# The National Institute of Engineering

Mysuru – 570 008

## Office of Dean (Academic Affairs)

*No: NIE/Dean (AA)-102/2025-26/Odd/21* Date: 09.12.2025

**CIRCULAR**

**Attention: Students of B.E. V semester**

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

| Sl. No. | Course Code | Title of Open Elective | Offering Department |
|---|---|---|---|
| 1. | BCV654C | Integrated Waste Management for a Smart City | Civil Engineering |
| 2. | BCV654D | Sustainable Development Goals | |
| 3. | BCV654E | Disaster Management and Mitigation | |
| 4. | BME654A | Introduction to Hybrid and Electric Vehicles | Mechanical Engineering |
| 5. | BME654C | Introduction to Additive Manufacturing | |
| 6. | BME654D | Product Design and Development | |
| 7. | BME654E | Project Management | |
| 8. | BME654F | Introduction to Mechatronics | |
| 9. | BME654G | Engineering Computation using MATLAB | |
| 10. | BME654H | Microgrids | |
| 11. | BEC654B | Vehicular Electronics | Electronics & Communication Engineering |
| 12. | BEC654C | Multicore Systems and Programming | |
| 13. | BEC654D | Introduction to VLSI | |
| 14. | BEC654E | Introduction to Radar systems for Autonomous driving | |
| 15. | BEE654A | Sensors and Signal Conditioning | Electrical & Electronics Engineering |
| 16. | BEE654B | Introduction to Electric Vehicle Technology | |
| 17. | BCS654E | Introduction to Data Science | Computer Science & Engineering |
| 18. | BCS654F | Introduction to Blockchain Technology | |
| 19. | BCI654D | Introduction to AI | Computer Science & Engineering (AI&ML) |
| 20. | BIS654B | Fundamentals of Operating Systems | Information Science & Engineering |
| 21. | BPH654A | Materials for Engineering Applications-1 | Physics |
| 22. | BPH654B | Quantum Computing | |
| 23. | BMA654A | Finite Fields and Their Applications | Mathematics |
| 24. | BMA654B | Complex Analysis | |

**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. These courses **shall not have been studied** as a Core Course/ Elective Course/ MOOC-NPTEL Course till V semester.
5. These courses are **not a part of curriculum** in VI, VII & VIII semester either as a Core Course/ Elective Course/ MOOC-NPTEL Course [Students need to verify in the respective departments].
6. **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**.
7. The detailed Curriculum has been attached for reference.
8. **The Registration procedure will be notified shortly.**

Dr. H. Pradeepa
Dean (AA)
Dean (Academic Affairs)
The National Institute of Engineering
Mysuru: 570 008

**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 / PHY / MATHS

4. Time Table Committee Chairman

ESTD : 1946

# Blownup Syllabus of Open Elective Courses:

VI Semester B.E. (2022 Scheme)

# 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. VI Semester

Scheme: 2022

Academic Year: 2025-26

**Code: BCV654C** **Course: Integrated Waste Management for a Smart City**
**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. To introduce the fundamentals of Solid Waste Management<br>2. To provide details of Sustainable Cities<br>3. Understand the Sustainable Development Goals. |

**Course Outcomes:**

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

| COs | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Understand basic idea about Sustainable Development. | Understand |
| CO2 | Get knowledge about Sustainable Cities. | Apply |
| CO3 | Gain knowledge on Saving Biodiversity and understand Sustainable Development Goals. | Apply & understand |

