lean Manufacturing** 5S system,	01	-	-
3.2	Why why analysis,	01	-	-
3.3	Ishikawa diagram,	01	-	-
3.4	Job rotation,	01	-	-
3.5	Production leveling,pull system, Value stream mapping,	02	-	-
3.6	Improvement activities to reduce work force and increase worker, morale Foundation for improvements,	02	-	-
Module 4				
4.1	**Secondary Tools used in Lean Manufacturing and Shortening of Production Lead Times:** Principle of JIT, JIT system,	01	-	-
4.2	Kanban system, e-Kanban, Kanban rules,	01	-	-
4.3	**Jidoka concept:** Poka-yoke systems, Inspection systems and zone control, Types and use of poka-yokesystems, Implementation of Jidoka,	03	-	-
4.4	Component of Production lead time, Reduction of setup time, Concept and techniques,Practical procedures for reducing setup time,	03	-	-
Module 5				
5.1	**Hoshin Planning and Six sigma Hoshin Planning:** Hoshin Planning system, Control department concept A3 Thinking,		-	-

	Phases of hoshin planning,	03		
5.2	Six Sigma, Karakuri concept, Lean 4.0, The Culture of Lean Manufacturing,Global Enterprise and their benefits, gemba concept	05	-	-
	Total No. of Lecture Hours	**40**		
	Total No. of Tutorial Hours		-	-
	Total No of Self- Learning Hours			-

Assessment Pattern:

Bloom's level	**Continuous Internal Examination**			**End Semester Examination**
	Test 1	**Test 2**	**Assignment/Quiz**	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓

TEXTBOOKS:

1. Lean Production Simplified, A Plain- Language Guide to the World's Most Powerful Production System, Pascal Dennis, 3rd edition, Productivity Press, New York, 2015.
2. Toyota Production System, An integrated approach to just in time by Yasuhiro Monden Engineering and Management press – Institute of Industrial Engineers Nor cross Georgia 4th edition. 2012.

REFERENCE BOOKS:

1. Mike Rother and John Shook, Learning to See, Value Stream Mapping to Add Value and Eliminate MUDA, Lean Enterprise Institute,1999.

2. Just in Time Manufacturing, Amaldo Hernandez , PH International,2014.

3. The Machine that changed the World, by Daniel Roos,2014.

Online Resources:

NOC –Toyota Production System, by Prof. Rajat Agarwal, IIT Roorkee

Course Code	**: BME754J**	**Course : Supply Chain Management**	
Credits	**: 3**	**L: T: P: S**	**: 3:0:0:0**
SEE	**: 100 Marks**	**CIE**	**: 50 Marks**
SEE Hours	**: 3 Hrs**	**Total Marks**	**100**

Prerequisites if any	Nil
Learning objectives	1.Develops a sound understanding of the important role of supply chainmanagemt in today's business environment. 2. Under the strategic importance to achieve business success by creating valuethrough supply chains.

Course Outcomes:

On the successful completion of the course, the student will be able to

	Course Outcomes	**Bloom's level**
CO1	Understand supply chain concepts, systemic and strategic role of SCM in global competitive environment and evaluate alternative supply and distribution network structures using optimization models.	Remember Understand Apply
CO2	Understand the impact of planning and decision on logistical driver like facility, inventory, and transportation and apply in designing accordingly in supply chain to improve the performance.	Remember Understand Apply
CO3	Understand the impact of planning and decision on cross functional driver like information, supplier selection and pricing, and apply in designing accordingly in supply chain to improve the performance.	Remember Understand Apply

Mapping with POs and PSOs:

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

Strong: 3 Medium: 2 Low: 1

	Module – 1	No. of Lecture Hours	No. of Tutorial Hours	Self-Learning Hours
1.1	**Building a Strategic Framework to Analyze Supply Chains:** Supply chain stages.	01	-	-
1.2	Decision phases in supply chain, supply chain flows	01	-	-
1.3	Process view of a supply chain	01	-	-
1.4	Competitive and supply chain strategies, achieving strategic fit expanding strategicscope	02	-	-
1.5	Drivers of supply chain performance, framework for structuring drivers –inventory, transportation, facilities, information, obstacles to achieving fit	03	-	-
	Module – 2			
2.1	**Designing the Supply Chain Network:** Distribution, networking – role, design	01	-	-
2.2	Supply chain network (SCN) role, factors, framework for design decisions	01	-	-
2.3	**Facility Location and Network Design:** Models for facility location and capacityallocation.	02	-	-
2.4	Impact of uncertainty on SCN – discounted cash flow analysis	02	-	-
2.5	Evaluating network design decisions using decision trees	02	-	-
	Module – 3			
3.1	**Planning and Managing Inventories in a Supply Chain:** Role of cycle inventory, estimating cycle inventory related cost, economics of scale,	03	-	-
3.2	Managing multi-echelon cycle inventory,	01	-	-
3.3	Safety inventory determination, impact of supply uncertainty aggregation andreplenishment policies on safety inventory,	02	-	-
3.4	Optimum level of product availability, important factors, managerial levers toimprove supply chain profitability	02	-	-
	Module – 4			
4.1	**Managing Cross-Functional Drivers In A Supply Chain:** The role of sourcing in a supply chain, in-house or outsource, Third- and Fourth-partylogistics providers	02	-	-
4.2	Supplier and assessment, Supplier Selection-Auctions and Negotiations, Contracts and supply chain performance, Design Collaboration, The procurement process, sourcing planning and analysis.	02	-	-
4.3	**IT in a supply chain:** Role of IT in a supply chain, The supply chain in ITframework, The supply chain macro processes	02	-	-
4.4	Lack of Supply Chain coordination and the Bullwhip effect, managerial levers to achieve coordination, continuous replenishment and vendor-managed inventories.	02	-	-

Module – 5				
5.1	**Transportation and Pricing Products:** Role of transportation, factors affecting transportation decisions, modes of transportation and their performance characteristics,	02	-	-
5.2	Designing transportation network. trade-off in transportation design, tailored transportation, routing and scheduling in transportation, international transportation	02	-	-
5.3	Role revenue management in the supply chain, revenue management for multiplecustomer segments,	01	-	-
5.4	Revenue management for perishable assets, seasonal demand and bulk and spotmarket,	02	-	-
5.5	Introduction to Supply Chain 4.0 and its Tools and Technologies	01		
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		0	-
	Total No. of Self learning Hours			0

Assessment Pattern:

Bloom's level	**Continuous Internal Examination**			**End Semester Examination**
	Test 1	**Test 2**	**Assignment**	
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓

TEXTBOOK:

1. Supply Chain Management – Strategy, Planning and Operation, by Sunil Chopraand Peter Meindl, D.V. Kalra Pearson 2015, 6th edition.

REFERENCE BOOKS:

1. Principles of Supply Chain Management Resource Management Richard E.Crandall, William R. Crandall, Charlie Chen, CRC Press, 4th edition, 2010 .

ONLINE RESOURCES:

1. NOC -Operations and Supply Chain Management By Prof. G. Srinivasan, IIT Madras
2. NOC -Modelling And Analytics For Supply Chain Management and Supply Chain Management By Prof. Kunal Kanti Ghosh, Prof. Anupam Ghosh, IIT Kharagpur

ESTD : 1946

Blownup Syllabus of Open Elective Courses Offered by the **Department of Electronics & Communication Engineering**

for the students of:

B.E. VII Semester

Scheme: 2022

Academic Year: 2025-26

Course Code: BEC754A **Course: Introduction to Quantum computing**

Credits: 3 **L:T:P – 3:0:0**

CIE: 50% **SEE: 50%**

SEE Hours: 3hours **Max. Marks:100**

Prerequisites if any	Linear Algebra, Quantum Physics, Quantum Mechanics
Learning objectives	1. Understand the theoretical foundations of quantum mechanics relevant to computation, including superposition, entanglement, and measurement. 2. Analyze the principles behind key quantum algorithms and error correction techniques from a theoretical perspective.