**Mapping with POs and PSOs**:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | | | | | 3 | | | | | | | 1 | 3 | |
| CO2 | 1 | | | | | 2 | 2 | | | | | | | 1 | 2 | |
| CO3 | 1 | | | | | 3 | 3 | | | | | 2 | | 1 | 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 | **Introduction to Solid Waste Management**<br>Municipal Solid Waste Characteristics | 4 | - | - |
| 1.2 | Quantities generation rates and waste composition; | 3 | - | - |
| 1.3 | Integrated waste management issues, collection, recovery, reuse, recycling, energy-from-waste, and landfilling; | 3 | | |
| | **Module – 2** | | | |
| 2.1 | **Biological treatment of the organic waste fraction;**<br>Direct land application, | 4 | | |
| 2.2 | Composting, and anaerobic digestion. | 4 | | |
| 2.3 | MSW Rules 2016, Swachh Bharat Mission and Smart Cities Program | 2 | | |
| | **Module – 3** | | | |
| 3.1 | **Biochemical Processes and Composting**<br>Energy Recovery from Municipal Solid Waste. | 4 | | |
| 3.2 | Current Issues in Solid Waste Management and Review of MSW Management Status in First List of 20 Smart Cities in the Country | 4 | | |
| | **Module – 4** | | | |
| 4.1 | **Construction and Demolition (C&D) Waste**<br>Construction and Demolition (C&D) Waste Management - Overview | 4 | | |
| 4.2 | C&D Waste – Regulation, Beneficial Reuse of C&D Waste Materials | 3 | | |

| Module – 5 | | | | |
|---|---|---|---|---|
| 5.1 | **Electronic Waste (E-Waste)**<br>Electronic Waste (E-Waste) Management - Overview | 4 | | |
| 5.2 | Electronic Waste Management – Issues and Status in India and Globally, E-Waste Management Rules 2016 and Management Challenges. | 3 | | |
| | ***Total No. of Lecture Hours*** | 42 | | |
| | ***Total No. of Tutorial Hours*** | | - | |
| | ***Total No. of Practical Hours*** | | | - |

**Self-learning topics identified:**

1. Scope and importance of Solid Waste Management.
2. Geosynthetic Fabric in Sanitary Landfills

**Textbooks:**

1. George Tchobanoglous, Hilary Theisen and Samuel A Vigil, Integrated Solid Waste management, Tata McGraw Hill

**Reference Books:**

1. William A Worrell and P. Aarne Veslind Solid Waste Engineering, 2nd Edition (SI Edition) Cengage Learning, 2012 (ISBN-13: 978-1-4390-6217-3)
2. Manual on Solid Waste Management, prepared by The Central Public Health and Environmental Engineering Organization (CPHEEO), India
3. MSW Management Rules 2016, Govt. of India, available online at CPCB website.
4. Electronic Waste Management Rules 2016, Govt. of India, CPCB website.

**Online Resources:**

1. NPTEL MOOC course on “Integrated Waste Management for a Smart City” by Prof. Brajesh Kumar Dubey IIT Kharagpur

**Code: BCV654D** **Course: Sustainable Development Goals**
**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. Understand the embedment of sustainability issues in environmental, societal, and economic systems, and the relevance of the conditions, interrelations, and dynamics of these systems.<br>2. To learn and analyze the factors that support to achieve sustainability and resilience in an individual level and in a community |

**Course Outcomes:**

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

| COs | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Students will be able to develop a fair understanding of the social, economic and ecological linkage of human production and consumption | L1, L2 |
| CO2 | To use environmental management tools that help to improve the quality of environment, to assess local vulnerabilities with respect to climate, natural disasters and to achieve sustainable developmental needs. | L1, L2, L3 |

**Mapping with POs and PSOs**:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 1 | | | 1 | 3 | | | | | 2 | | 1 | | |
| CO2 | | | 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 | Sustainable Development: Introduction to Sustainable Development | 03 | - | - |
| 1.2 | Economic Growth and Progress, Continuing Poverty | 03 | - | - |
| 1.3 | Environmental Threats, Business as Usual Versus, Sustainable Development | 03 | | |
| | **Module – 2** | | | |
| 2.1 | Sustainable Cities, | 02 | - | - |
| 2.2 | The Patterns of Urbanization Around the World, | 02 | - | - |
| 2.3 | Development of Sustainable city, Smart Infrastructure, | 03 | - | - |
| 2.4 | Urban Resilience, Planning for Sustainable Development. | 03 | - | - |
| | **Module – 3** | | | |
| 3.1 | Curbing Climate Change | 03 | - | - |
| 3.2 | The Basic Science of Climate Change, | 03 | - | - |
| 3.3 | Consequences, Mitigation | 02 | - | - |
| 3.4 | Adaptation, Mitigation Policies | 02 | - | - |
| | **Module – 4** | | | |
| 4.1 | Saving Biodiversity: | 02 | - | - |
| 4.2 | Concept of Biodiversity, | 02 | - | - |