Course Outcomes:

On successful completion of the course, the student will be able to:

COs	Course Outcomes	Bloom's level
CO1	Explain fundamental quantum concepts such as qubits, superposition, and entanglement.	L2
CO2	Interpret and construct quantum circuits using standard quantum gates.	L3
CO3	Describe the working principles of basic quantum algorithms.	L3
CO4	Discuss the significance of quantum error correction and its role in reliable quantum computation.	L3

Mapping with POs and PSOs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	**2**	**2**										**1**		**2**		
CO2	**2**	**2**	**1**		**1**							**1**		**2**	**1**	
CO3	**2**	**2**	**1**		**1**							**1**		**2**	**1**	
CO4	**2**	**2**			**1**	**1**	**1**	**1**				**1**		**2**		**1**

3 – Strong 2 – Medium 1 – Low

Course Structure

	Module – 1 Foundations of Quantum Theory	No. of Lecture Hours	No. of Tutorial Hours	Self-Learning Hours
1.1	Introduction to Quantum Computing: Classical vs. Quantum bits, What is a qubit?, Qubits and quantum states, Introduction to Dirac notation ($\|0\rangle$, $\|1\rangle$, $\|\psi\rangle$).	3		
1.2	Bloch Sphere Representation of a Qubit, Bra-ket notation, superposition, Measurement and probability (outcomes of measuring a qubit), quantum principles, Bell state.	3		
1.3	Vectors and complex numbers (basic operations), Matrices and matrix multiplication, Single Qubit, Multiple Qubits.	2		
	Module - 2: Quantum Gates and Circuits			
2.1	Single-Qubit Gates: Identity (I), Pauli-X (NOT), Pauli-Y, Pauli-Z gates, Hadamard (H) gate and superposition, Phase gates: S and T, Unitary property of gates, Simple circuit diagrams with single-qubit gates.	4		
2.2	Multi-Qubit Gates and Entanglement: CNOT (Controlled-NOT) gate, SWAP gate, and basic Controlled-U concept, Creating entanglement using H + CNOT, Introduction to Toffoli, Circuit examples with 2-qubit operations.	4		
	Module – 3: Quantum Algorithms			
3.1	Introduction to Quantum Algorithms & Deutsch-Jozsa: Why quantum algorithms? (motivation, classical vs. quantum performance), Deutsch and Deutsch-Jozsa algorithm.	3		
3.2	Shor's Algorithm and Quantum Fourier Transform (QFT): Importance of Integer Factorization, Classical difficulty of factoring large numbers, Overview of Shor's algorithm (high-level steps), QFT: intuition, basic circuit, and role in Shor's algorithm, Significance of breaking the RSA encryption.	4		
3.3	Grover's Search Algorithm: Simulate 2-qubit Grover search in Qiskit.	1		
	Module – 4: Quantum Errors and Correction			
4.1	Basic Error Types and Intuition: Sources: noise, decoherence, imperfect gates, Bit-flip and phase-flip errors, Impact of errors on quantum state	4		
4.2	Basic Error Correction Concepts: Idea of redundancy: 3-qubit repetition code, How measurement helps detect errors, Importance of fault-tolerant computing.	4		
	Module - 5: Real-World Applications and Future Trends			

5.1	Quantum Machine Learning (QML): Combining quantum computing with machine learning, Examples: quantum support vector machines	4		
5.2	Quantum Cryptography: Concept of secure communication with qubits, Importance of quantum key distribution (QKD).	3		
5.3	Current Technology and Career Scope: Leading platforms: IBM, Google, IonQ, Hardware types: superconducting, trapped ions, **Open-source quantum computing tools**: **Qiskit** (IBM), **Cirq** (Google, **PennyLane** (Xanadu), **QuTiP**.	1		
	Total No. of Lecture Hours	40		
	Total No. of Tutorial Hours		0	
	Total No. of Self learning Hours			0

Suggested Learning Resources:

Text Books:

1. **Michael A. Nielsen & Isaac L. Chuang** – *Quantum Computation and Quantum Information (Cambridge University Press, 10th Anniversary Edition)*.
2. **Chris Bernhardt** – *Quantum Computing for Everyone.(MIT Press)*
3. **P. K. Sinha & S. S. Shrivastava** – *Introduction to Quantum Computing,(Narosa Publishing House)*.
4. **N. S. Narayan – *Quantum Computing: A Beginner's Introduction,*** *(Universities Press / Orient Blackswan)*

Online Resources:

1. IBM Quantum Lab + Qiskit Textbook: https://qiskit.org/textbook
2. Coursera – Quantum Computing Courses: https://www.coursera.org/search?query=quantum%20computing

Course Code: BEC754B **Course: Next-Gen Wireless: 5G Systems and Cross-Industry Use Cases**

Credits: 3 **L: T: P: 3:0:0**

SEE: 50% Marks **CIE:50% Marks**

SEE Hours: 3 hrs **Max.Marks:100**

Prerequisites if any	Communication systems, Wireless Communication
Learning objectives	Students will be able to learn: 1. Understand the architecture and enabling technologies of 5G systems. 2. Analyze the performance and challenges of 5G networks. 3. Explore practical applications and use cases of 5G in real-world scenarios.

Course Outcomes:

On successful completion of the course, the student will be able to:

COs	Course Outcomes	Bloom's level
CO1	Understand the architecture and enabling technologies of 5G systems.	L1
CO2	Analyze the performance and challenges of 5G networks.	L3
CO3	Explore practical applications and use cases of 5G in real-world scenarios.	L3

Mapping with POs and PSOs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12		PSO 1	PSO 2	PSO 3
CO1	**3**	**3**	**2**	**2**	**2**									**3**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**2**									**3**	**2**	**2**
CO3	**3**	**3**	**2**	**2**	**2**									**3**	**2**	**2**

3 – Strong 2 – Medium 1 – Low

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
Module – 1				
1.1	**Introduction to 5G & 3GPP Specs**	2		
1.2	Evolution of Mobile Technologies from 1G to 5G 5G vision, KPIs (Key Performance Indicators)	2		
1.3	Use cases (eMBB, mMTC, URLLC), ITU and 3GPP 5G standardization timeline	1		
1.4	**5G Architecture and Network Components :O**verall 5G system architecture: Access, Core, and Transport	1	-	-
1.5	Functional split between gNB and CU/DU, 5G NR and NG Core (AMF, SMF, UPF, AUSF)	1	-	-
1.6	Comparison with LTE architecture	1		
Module – 2				
2.1	**Radio Interface in 5G NR** :Frequency ranges (FR1 and FR2 – Sub-6 GHz and mmWave)	2	-	-
2.2	Numerology and flexible frame structure, Channel bandwidths and SCS (Sub-Carrier Spacing)	1		
2.3	Massive MIMO and beamforming	1		
2.4	**Key Enabling Technologies** Massive MIMO, Beamforming and Beam Management, Millimeter Wave Communication	2	-	-
2.5	Network Slicing and Virtualization (NFV, SDN)	1		
2.6	Mobile Edge Computing (MEC), Energy Efficiency and Green 5G.	1		

Module – 3				
3.1	**Protocol Stack and Resource Management ,**5G NR protocol layers: PHY, MAC, RLC, PDCP, RRC	2	-	-
3.2	Scheduling and HARQ in 5G, Uplink/Downlink channel structures Mobility management and handover procedures.	2	-	-
3.3	**5G Applications and Security:** Smart cities, IoT, Connected Vehicles, Healthcare, Industrial Automation.	2		
3.4	5G Security Framework: Threats and Solutions, Authentication and encryption in 5G.	2		
Module – 4				
4.1	Call Management: Registration Management, Connection Management, Access Control	3		
4.2	5G Signaling: Signaling Radio Bearers, PDU Sessions, QoS	2		
4.3	**Cloud and Edge in 5G:** Role of cloud-native architectures in 5G, 5G and containerization (Docker, Kubernetes basics), Multi-access edge computing (MEC), Integration with AI services at the edge	3		
Module – 5				
5.1	Security and Privacy in 5G, 5G network vulnerabilities	1		
5.2	Security in slicing and virtualized components, AI for security: intrusion detection systems	1		
5.3	Privacy challenges with IoT and mobile edge devices.	1		
5.4	5G ORAN, 5G Cloud, Femto Cells .	2		
5.5	5G Testbeds and Future Research Trends Open-source 5G testbeds (OpenAirInterface, srsRAN, NI USRP) Beyond 5G (6G vision),	2		
5.6	AI/ML for 5G optimization	1		
Total No. of Lecture Hours		40	-	-
Total No. of Tutorial and Practical's Hours			**0**	**0**

Suggested Learning Resources:

Books:

1. *Fundamentals of 5G Mobile Networks* – Jonathan Rodriguez
2. *5G NR: The Next Generation Wireless Access Technology* – Erik Dahlman, Stefan Parkvall.

Reference books:

1. 3GPP Specifications (TS 38.xxx series)
2. Research papers and white papers from IEEE, ITU, Qualcomm, Ericsson

Course Code: BEC754C **Course: Mobile Communication**

Credits: 3 **L:T:P –** 3:0:0

CIE: 50% Marks **SEE:** 50% Marks

SEE Hours: 3 Hrs **Max. Marks: 100**

Prerequisites if any	
Learning objectives	• To understand the fundamental concepts of mobile communication systems. • To study the architectures, protocols, and standards such as GSM, GPRS, UMTS, LTE. • To explore wireless LANs, PANs, mobile IP, and transport protocols. • To examine WAP architecture and emerging trends in future wireless networks.

Course Outcomes:

On successful completion of the course, the student will be able to:

COs	**Course Outcomes**	**Bloom's level**
CO1	Understand wireless transmission principles and cellular communication fundamentals	L2
CO2	Analyze GSM, GPRS, UMTS, and LTE architecture and standards	L4
CO3	Explain MAC techniques and wireless LAN protocols (IEEE 802.11, Bluetooth, Zigbee)	L3
CO4	Evaluate mobile IP, mobility protocols, and transport mechanisms in wireless networks	L5
CO5	Explore wireless application protocols and future trends in mobile communication	L3

Mapping with POs and PSOs:

COs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO12**		**PSO 1**	**PSO 2**	**PSO 3**
CO1	**3**				**2**									**2**		
CO2	**2**	**3**	**2**		**2**									**3**	**2**	
CO3	**2**	**2**	**3**		**2**									**2**		
CO4		**3**	**3**	**3**	**2**									**2**	**3**	
CO5	**1**		**2**	**2**	**3**									**2**	**2**	**1**

3 – Strong 2 – Medium 1 – Low

Course Structure

	Module – 1: Introduction & Wireless Transmission	No. of Lecture Hours	No. of Tutorial Hours	Self-Learning Hours
1.1	Introduction- Use-cases, applications- Challenges, history	2		
1.2	Wireless Transmission- Frequencies & regulations,	1		
1.3	Cognitive Radio- Signals, antennas, signal propagation,	2		
1.4	MIMO- Multiplexing, modulation, cellular system, SDR	3		
	Module – 2 : Medium Access & Wireless Telecommunication Systems			
2.1	Medium Access- SDMA, FDMA, TDMA, CDMA	2		
2.2	CSMA/CA, versions of Aloha, Collision avoidance, polling (Optional)	-		
2.3	Wireless Telecommunication Systems- GSM, GPRS,	3		
2.4	TETRA, UMTS, IMT-2000, LTE	3		
	Module – 3 : Wireless LANs			
3.1	Characteristics	1		
3.2	IEEE 802.11 (PHY, MAC, Roaming)	3		
3.3	Bluetooth , ZigBee	3		
3.4	Comparison	1		
	Module – 4 : Internet Protocols			
4.1	Mobile IP, Security, MIPv6, PMIPv6 Micro mobility support, Locator/ID split	2		
4.2	Ad-hoc networks, Routing protocols,	2		
4.3	WSN/IoT TCP-mechanisms Classical approaches,	2		
4.4	PEPs in general Additional optimizations	2		
	Module – 5 : WAP & Future Networks			
5.1	Wireless application protocol: Architecture, Wireless datagram protocol, Wireless transport layer security, Wireless transaction	2		

	protocol,			
5.2	Wireless session protocol, Wireless application environment, Wireless markup language,	2		
5.3	Push architecture, Push/pull services, Example stacks with WAP 1.x, i-mode, SyncML, WAP 2.0	2		
5.4	The architecture of future networks	2		
	Total No. of Lecture Hours	**40**		
	Total No. of Tutorial Hours		**0**	
	Total No. of Self learning Hours			**0**

Suggested Learning Resources:

Textbooks:

1. Jochen Schiller, *Mobile Communications*, 2nd Edition, Pearson Education, 2004.
2. Theodore S. Rappaport, *Wireless Communications: Principles and Practice*, 2nd Edition, Prentice Hall, 2002.

Reference Books

1. William Stallings, *Wireless Communications and Networks*, 2nd Edition, Pearson, 2005.
2. Simon Haykin & Michael Moher, *Modern Wireless Communications*, Pearson, 2005.
3. Vijay K. Garg, *Wireless Communications and Networking*, Morgan Kaufmann, 2007.
4. Andreas F. Molisch, *Wireless Communications*, 2nd Edition, Wiley, 2011.

Online Resources:

a. IEEE Xplore Digital Library – Research articles on wireless/mobile communication
https://ieeexplore.ieee.org
b. nptel.ac.in/courses/117104115

Course Code: BEC754D **Course: Neuromorphic Engineering**

Credits: 3 **L:T:P – 3:0:0**

CIE: 50% **SEE: 50%**

SEE Hours: 3hours **Max. Marks:100**

Prerequisites if any	Mathematics of Neural Networks
Learning objectives	

Course Outcomes:

On successful completion of the course, the student will be able to:

COs	Course Outcomes	Bloom's level
CO1	Understand the concept of biological background of Neuromorphic Engineering	L2
CO2	Analyze and understand the Spiking Neural networks	L3
CO3	Exploring the real world application of Neuromorphic computing	L3

Mapping with POs and PSOs:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	**3**	**3**	**2**	**2**	**2**									**3**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**2**									**3**	**2**	**2**
CO3	**3**	**3**	**2**	**2**	**2**									**3**	**2**	**2**