| | | | | |
|---|---|---|---|---|
| 4.3 | Biodiversity Under Threat, Oceans and Fisheries | 01 | - | - |
| 4.4 | Deforestation International Dynamics. | 02 | | |
| **Module – 5** | | | | |
| 5.1 | Sustainable Development Goals,<br>Introduction to Sustainable Development Goals,<br>Goal-Based Development, Financing for Sustainable | 02 | - | - |
| 5.2 | Development, Principles of Good Governance, Feasibility of Sustainable Developmen | 02 | - | - |
| | ***Total No. of Lecture Hours*** | **40** | | |
| | | ***Total No. of Tutorial Hours*** | **00** | |
| | | | ***Total No. of Practical Hours*** | **00** |

**Self-learning topics identified:**

1. Sustainable Acquisitions, Sustainable Communities Electronics Stewardship
2. Implementation of green infrastructure, urban farming
3. Global warming , alternative energy or renewable energy
4. Biodiversity at global, national and local levels, India as a mega diversity nation

**Textbooks:**

1. Ram Kumar Mishra, Ch Lakshmi Kumari, Sandeep Chachra, P.S. Janaki Krishna "Smart Cities for Sustainable Development" Springer, 2022 Edition

**Reference Books:**

1. The Sustainable Development Goals Report 2020 Kindle Edition, Department of Economic and Social Affairs
2. The Sustainable Development Goals" Hardcover – December 4, 2018 United Nations.

**Online Resources;**

1. NPTEL :: Humanities and Social Sciences - NOC:United Nations Sustainable Development Goals (UN SDGs)
2. NPTEL :: Civil Engineering - NOC:Sustainable River Basin Management
3. NPTEL :: Architecture - NOC:Strategies for Sustainable Design
4. NPTEL :: Multidisciplinary - NOC:Sustainable and Affordable Sanitation Solutions For Small Towns: Policy, Planning and Practice
5. NPTEL :: Civil Engineering - NOC:Sustainable Materials and Green Buildings
6. NPTEL :: Management - NOC:Business and Sustainable Development

**Code:** BCV654E **Course: Disaster Management and Mitigation**
**Credits:** 3 **L:T:P: 3:0:0**
**SEE:** 50% **CIE: 50%**
**SEE Hours:** 3 **Max. Marks: 100**

| | |
|---|---|
| **Prerequisites if any** | Basic Knowledge of Identification and Implication of Hazard, Risk and Disaster |
| **Learning objectives** | 1. Understand concepts of risk and disaster management ,<br>2. Emerging Risks of Disasters , prevention and mitigation of Disasters |

**Course Outcomes:**

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

| COs | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Understand the concepts of risk and disaster management , | Understand |
| CO2 | To analyze Emerging Risks of Disasters , prevention and mitigation of Disasters, need and importance of implementation of Disaster Management Act 2005 | Analyze |
| CO3 | To Apply the knowledge of Science and Technology for Disaster Management & Mitigation | 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 | | | | | 2 | | |
| CO2 | | | 2 | | | | 2 | | | 3 | | | | | | 1 |
| CO3 | 2 | | | | 1 | | | | | | | 1 | | | 3 | 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 Introduction** | | | | |
| 1.1 | Understanding the Concepts and definitions of Disaster | 01 | - | - |
| 1.2 | Disaster types, Hazard, Vulnerability, Risk, Capacity | 01 | - | - |
| 1.3 | Disaster and Development | 01 | - | - |
| 1.4 | Disaster management | 01 | - | - |
| **Module – 2 Consequences and Control of Disasters** | | | | |
| 2.1 | Geological, Hydro-Meteorological Disasters | 02 | - | - |
| 2.2 | Technological and Man-made Disasters, Global Disaster Trends | 02 | - | - |
| 2.3 | Climate Change and Urban Disasters, Emerging Risks of Disasters | 02 | - | - |
| 2.4 | Global Disaster Trends | 02 | - | - |
| **Module – 3 Disaster Management Cycle and Framework** | | | | |
| 3.1 | Disaster Management Cycle, Paradigm Shift in Disaster Management Pre-Disaster Risk Assessment and Analysis, Risk Mapping, zonation and Micro zonation, Prevention and Mitigation of Disasters, Early Warning System | 03 | - | - |
| 3.2 | Preparedness, Capacity Development, Awareness During Disaster Evacuation, Disaster Communication, Search and Rescue, Emergency Operation Centre, Incident Command System, Relief and Rehabilitation | 03 | - | - |
| 3.3 | Damage and Needs Assessment, Restoration of Critical Infrastructure, Early Recovery, Reconstruction and Redevelopment, IDNDR, Yokohama Strategy | 03 | - | - |
| **Module – 4 Disaster Management in India** | | | | |