3 – Strong 2 – Medium 1 – Low

Course Structure

	Module – 1 - Module 1: Introduction to AI and Fundamentals of Neuromorphic Computing	No. of Lecture Hours	No. of Tutorial Hours	Self-Learning Hours
1.1	Overview of AI technologies, The growing energy demands of AI, The importance of sustainable AI	3		
1.2	Definition and history of neuromorphic computing, Key differences from traditional AI architectures, Introduction to Spiking Neural Networks (SNNs)	3		
1.3	Introduction to python libraries for SNN models -Lab	2		
	Module – 2 - Biological Inspiration for Neuromorphic AI and Spiking Neural Networks (SNNs) Theory			
2.1	Structure and function of the human brain, Neurons, synapses, and neuro-plasticity, How neuromorphic systems mimic biological processes	3		
2.2	Difference between SNNs and artificial neural networks (ANNs), Types of neuron models (e.g., Hodgkin-Huxley, Leaky Integrate-and-Fire), Learning mechanisms in SNNs (STDP, Hebbian learning)	3		
2.3	Development of different neuron models using Python-Lab	2		
	Module – 3 – Neuromorphic Hardware Architectures and Neuromorphic Programming & Simulation Tools			
3.1	Overview of neuromorphic chips (Intel Loihi, IBM TrueNorth, SpiNNker), Comparison with GPUs and TPUs, Energy efficiency and sustainability in neuromorphic hardware	3		
3.2	Introduction to NEST, Brian2, and SpiNNaker SDK,	2		
3.3	Hands-on: Implementing a simple SNN model, Debugging and optimizing neuromorphic algorithms	3		
	Module – 4 – Neuromorphic AI vs. Traditional AI: A Comparative Analysis			
4.1	Strengths and weaknesses of neuromorphic AI, Future trends in AI hardware, When to use neuromorphic computing over deep learning	4		
4.2	Carbon footprint analysis of AI models, Tools for measuring energy consumption in AI, Policies and regulations for sustainable AI	4		
	Module – 5 – Future Trends in Neuromorphic AI			
5.1	Advances in neuromorphic chips and architectures	2		

5.2	Hybrid AI systems combining deep learning and neuromorphic AI	2		
5.3	The role of AI in climate change mitigation	2		
5.4	Discussion on future research and career opportunities in neuromorphic AI	2		
	Total No. of Lecture Hours	40		
	Total No. of Tutorial Hours		0	
	Total No. of Self learning Hours			0

Suggested Learning Resources:

Text Books:

1. Abderazek Ben Abdallah , Khanh N. Dang, “Neuromorphic Computing Principles and Organization”, Springer, 2022.
2. Neuromorphic Engineering: The Scientist’s, Algorithm Designer’s, and Computer Architect’s Perspectives on BrainInspired Computing, Elishai Ezra Tsur, CRC Press, 2022
3. Giacomo Indiveri, “Neuromorphic Engineering”, a book chapter from “Smart Adaptive Systems on Silicon”, Springer, 2004.
4. Research papers on neuromorphic computing and sustainable AI

Online Resources:

Online tutorials and documentation for neuromorphic programming frameworks

ESTD : 1946

Blownup Syllabus of Open Elective Courses Offered by the **Department of Electrical & Electronics Engineering**

for the students of:

B.E. VII Semester

Scheme: 2022

Academic Year: 2025-26

Course Code: BEE754A
Credits: 3
CIE: 50% Marks
SEE Hours: 3

Course Name: Introduction to Smart grid
L:T:P:S – 3:0:0:0
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. Discuss the fundamentals of smart grid, its modelling and features 2. Explain the communication protocols and security features associated with smart grid 3. Apply IoT for solar energy forecasting in smart grid

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss the fundamentals of smart grid, its modelling and features	Understand
CO2	Explain the communication protocols and security features associated with smart grid	Understand
CO3	Apply IoT for solar energy forecasting in smart grid	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	1	-	-	-	-	1		To be mapped by Respective Department		
CO2	3	-	-	-	-	2	1	-	-	-	-	1				
CO3	3	3	2	-	-	2	1	-	-	-	-	2				

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to Smart Grid		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Background and history of smart Grid evolution, Definition and characteristics of smart grid.	3	Nil
1.2	Benefits of smart grid, Smart Grid vision and its realisation, Motives behind developing the Smart Grid concept.	2	Nil
1.3	Examples of Smart Grid projects/initiatives, The Smart Grid basic infrastructure.	1	Nil
1.4	Comparison between Smart Grid and conventional electrical networks.	1	Nil
Module – 2: Smart Grid modelling, control, and optimization			
2.1	Decentralized models for real-time renewable integration in future grid - Introduction to future smart grid.	2	Nil
2.2	Hybrid model of centralized resource management and decentralized grid control, Graph Modelling, General decentralized approaches - Distributed Nodal Approach.	2	Nil
2.3	Distributed Clustering Approach - Tie Set Graph theory and its Application to Distribution Systems.	2	Nil
2.4	Case Study of decentralized Grid Control.	1	Nil
Module – 3: Smart Grid to Evolve a Perfect Power System			
3.1	Introduction, overview of the perfect power system configurations, device level power system	3	Nil
3.2	Building integrated power systems, distributed power systems, overview of a dynamic energy management, key characteristics of smart devices.	4	Nil
Module – 4: Communication Protocols for the Smart Grid			
4.1	Introduction, IoT Application types, IoT based Smart-Grid review, Current	3	Nil

	IoT Based Smart Grid Technology Enablers.		
4.2	**Smart Grid Hardware Security:** Introduction, Smart Grid Architecture Patterns, Hardware Device Authentication,	3	Nil
4.3	Confidentiality of Power Usage, Integrity of Data, Software and Hardware.	2	Nil
4.4	Future and Enabling Technologies for IoT based Smart Grid.	1	Nil
Module – 5: Solar Energy Forecasting in the Era of IoT Enabled Smart Grids			
5.1	Introduction, The Future Role of Forecasting, Summary of Solar Forecasting Methods, Example of a Detailed, Short-Term Forecasting Method.	3	Nil
5.2	**Intelligence in IoT-enabled Smart Cities:** Energy Consumption monitoring in IoT based smart cities, Smart homes in the crowd of IoT based cities,	3	Nil
5.3	Smart meters for the smart city's grid, Intelligent parking solutions in IoT based smart cities.	3	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. Salman K. Salman, ***"Introduction to the Smart Grid Concepts, Technologies and Evolution",*** The Institution of Engineering and Technology, London, United Kingdom, 2017.
2. Kostas Siozios, Dimitrios Anagnostos, Dimitrios Soudris, Elias Kosmatopoulos, ***"IoT for Smart Grids: Design Challenges and Paradigms",*** Springer, 2019

Reference Books:

1. Hongjian Sun, Nikos Hatziargyriou, ***"Smarter Energy: From Smart Metering to the Smart Grid",*** IET Power and Energy Series, 2016.