| | | | | |
|---|---|---|---|---|
| 4.1 | Disaster Profile of India, Mega Disasters of India and Lessons Learnt | 03 | - | - |
| 4.2 | Disaster Management Act 2005 | 02 | - | - |
| 4.3 | Institutional and Financial Mechanism, National Policy on Disaster Management | 02 | - | - |
| 4.4 | National Guidelines and Plans on Disaster Management, Role of Government, Non-Government Agencies | 03 | - | - |
| **Module – 5 Applications of Science and Technology for Disaster Management & Mitigation** | | | | |
| 5.1 | Geo-informatics in Disaster Management | 03 | - | - |
| 5.2 | Land Use Planning and Development Regulations, Structural and Non-Structural Mitigation o | 03 | - | - |
| 5.3 | S&T Institutions for Disaster Management in India | 03 | - | - |
| | ***Total No. of Lecture Hours*** | **40** | | - |
| | ***Total No. of Tutorial Hours*** | | **00** | - |
| | ***Total No. of Practical Hours*** | | | **00** |

**Self-learning topics identified:**

1.Biological Disasters
2.Hyogo Framework of Action
3.National Guidelines and Plans on Inter-Governmental Agencies
4.Disaster Communication System

**Textbooks:**

**1.** S C Sharma 2022 , Disaster Management, preparedness, impact, risk reduction mitigation and management,Khanna Publication

**Reference Books:**

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.

2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi

3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi

4. Disaster Management Act, Publisher by Govt. of India

5. Publications of National Disaster Management Authority (NDMA) on Various

Templates and Guidelinesfor Disaster Management

6. National Disaster Management Policy, GoI

**Online Resources:**

https://nptel.ac.in/courses/105104183
https://onlinecourses.swayam2.ac.in/cec19_hs20/previe
whttps://ndma.gov.in/
https://www.ucf.edu/online/leadership-management/news/the-disaster-management-cycle/


ESTD : 1946

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

for the students of:

B.E. VI Semester

Scheme: 2022

Academic Year: 2025-26

| Course Code: BME654A | Course: Introduction to Hybrid and Electric Vehicles |
|---|---|
| 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 technology.<br>2. Impart information about the electric vehicle technology. |

**Course Outcomes:**

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

| Course Outcomes | | Bloom's level |
|---|---|---|
| CO1 | Understand the fundamentals of vehicle and various engines | Understand |
| CO2 | Outline the concept of EVs and its storage technology | Apply |
| CO3 | Describe the technology involved in fuel cells for automobile. | 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 | - | - | - | - | - | - | - | - | - | | 3 | - | - | - |
| CO2 | 3 | 2 | 2 | - | - | - | 2 | - | - | - | - | - | | 2 | 2 | - | - |
| CO3 | 3 | 2 | 2 | - | - | - | 2 | - | - | - | - | - | | 3 | - | - | - |

**3 – Strong 2 – Medium 1 – Low**

## Course Content

| | Module | No. of Lecture Hours | No. of Tutorial Sessions |
|---|---|---|---|
| | **Module – 1** | | |
| 1.1 | **Environmental Impact -** Air Pollution and Global Warming | 1 | - |
| 1.2 | **History of Modern Transportation -** History of IC Engines, Electric Vehicles, Hybrid Electric Vehicles and Fuel Cell Vehicles | 2 | - |
| 1.3 | **Vehicle Fundamentals -** General Description of Vehicle Architecture and Movement, Vehicle Resistance (Rolling Resistance, Aerodynamic Drag, Grading Resistance), Transmission, Brakes, Steering System. | 4 | - |
| | | | |
| | **Module – 2** | | |
| 2.1 | **IC Engines:** 4-Stroke SI & CI Engines - Operating Principles, Operation Parameters (Rating Values of Engines, Mechanical Efficiency, Specific Emissions). | 3 | - |
| 2.2 | **Hybrid Electric Vehicles:** Hybrid Electric Drive Trains - Series Hybrid, Parallel Hybrid (Torque coupling, Speed coupling and Torque Coupling & Speed Coupling) | 5 | - |
| | **Module – 3** | | |
| 3.1 | **Electric Vehicles:** Configurations of Electric Vehicles, Performance of electric Vehicles (Traction Motor Characteristics, Tractive Effort and | 4 | - |

| | | | |
|---|---|---|---|
| | Transmission Requirement and Vehicle Performance**),** Energy Consumption in EV | | |
| 3.2 | ***Battery Technologies:*** Lead-Acid Batteries, Lithium-Based Batteries such as Lithium-Polymer (Li-P) Battery and Lithium-Ion (Li-Ion) Battery, Sodium based batteries and Metal Air Battery. | 5 | - |
| | **Module – 4** | | |
| 4.1 | Ultra-capacitors & Ultrahigh-Speed Flywheels Technology, Hybridization of Energy Storages | 3 | - |
| 4.2 | **Fundamentals of Regenerative Braking:** Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Antilock Brake System (ABS) for Regenerative Braking | 5 | - |
| | **Module – 5** | | |
| 5.1 | **Fuel Cell Vehicles:** Operating Principles of Fuel Cells, Electrode Potential and I-V Curve, Fuel and Oxidant Consumption, Fuel Cell System Characteristics, | 4 | - |
| 5.2 | **Fuel Supply:** Hydrogen Storage – Compressed Hydrogen, Cryogenic Liquid Hydrogen and Metal Hydrides<br>Hydrogen Production – Steam Reforming and Carbon Capture<br>Hybrid Fuel cell vehicles | 4 | - |
| | ***Total No. of Lecture Hours*** | **40** | **-** |

**Text Books:**

1. **Modern Electric, Hybrid Electric, and Fuel Cell Vehicles - Fundamentals, Theory, and Design** by Mehrdad Ehsani, Yimin Gao and Ali Emadi, 3rdEdition, CRC Press, London, 2019.

**Reference Books:**

1. **Electric and Hybrid Vehicles** by Tom Denton, Taylor & Francis (Routledge), 2018.
2. **Automobile Electrical and Electronic Systems** by Tom Denton, 5th Edition, Elsevier Butterworth-Heinemann, 2004.

**Online Resources:**

1. Introduction to Hybrid and Electric Vehicles - Web course in NPTEL (https://nptel.ac.in/courses/108/103/108103009/#)
2. Electric Vehicles and Renewable Energy- Web course in NPTEL (https://onlinecourses.nptel.ac.in/noc21_ee112/preview)

| Course Code: BME654C | Course: Introduction to Additive Manufacturing |
|---|---|
| Credits: 3 | L:T:P 3:0:0 |
| SEE: 50% Marks | CIE: 50% Marks |
| SEE Hours: 3 hours | Total Marks: 100 |

| Prerequisites if any | None |
|---|---|
| Learning objectives | 1. Describe additive manufacturing and explain its advantages and disadvantages<br>2. Explain the processes used in additive manufacturing for a range of materials and applications<br>3. Understand the role of additive manufacturing in the design process and the implications for design<br>4. Understand and analyze the process of rapid tooling and reverse engineering |