Course Code: BEE754C
Credits: 3
CIE: 50% Marks
SEE Hours: 3

Course Name: Renewable Energy
L:T:P:S - 3:0:0:0
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. Discuss various available Energy Sources, energy storage and Energy Conversion systems. 2. Explain Photo Voltaic Cell systems, Biomass, Biogas and Urban waste conversion 3. Describe Ocean Energy Technologies and Fuel Cells.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss various available Energy Sources, energy storage and Energy Conversion systems.	Understand
CO2	Explain Photo Voltaic Cell systems, Biomass, Biogas and Urban waste conversion	Understand
CO3	Describe Ocean Energy Technologies and Fuel Cells.	Understand
CO4	Prepare and present a case study on renewable energy application	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	1	1	-	-	-	-	-		To be mapped by Respective Department		
CO2	3	-	-	-	-	1	1	-	-	-	-	-				
CO3	3	-	-	-	-	1	1	-	-	-	-	-				
CO4	3	3	3	-	-	2	2	-	2	2	-	2				

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Renewable Energy Sources		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction, Importance of Energy in Economic Growth, Renewable energy sources - advantages and limitations, Solar Energy: Potential	3	Nil
1.2	Present Utilization, Solar constant	2	Nil
1.3	Simple energy calculations of Solar Radiation, Pyranometer and Pyrheliometer.	3	Nil
Module – 2: Solar Thermal Energy Conversion Systems			
2.1	Principle of Conversion of Solar Radiation into Heat	2	Nil
2.2	Liquid Flat Plate Collectors, Solar Water Heaters,	4	Nil
2.3	Solar Thermal Electric Systems.	2	Nil
Module – 3: Photo Voltaic (PV) Cell Systems			
3.1	Basics of Solar Cells, V-I characteristics, configuration of Interconnected panels.	3	Nil
3.2	**Wind Energy**: Wind Energy Potential in India, Basic calculations and factors governing location of site, Wind Energy Conversion Systems (WECS)	3	Nil
3.3	Classification of WECS - Principle of working with block diagram, Advantages and disadvantages.	2	Nil
Module – 4: Biomass Energy Resources			
4.1	Energy by Photosynthesis, Classification–Cultivated biomass, Waste Organic Matter; Biomass conversion processes – Direct, Thermo-chemical	3	Nil

	and Biochemical.		
4.2	**Urban Waste Conversion:** Waste composition, conversion by incineration process, by pyrolysis, Landfill biogas plant.	4	Nil
Module – 5: Ocean Energy Technologies			
5.1	Thermal energy conversion by Claude cycle, Anderson cycle and Hybrid cycle.	3	Nil
5.2	**Tidal Energy Conversion** –Site selection criteria, Single basin and double basin schemes, Tidal power potential in India.	3	Nil
5.3	**Energy Storage and conversion**: Methods of energy storage. Types of batteries available for renewable energy storage, Selection and Sizing of batteries.	3	Nil
	Total No. of Lecture Hours	40	
	Total No. of Tutorial Hours		Nil

Textbooks:

1. S. Rao and Dr. B.B. Parulekar, **"Energy Technology",** 3rd edition, Khanna Publishers.
2. Rai G.D**, "Non-conventional Sources of Energy",** 4th edition, Khanna Publishers, New Delhi, 2007.

Reference Books:

1. Mukherjee D, and Chakrabarti S, **"Fundamentals of Renewable Energy Systems",** New Age International Publishers, 2005.
2. B.H. Khan, **"Non-conventional energy resources",** 2nd Edition, McGraw Hill, Education (India) Pvt. Ltd, 2009.

Course Code: BEE754D
Credits: 3
CIE: 50% Marks
SEE Hours: 3

Course Name: Agriculture Engineering
L:T:P:S - 3:0:0:0
SEE: 50% Marks
Max. Marks: 100

Prerequisites if any	Nil
Learning objectives	1. Discuss the basic concepts of Agriculture practices. 2. Understand and Apply the techniques of precision farming. 3. Apply modern techniques in agriculture practices.

Course Outcomes:
On the successful completion of the course, the student will be able to

COs		**Bloom's level**
CO1	Discuss the basic concepts of Agriculture practices.	Understand
CO2	Apply modern technologies to precision farming.	Apply
CO3	Apply nanotechnology and IoT in agriculture practices.	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3
CO1	3	-	-	-	-	2	3	-	-	-	-	1		To be mapped by Respective Department		
CO2	3	2	2	-	2	2	3	-	-	-	-	1				
CO3	3	2	2	-	2	2	3	-	-	-	-	1				

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

Module – 1: Introduction to Agriculture		**No. of Lecture Hours**	**No. of Tutorial Hours**
1.1	Introduction, scope and its role in crop production, Major field crops of India	4	Nil
1.2	Farming and cropping systems,soil–plant-water-relationships, water requirement of crops, scheduling irrigation based on various approaches, Tillage, Soil productivity and fertility, Nutrient sources	2	Nil
1.3	Control vs prevention of weeds, planting systems and planting densities, Horticultural zones of state and country, Impact of Agriculture in GDP of the nation	2	Nil
Module – 2: Sensors and signal conditioning in Agricultural Engineering			
2.1	Introduction to sensors, selection criteria for sensors, pH sensor, moisture sensor, humidity sensor	3	Nil
2.2	Measurement of soil nutrients (NPK), need for signal conditioning.	2	Nil
2.3	Fundamentals circuits of signal conditioning – Filtering, Amplifying, DAC and ADC	3	Nil
Module – 3: Geoinformatics and Precision Farming			
3.1	Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture	3	Nil
3.2	Geoinformatics- definition, concepts, tool and techniques; their use in Precision Agriculture. soil mapping; fertilizer recommendation using geospatial technologies; Global positioning system (GPS).	3	Nil
3.3	Spatial data creation and editing in GIS	2	Nil
Module – 4: Nanotechnology in Agriculture Engineering			
4.1	Brief introduction concepts and techniques, nano-pesticides, nano fertilizers, nano-sensors	4	Nil
4.2	Carbon nano tubes for trapping nutrients in soil, use of nanotechnology in seed, water, fertilizer, plant protection for scaling up farm productivity	4	Nil

Module – 5: Computer Vision and IoT in Agricultural Engineering			
5.1	Toxins in Agriculture products, (Aflatoxin), Methods of detection of toxins, Detection of Aflatoxin in Agricultural products by Deep Learning	4	Nil
5.2	**IoT in Agriculture Engineering:** Introduction to IoT, Case Studies – Design of IoT based smart irrigation system, Design of smart agriculture monitoring system using IoT.	4	Nil
	Total No. of Lecture Hours	**40**	
	Total No. of Tutorial Hours		**Nil**

Textbooks:

1. Francisco J. Villalobos, Elias Fereres, **"Principles of Agronomy for Sustainable Agriculture",** Springer International Publishing, 2017.
2. Balasubramaniyan P and Palaniappan S.P., **"Principles and Practices of Agronomy",** AgroBios (India) Ltd., Jodhpur,2001.
3. Ramon Pallas-Areny, John G. Webster**, "Sensors and Signal Conditioning",** Wiley,2012.
4. Campbell J.B., **"Introduction to Remote Sensing"**-Third edition. Taylor and Francis, London 2002.
5. Prasant Kumar Pattnaik, Raghvendra Kumar, Souvik Pal, S. N. Panda, **"IoT and Analytics for Agriculture",** 2019

Reference Books:

1. Brady, N.C. and Well, R.R., **"The Nature and Properties of Soils",** (13th ed.), Pearson Education, Delhi, 2002.
2. Brouwer C., Prins K, Kay, M., and Heibloem M, **"Irrigation Water Management: Irrigation Methods".** Training Manual No. 5. FAO, Rome,1989
3. Mohesin, N.N. **"Thermal Properties of Foods and Agricultural Materials".** Gordon & Breach Science Publishers, New York, 1980.
4. Joseph T. and Morrison M., **"Nano Technology in Agriculture and Food".** Nanoforoum.org., 2006

ESTD : 1946

Blownup Syllabus of Open Elective Courses Offered by the **Department of Computer Science & Engineering (AIML)** for the students of:

B.E. VII Semester

Scheme: 2022

Academic Year: 2025-26

Code: BCI754B **Course: Introduction to Algorithms**

Credits: 3 **L:T:P-3:0:0**

SEE: 50Marks **CIE: 50Marks**

SEE Hours: 03 **Max.Marks:100**

Prerequisites if any	Recurrence Relations , Data Structures
Learning objectives	• To learn the methods for analyzing algorithms and evaluating their performance. • To demonstrate the efficiency of algorithms using asymptotic notations. • To solve problems using various algorithm design methods, including brute force, greedy, divide and conquer, decrease and conquer, transform and conquer, dynamic programming, backtracking, and branch and bound. • To learn the concepts of P and NP complexity classes

Course Outcomes:*On the successful completion of the course, the student will be able to*

COs	Course Outcomes	Bloom'slevel
CO1	Apply asymptotic notational method to analyze the performance of the algorithmsin terms of time complexity.	Analyze
CO2	Demonstrate Brute force, divide & conquer approaches and decrease & conquerapproaches to solve computational problems	Apply
CO3	Make use of transform &conquer, dynamic programming and greedy approachesto solve the given real world or complex computational problems.	Apply
CO4	Illustrate backtracking, branch & bound and P,NP and NP Complete problems	Apply

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	2	2	1	-	-	-	-	-	-	-	-	1		3	2
CO2	3	2	3	-	-	-	-	-	-	-	-	1		3	2
CO3	2	2	3	-	-	-	-	-	-	-	-	1		3	2
CO4	2	2	3	-	-	-	-	-	-	-	-	1		3	2

Mapping Strength: Strong–3 Medium–2 Low–1

Course Structure

Sl. No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module - 1			
1	**INTRODUCTION:**			
1.1	What is an Algorithm?	1	-	-
1.2	Fundamentals of Algorithmic Problem Solving.	2	-	-
	FUNDAMENTALS OF THE ANALYSIS OF ALGORITHM EFFICIENCY:			
1.3	Analysis Framework	1	-	-
1.4	Asymptotic Notations and Basic Efficiency Classes	1	-	-
1.5	Mathematical Analysis of Non recursive Algorithms	1	-	-
1.6	Mathematical Analysis of Recursive Algorithms.	1	-	-
	BRUTE FORCE APPROACHES:			
1.7	Selection Sort	1	-	-
1.8	Sequential Search	1	-	-
	Module–2			
	BRUTE FORCE APPROACHES(contd..):			
2.1	Brute Force String Matching	1	-	-
2.2	Exhaustive Search (Travelling Salesman problem)	1	-	-
2.3	Exhaustive Search (Knapsack Problem).	1	-	-
	DECREASE-AND-CONQUER:			
2.4	Topological Sorting.	1	-	-
	DIVIDE AND CONQUER:			
2.5	Merge Sort	1	-	-
2.6	Quick Sort	1	-	-
2.7	Strassen'sMatrix Multiplication.	2	-	-
	Module–3			
	TRANSFORM-AND-CONQUER:			
3.1	Balanced Search Trees	2	-	-
3.2	Heaps and Heapsort.	3	-	-
	SPACE-TIME TRADE OFFS:		-	-
3.3	Input Enhancement in String Matching: Horspool'sAlgorithm.	3	-	-
	Module–4:			
	DYNAMICPROGRAMMING:			
4.1	The Knapsack Problem and Memory Functions	2	-	-
4.2	Warshall'sand Floyd'sAlgorithms.	2	-	-
	THEGREEDYMETHOD:			
4.3	Prim's Algorithm	2	-	-
4.4	Kruskal's Algorithm	1	-	-
4.5	Dijkstra's Algorithm	1	-	-
	Module–5			
	LIMITATIONSOFALGORITHMICPOWER:			
5.1	Decision Trees	2	-	-
	COPINGWITHLIMITATIONSOFALGORITHMICPOWER:			
5.2	Backtracking (n-Queens problem)	2	-	-
5.3	Backtracking(Subset-sum problem)	2	-	-
5.4	Branch-and-Bound (Travelling Salesman Problem),	1	-	-
	Total No. of Lecture Hours	**40**	-	-
	Total No. of Tutorial Hours		**00**	-
	Total No. of Practical Hours			**00**

Textbook

1. Introduction to the Design and Analysis of Algorithms, By Anany Levitin, 3rd Edition (Indian), 2017, Pearson.

Reference books

1. Computer Algorithms/C++, Ellis Horowitz, SatrajSahni and Rajasekaran, 2nd Edition, 2014, Universities Press.
2. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronal L. Rivest, Clifford Stein, 3rd Edition, PHI.
3. Design and Analysis of Algorithms, S. Sridhar, Oxford (Higher Education)

Online Resources:

- Design and Analysis of Algorithms: https://nptel.ac.in/courses/106/101/106101060/

Course Code: BCI754D | **Course: Introduction to Machine Learning**

Credits:3 | **L: T: P : 3:0:0**

SEE: 50Marks | **CIE:50 Marks**

SEE Hours: 3 | **Max.Marks:100**

Prerequisitesi fany	Programming Language, Mathematics foundations (Linear algebra, Probability, Statistics)
Learning objectives	• To introduce the fundamental concepts and techniques of machine learning. • To understand the various types of machine learning and the challenges faced in real-world applications. • To familiarize with machine learning algorithms such as regression, decision trees, Bayesian models, and clustering. • To explore advanced concept like reinforcement learning and enable students to model and evaluate machine learning solutions for different types of problems

Course Outcomes:

On the successful completion of the course, the student will be able to

COs	Course Outcomes	Bloom'slevel
CO1	Describe the machine learning techniques, their types and Applications.	Understanding
CO2	Apply mathematical concepts for feature engineering and perform dimensionality reduction to enhance model performance.	Apply
CO3	Develop similarity-based learning models for solving classification and prediction tasks.	Apply
CO4	Develop regression models, decision tree models and Bayesian models for solving classification and prediction tasks.	Apply
CO5	Utilize clustering algorithms to identify patterns in data and implement reinforcement learning techniques	Apply

Mapping with Posand PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	1	2	1	2	1	1	1	1	1	1	2		1	1
CO2	3	2	2	3	3	1	1	1	1	1	1	2		1	1
CO3	3	3	3	2	2	1	1	1	1	1	1	2		2	2
CO4	3	3	3	2	2	1	1	1	1	1	1	2		2	2
CO5	3	2	2	2	3	1	1	1	1	1	1	2		2	2

MappingStrength:Strong– 3 Medium–2 Low –1

Course Structure

Sl.No	Modules	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	**Introduction:** Need for Machine Learning, Machine Learning Explained	1	-	-
1.2	Machine Learning in Relation to other Fields	1	-	-
1.3	Types of Machine Learning	3	-	-
1.4	Challenges of Machine Learning, Machine Learning Process	1	-	-
1.5	Machine Learning Applications	1	-	-
	Module–2			
2.1	**Understanding Data:** Introduction	2	-	-
2.2	Big Data Analysis Framework	1	-	-
2.3	Descriptive Statistics	1	-	-
2.4	Bivariate Data and Multivariate Data	1	-	-
2.5	Multivariate Statistics	1	-	-
2.6	Essential Mathematics for Multivariate Data (Only Linear Systems and Gaussian Elimination for Multivariate Data, Matrix Decompositions	2	-	-
2.7	Feature Engineering and Dimensionality Reduction Techniques (only Introduction)	1	-	-
	Module–3			
3.1	**Basic Learning Theory:** Design of Learning System,	1	-	-
3.2	Introduction to Concept of Learning	1	-	-
3.3	Find-S Algorithm	1		
3.4	**Similarity-based Learning:** Nearest-Neighbor Learning	1	-	-
3.5	Weighted K-Nearest-Neighbor Algorithm	1	-	-
3.6	Nearest Centroid Classifier	1	-	-
	Module – 4			
4.1	**Regression Analysis:** Introduction to Regression, Introduction to Linear Regression	1	-	-
4.2	Multiple Linear Regression	1	-	-
4.3	Polynomial Regression	1	-	-
4.4	Logistic Regression	1	-	-
4.5	**Decision Tree Learning:** Introduction to Decision Tree Learning Model	1	-	-
4.6	Decision Tree Induction Algorithms **(**Only ID3 Tree construction)	2	-	-
4.7	**Bayesian Learning:** Introduction to Probability-based Learning, Fundamentals of Bayes Theorem	1	-	-
4.8	Classification Using Bayes Model (Only Naïve Bayes Algorithm)	2	-	-