**Course Outcomes:**

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

| | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Understand and use techniques for processing of CAD models for Additive Manufacturing (AM). | Understand |
| CO2 | Understand and apply fundamentals of AM techniques & optimize the design for AM. | Apply |
| CO3 | Use appropriate tooling for rapid prototyping process. | Apply |
| CO4 | Use rapid prototyping techniques for reverse engineering. | Apply |

**Mapping with POs and PSOs**:

| COs | PO1 | PO2 | PO3 | PO 4 | PO 5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | | PSO1 | PSO 2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | - | 3 | | 2 | | | | | | | | | 3 | | | |
| CO 2 | 3 | | 2 | | 2 | | | | | | | | | | | | 2 |
| CO 3 | 3 | | 2 | | 2 | | | | | | | | | 2 | | | |
| CO 4 | 3 | 2 | | | 2 | | | | | | | | | 2 | | | |

**3 – Strong 2 – Medium 1 – Low**

## Course Content

| | Module – 1 | No. of Lecture Hours | No. of Tutorial Sessions |
|---|---|---|---|
| 1.1 | Introduction to Additive Manufacturing (AM) General overview Introduction, The Generic AM Process | 1 | - |
| 1.2 | The Benefits of AM, Distinction between AM and CNC machining, need for the time compression in product development | 2 | - |
| 1.3 | History of RP systems, Survey of applications, Classification of AM | 2 | |
| 1.4 | CAD model preparation, Data Requirements, Data formats (STL, SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP), Data interfacing, | 2 | - |

| | | | |
|---|---|---|---|
| 1.5 | Part orientation and support generation, Tool path generation. | 1 | |
| **Module – 2** | | | |
| 2.1 | Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application | 3 | - |
| 2.2 | Selective Laser Sintering, Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Process parameter, Path generation, Applications | 2 | - |
| 2.3 | Fusion Deposition Modeling, Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Process parameter, Path generation, Applications | 3 | |
| 2.4 | Solid Ground Curing: Principle of operation, Machine details, Applications | 1 | |
| 2.5 | Laminated Object Manufacturing: Principle of operation, Process details, application. | 1 | |
| **Module – 3** | | | |
| 3.1 | Design for Additive Manufacturing: Design for Manufacturing and Assembly, Core DFAM Concepts and Objectives. | 2 | |
| 3.2 | AM Unique Capabilities | 2 | - |
| 3.3 | Exploring Design Freedoms. | 1 | - |
| 3.4 | Design Tools for AM. | 1 | - |
| 3.5 | Process optimization: factors influencing accuracy, data preparation errors, part building errors, selection of part build orientation. | 2 | |
| **Module – 4** | | | |
| 4.1 | Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, | 1 | |
| 4.2 | Rapid Tooling: Indirect Rapid Tooling - Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, etc | 3 | - |
| 4.3 | Direct Rapid Tooling - Direct AIM, Quick cast process, | 1 | |
| 4.4 | Direct Metal Laser Sintering Tooling (DMLS) Rapid Tool, | 2 | |
| 4.5 | ProMetal, Laminate tooling, soft tooling vs hard tooling. | 1 | |
| **Module – 5** | | | |
| 5.1 | Introduction: Reverse engineering fundamentals-The generic process-Three phases of reverse engineering-Phase I: Scanning, Phase II: Point processing, Phase III: Geometric model development. | 3 | |
| 5.2 | Introduction, Reverse engineering hardware, Reverse engineering software, Selection of a reverse engineering system, Case studies with implementation. | 3 | - |
| | ***Total No. of Lecture Hours*** | **40** | **-** |
| | ***No. of Tutorial Sessions*** | | |

**Text Books:**

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to
Direct digital manufacturing Springer, 2010.
2. Pham D.T. & Dimov S.S "Rapid Manufacturing" Springer London 2011.
3. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid
Manufacturing, Hanser Publishers, 2011.