	Module–5			
5.1	**Clustering Algorithms:** Introduction to Clustering Approaches	1	-	-
5.2	Hierarchical Clustering Algorithms (Only Single Linkage or MIN Algorithm and Complete Linkage or MAX or Clique)	2	-	-
5.3	Partitional Clustering Algorithm; K-Means Algorithm	2	-	-
5.4	**Reinforcement Learning:** Overview of Reinforcement Learning, Scope of Reinforcement Learning	1	-	-
5.5	Reinforcement Learning as Machine Learning, Components of Reinforcement Learning	1	-	-
5.6	Q-Learning	1	-	-
	Total No.Of LectureHours	**40**	-	-
	Total No.OfTutorial Hours		**00**	-
	Total No.ofPractical Hours			**00**

Text Book

1. S Sridhar, M Vijayalakshmi, “Machine Learning”, OXFORD University Press 2021, First Edition.

Module 1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7

Module 2: 2.1, 2.3, 2.4, 2.6, 2.7, 2.8.1, 2.8.2, 2.10(only introduction)

Module 3: 3.3, 3.4, 4.2, 4.3, 4.4

Module 4: 5.1, 5.3, 5.5, 5.6, 5.7, 6.1, 6.2.1, 8.1, 8.2, 8.3.1

Module 5: 13.1, 13.3.1, 13.3.2, 13.4, 14.1, 14.2, 14.3, 14.4, 14.9

Reference Books

1. Murty, M. N., and V. S. Ananthanarayana. Machine Learning: Theory and Practice, Universities Press, 2024.

2. T. M. Mitchell, “Machine Learning”, McGraw Hill, 1997.

3. Burkov, Andriy. The hundred-page machine learning book. Vol. 1. Quebec City, QC, Canada: Andriy Burkov, 2019.

Web links and Video Lectures (e-Resources):

1. https://www.universitiespress.com/resources?id=9789393330697
2. https://www.drssridhar.com/?page_id=1053
3. Machine Learning Tutorials: https://www.geeksforgeeks.org/machine-learning/
4. Machine Learning Tutorials: https://www.tutorialspoint.com/machine_learning/index.htm
5. Python for Machine Learning: https://www.w3schools.com/python/python_ml_getting_started.asp

Introduction to Machine Learning: https://onlinecourses.nptel.ac.in/noc22_cs29/preview

ESTD : 1946

Blownup Syllabus of Open Elective Courses Offered by the **Department of Information Science & Engineering**

for the students of:

B.E. VII Semester

Scheme: 2022

Academic Year: 2025-26

Course Code: BIS754A **Course:** Introduction to DBMS

Credits: 3 **L:T:P -** 3:0:0

CIE: 100 Marks **SEE:** 100 Marks

SEE Hours: 3 hours **Total. Marks:** 100

Prerequisites if any	• Basic understanding of data and its representation (no programming required) • Logical reasoning and problem-solving ability
Learning objectives	1. Understand the role and components of database management systems. 2. Model real-world data and design basic relational databases. 3. Use SQL to create, query, and manipulate data effectively.

Course Outcomes:

On successful completion of the course, the student will be able to:

COs	Course Outcomes	Bloom's level
CO1	Understand the basic concepts, architecture, and components of a Database Management System.	Understand
CO2	Apply Entity-Relationship modeling to design a database for a real-world engineering application.	Apply
CO3	Apply SQL commands to create, retrieve, and manipulate data in a relational database.	Analyze
CO4	Analyze the normalization process to improve the structure and efficiency of a database.	Evaluate

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2
CO1	3	-	-	-	-	-	-	-	-	-	-	-		2	-
CO2	3	2	2	-	2	-	-	-	-	-	-	-		3	1
CO3	3	2	2	-	2	-	-	-	-	-	-	-		3	1
CO4	3	2	2	2	-	-	-	-	-	-	-	-		2	-

3 – Strong 2 – Medium 1 – Low

Course Structure

	Module – 1:Introduction to Databases and DBMS	No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
1.1	Data, Information, and Database Concepts	1	-	-
1.2	Characteristics of Database Systems	1	-	-
1.3	File-based Systems vs DBMS	1	-	-
1.4	DBMS Architecture: Components and Functions	2	-	-
1.5	Data Models: Hierarchical, Network, Relational	1	-	-
1.6	Introduction to Relational Databases and Terminology	1	-	-
1.7	Applications of Databases in Engineering Domains	1	-	-
	Module – 2:Data Modeling and ER Diagrams			
2.1	Introduction to Data Modelling	1	-	-
2.2	Entity, Attributes, and Entity Sets	1	-	-
2.3	Relationships and Relationship Sets	2	-	-
2.4	Keys and Constraints	1	-	-
2.5	ER Diagrams: Symbols and Notations	1	-	-
2.6	Enhanced ER Models (Specialization, Generalization) – Intro only	1	-	-
2.7	Mapping ER Models to Relational Schemas	1	-	-
	Module – 3:Relational Model and Structured Query Language (SQL)			
3.1	Relational Model Concepts (Relations, Tuples, Attributes)	2	-	-
3.2	Relational Algebra – Basic Operations	1	-	-
3.3	Introduction to SQL: Data Types, DDL (CREATE, ALTER, DROP)	1	-	-
3.4	DML Operations (INSERT, UPDATE, DELETE)	1	-	-
3.5	Basic SQL Queries (SELECT, WHERE, ORDER BY)	2	-	-
3.6	Joins and Aggregate Functions	1	-	-
	Module – 4:Database Design and Normalization			
4.1	Characteristics of a Good Database Design	1	-	-
4.2	Functional Dependencies	1	-	-
4.3	Introduction to Normalization: 1NF, 2NF, 3NF	2	-	-
4.4	Anomalies in Unnormalized Databases	2	-	-
4.5	Design Example: Normalizing a Sample Database	2	-	-
	Module – 5:Transactions, Storage, and Database Applications			
5.1	Introduction to Transactions and ACID Properties	2	-	-
5.2	Concurrency Control (basic idea only)	1	-	-
5.3	Database Storage Concepts and File Organization (overview only)	1	-	-
5.4	Indexing and Query Optimization (basic concepts)	1	-	-
5.5	Backup, Recovery, and Security Basics	1	-	-
5.6	Real-World Database Applications in Core Engineering Disciplines.	2	-	-
	Total No. of Lecture Hours	40		
	Total No. of Tutorial Hours		-	
	Total No. of Self learning Hours			-

Textbooks:

1. "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, and S. Sudarshan – 7th Edition, McGraw-Hill Education.

Reference Books:

1. "Fundamentals of Database Systems" by Ramez Elmasri and Shamkant B. Navathe – 7th Edition, Pearson Education.

Online Resources:

1. **NPTEL – Database Management Systems** by Prof. P. P. Chakrabarti, IIT Kharagpur
   https://nptel.ac.in/courses/106105175

2. **w3schools SQL Tutorial**
   https://www.w3schools.com/sql\

ESTD : 1946

Blownup Syllabus of Open Elective Courses Offered by the **Department of Physics**

for the students of:

B.E. VII Semester

Scheme: 2022

Academic Year: 2025-26

Open Elective for VII Semester Students

Department – Physics

Code: BPH754A	**Course:** Materials for Engineering Applications-2
Credits: 3	**L:T:P:S** 3:0:0:0
SEE: 50 Marks	**CIE:** 50 Marks
SEE Hours: 3	**Max. Marks:** 100

***Course Offered to : ECE, EEE, ME, CE students only.**

Course Objectives	After learning the course the students should be able to do: **1.** To learn about biomaterials, classifications, their properties, performance specification and biological applications. 2. To judge which material/implant should be used for what kind of application. 3. To compare different materials based on its strength, flexibility, inertness and its response to biological tissues. 4. To apply the knowledge of engineering materials for biomedical applications.

Mapping with POs and PSOs:

COs	**POs**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	**3**	**3**	**2**						**2**	**1**		
CO2	**3**	**3**	**2**									
CO3	**3**	**3**										
CO4	**3**	**3**							**2**	**1**		**2**

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Teaching - Learning Process

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective

1. Chalk and Talk
2. Power point presentation
3. Video Lecturing
4. E-sources
5. Self-learning

Course Structure

Module 1: Biomaterials - Introduction, Types & Properties
Synthetic, Metals and non-metallic alloys, Ceramics, Inorganics and glasses. Bio-resorbable and biologically derived materials, Bio-derived macromolecules, Standard and assessments of biomaterials, Surface properties of biomaterials and their testing.
Module 2: Polymeric Biomaterials
Polymerization, Polyethylene, Clinical study of soft polymers, Bio-erodible polymers, Blood compatible polymers, Bioactive polymers, Hydrogels; Hard Methacrylates, Drug incorporation polymer gels, Biocompatibility of polymers, processing techniques for the polymers, assembling medical disposable.
Module 3: Metals And Metallic Alloys - Biomaterials
Stainless steel, Titanium and Titanium alloys, Cobalt based alloy Nitinol, Dental metals, Dental amalgam, Gold, Nickel, and Corrosion of the metals.
Module 4: Ceramics And Composite Biomaterials
Ceramics- Introduction to biomedical usage- bonding natural tissues, Bio-active glass, High density alumina; Calcium phosphate ceramics- Porous materials, Biological interactions, Dental ceramics- High strength materials, Drug delivery from ceramics, Particulate and Fibrous composites, Soft composites, Dental Composites, Micro-field materials, White-light systems bonding to teeth, Matrix resins, Nano-biomaterials: properties, preparation, characterization, applications.
Module 5: Biomaterials for Implantation
CARDIAC IMPLANTS: Vascular grafts, Artificial Heart Valves, Synthetic Blood vessels, OPTHALMIC IMPLANTS: Contact lenses; Soft and hard lenses, Disposable lenses, Intra Occular Lenses (IOLs), Artificial Silicon Retina, ORTHOPEDIC IMPLANTS: Temporary fixation devices, ACL reconstruction using biological and synthetic materials, Joint replacements: Total Hip replacement, Total knee replacement, DENTAL IMPLANTS: Dental implant modalities: Dentures, Subperiosteal, Endosteal, Bases liners and varnishes for cavities, Impression materials, TISSUE GRAFTS AND SURGICAL AIDS: Artificial Skin, Artificial Blood, Maxillofacial implants, Suture Materials, Wound dressings, Catheters, Surgical Tapes.

Reference Books:

1. Biomaterials By Sujata V. Bhatt
2. Biomaterials Medial Devices and Tissue Engineering By Fredrick H. Silver Chapman and Hall
3. Biomaterials science and engineering By J. B. Park Plenum press, New York
4. Biomaterials Science- An introduction to materials in medicine By Buddy D. Ratner
5. Biomaterials- An introduction By Joon B. Park, Roderic S. Lakes

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ESTD : 1946

Blownup Syllabus of Open Elective Courses Offered by the **Department of Mathematics**

for the students of:

B.E. VII Semester

Scheme: 2022

Academic Year: 2025-26

Course Code: BMAT754A **Course: Mathematics for Machine Learning**
Credits: 3 **L:T:P:S 3:0:0**
SEE: 50% Marks **CIE: 50% Marks**
SEE Hours: 3 Hrs **Max. Marks: 100**

Prerequisites if any	Basic Linear Algebra, Calculus
Learning objectives	The goal of the course **Mathematics for Machine Learning is to** 1. Solve problems in Linear Algebra and Optimization. 2. Apply the important concepts and computational techniques of Linear Algebra and Optimization in AI&ML applications.

Course Outcomes:

On the successful completion of the course, the student will be able to

Course Outcomes		**Bloom's level**
CO1	Understand and apply SVD's role in low-rank approximation and PCA.	Understand, Apply, Analyze
CO2	Familiarize with constrained unconstrained and convex optimization.	

Mapping with POs and PSOs:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12		PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	-	-	-	-	-	-	-	-	1		-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1		-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	1		-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	1		-	-	-	-

Mapping Strength: Strong– 3 Medium – 2 Low – 1

Course Structure

		No. of Lecture Hours	No. of Tutorial Hours	No. of Practical Hours
	Module – 1			
1.1	Basic review of Linear Algebra	3	-	-
1.2	Positive definite matrices	1	-	-
1.3	Quadratic forms	2	-	-
1.4	Singular value decomposition.	2	-	-
	Module – 2			
2.1	Linear optimization: The graphical method	1	-	-
2.2	Simplex method	2	-	-
2.3	Integer programing problems-branch and bound method	3	-	-
2.4	Duality.	2	-	-
	Module – 3			
3.1	Sequence and limits	2	-	-
3.2	Differentiability, the derivative matrix	2	-	-
3.3	Level sets & gradients	2	-	-
3.4	Taylor series.	2	-	-
	Module – 4			
4.1	Non-linear Constrained and Unconstrained Optimization: conditions for local minimizers	1	-	-
4.2	Newton's method	2	-	-
4.3	The method of steepest descent	2	-	-
4.4	Convex Optimization Problems.	3	-	-
	Module – 5			
5.1	Least square solutions	2	-	-
5.2	Regression analysis	2	-	-
5.3	Principle component analysis	2	-	-
5.4	Eigenvector computation and low rank approximations.	2	-	-
Total No. of Lecture Hours		**40**	-	-

Detailed Lesson Plan:

Sr No. of Module	Number of related learning Objectives	Weeks/ Dates	Online Mode		ICT Tool/ Platform/ LMS	Face-to-face Mode	
			Resource (OER/ URL/ IM/ CP)	Activity (Describe activity in detail)		Resource (OER/ URL/ IM/ CP)	Activity
1.1	1		Essential Mathematics for Machine Learning	-		-	Group Discussion & Presentation
1.2	1			-		-	
1.3	1			-		-	
1.4	1			-		-	
2.1	1			-		-	
2.2	1			-		-	
2.3	1			-		-	
2.4	1			-		-	
3.1	1			-		-	
3.2	1			-		-	
3.3	1			-		-	
3.4	1			-		-	
4.1	1			-		-	
4.2	1			-		-	
4.3	1			-		-	
4.4	1			-		-	
5.1	2						
5.2	2						
5.3	2						
5.4	2						

Assessment Pattern:

Bloom's level	Test1	Test2	Quiz	SEE
Remember	✓	✓	✓	✓
Understand	✓	✓	✓	✓
Apply	✓	✓	✓	✓
Analyze	✓	✓		✓

Reference Books:

1. Gilbert Strang, Introduction to linear algebra, Wellesley Cambridge press, 4th edition.
2. Chong and Zak, An introduction to optimization, Wiley, second edition
3. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for machine learning, Cambridge University Press (2020).