4. K. Otto and K. Wood, Product Design: Techniques in Reverse Engineering and New Product Development, 1st
edition, Prentice Hall, 2001. ISBN-13: 978-0130212719.
5. Zhiqiang Fan and Frank Liou, Numerical modeling of the additive manufacturing (AM) processes of
titanium alloy, ln Tech, 2012.
6. C.K. Chua, K.F. Leong and C.S. Lim, Rapid prototyping: principles and applications, 3rd Edition,
World Scientific, 2010.
7. Wohlers Report 2021 ISBN 978-0-9913332-7-1.

| Course Code: BME654D | Course: Product Design and Development |
|---|---|
| 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. Students should develop a comprehensive understanding of the professional practice of product design.<br>2. Students will understand the concept of patent application. |

**Course Outcomes:**

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

| Course Outcomes | | Bloom's level |
|---|---|---|
| CO1 | Describe the fundamentals of new product development process and planning. | Understand |
| CO2 | Establish product specifications identifying customer needs. | Apply |
| CO3 | Generate and select various concepts for a product. | Apply |
| CO4 | Understand the concept of Product Architecture and Industrial Design. | Apply |
| CO5 | Appraise the concept of Design for Manufacturing, Prototyping and Patents. | 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 | | | | | | | | 3 | | | |
| CO2 | 3 | 2 | | | | | | | | | | | | 3 | | | |
| CO3 | 3 | | | 2 | | | | | | | | | | 3 | | | |
| CO4 | 3 | | | 2 | | | | | | | | | | 3 | | | |
| CO5 | 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 | Introduction: Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. | 2 | |
| 1.2 | Development Processes and Organizations: A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations. | 3 | |
| 1.3 | Product Planning: The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, | 3 | |

| | | | |
|---|---|---|---|
| | complete pre project planning, reflect all the results and the process. | | |
| | **Module – 2** | | |
| 2.1 | Identifying Customer Needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. | 4 | |
| 2.2 | Product Specifications: What are specifications, when are specifications established, establishing target specifications, setting the final specifications | 3 | |
| | **Module – 3** | | |
| 3.1 | Concept Generation: The activities of concept generation clarify the problem, search externally, search internally, explore systematically, reflect on the results and the process. | 3 | |
| 3.2 | Concept Selection: Overview of methodology, concept screening, and concept scoring, | 2 | |
| 3.3 | Concept Testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process. | 3 | |
| | **Module – 4** | | |
| 4.1 | Product Architecture: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning. | 4 | |
| 4.2 | **Industrial Design:** Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assess the quality of industrial design. | 4 | |
| | **Module – 5** | | |
| 5.1 | Design for Manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production. | 3 | |
| 5.2 | Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes. | 3 | |
| 5.3 | Patents and Intellectual Property: Overview of Patents, Preparing a Disclosure to apply for a patent. | 3 | |
| | ***Total No. of Lecture Hours*** | **40** | **-** |
| | ***No. of Tutorial Sessions*** | | **Nil** |

**Text Books:**

1. Product Design and Development - Karl. T. Ulrich, Steven D Eppinger – Fifth Edition, Irwin McGraw-Hill- 2000.

**Reference Books:**

1. Product Design and Manufacturing - A C Chitale and R C Gupta, PH1, - 3rd Edition,2003.
2. Product Design for Manufacture and Assembly - Geoffery Boothroyd, Peter Dewhurst and Winston Knight – 2002.

| | |
|---|---|
| **Course Code: BME654E** | **Course: Project Management** |
| **Credits: 3** | **L:T:P 3:0:0** |
| **SEE: 50% Marks** | **CIE: 50% Marks** |
| **SEE Hours: 3 hours** | **Total Marks: 100** |

| | |
|---|---|
| **Prerequisites if any** | **None** |
| **Learning objectives** | 1. To enable the students to understand the project management and its types.<br>2. To help the students focus on and analyse the issues and strategies required to Project Selection and Prioritization<br>3. To develop relevant skills necessary for Resourcing Projects and Budgeting the Projects.<br>4. To enable the students to integrate the understanding of various Network Analysis. |

## Course Outcomes:

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

| | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Discuss complete structure of project management and analyze the scope of project planning. | Understand |
| CO2 | Identify different project selection methods. | Understand |
| CO3 | Explain the importance of procurement and its techniques. | Understand |
| CO4 | Define the guidelines required for project control and its controlling techniques. | Understand |
| CO5 | Outline the basic idea of projects and its initial management. | Understand |

## Mapping with POs and PSOs:

| COs | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | | PSO 1 | PSO 2 | PSO3 | PSO4 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | - | - | 1 | - | 2 | 1 | - | 1 | 2 | | 3 | - | - | 1 |
| **CO2** | 3 | 3 | 2 | - | - | 1 | - | 2 | - | - | 1 | 2 | | 3 | - | - | 1 |
| **CO3** | 3 | 2 | 1 | - | - | 1 | 2 | 2 | 1 | - | 1 | 2 | | 3 | - | - | 1 |
| **CO4** | 3 | 3 | 1 | - | - | 1 | - | 2 | 1 | - | 1 | 2 | | 3 | - | - | 1 |
| **CO5** | 3 | 2 | 1 | - | - | 1 | 2 | 2 | 1 | - | 1 | 2 | | 3 | - | - | 1 |

**3 – Strong 2 – Medium 1 – Low**

## Course Content

| | Module – 1 | No. of Lecture Hours | No. of Tutorial Sessions |
|---|---|---|---|
| 1.1 | Characteristics of a project types of projects, Project Management Body of Knowledge (PMBOK), | 1 | - |
| 1.2 | Role of project manager and his qualities, project organization and benefits, idea generation, | 2 | - |
| 1.3 | Needs of society ,import substitution, project life cycle, Project charter, project sponsor. | 1 | - |
| 1.4 | **Project Planning**: Customer needs, stake holder concept, project scope, feasibility study and report, baseline plan, | 2 | - |
| 1.5 | SWOT analysis, project organization structure and hierarchy, project teams, formation, attitude and aptitude. | 2 | - |
| | **Module – 2** | | |
| 2.1 | **Structure:** Project selection methods, break even analysis, DCF methods | 2 | - |
| 2.2 | Project implementation, estimation, cost, price, value, scheduling, | 1 | - |
| 2.3 | Bar charts, network diagrams, PERT and CPM | 2 | - |
| 2.4 | Schedule crashing, simple introduction to risk management, | 2 | - |
| 2.5 | Probability in project management, decision trees. | 1 | - |
| | **Module – 3** | | |
| 3.1 | **Procurement:** Vendor selection methods, JIT, supply chains, quality, quality circles, | 2 | - |
| 3.2 | Quality control and quality assurance, cause and effect analysis, | 2 | - |
| 3.3 | ISO and concepts of total quality management and six sigma, | 2 | - |
| 3.4 | Resource planning and allocation, availability and constraints of resources, resource leveling and crashing | 2 | - |
| | **Module – 4** | | |
| 4.1 | **Project control:** Project scope, project change request, and control of schedule, resources, | 2 | - |
| 4.2 | Cost and quality, project communications, channels, means, meetings, | 2 | - |
| 4.3 | Project reports, project audits project evaluation, project close-out reports, guidelines, audit reports, | 2 | - |
| 4.4 | Maintenance and shutdown projects, plant turn- around and brief introduction to replacement analysis | 2 | - |
| | | | |
| | **Module – 5** | | |
| 5.1 | **Projects:** Contour maps, sitemaps, plant layout, suitability of project site, preparation of site, | 2 | - |
| 5.2 | Selection and leasing of construction equipment special considerations in selection and location of projects, | 2 | - |
| 5.3 | Safety, health, human and environmental factors, project finance, international projects, joint ventures, | 2 | - |
| 5.4 | Collaborations, impact of culture, implementation, and handing over of projects. | 2 | - |
| | | | |
| | ***Total No. of Lecture Hours*** | **40** | **-** |
| | ***No. of Tutorial Sessions*** | | - |

**Text Books:**

1. Kamaraju Ramakrishna, “Essentials of Project Management”, PHILearning,NewDelhi,2010.

**Reference Books:**

1. Prasanna Chandra, “Projects – Planning, analysis, selection, implementation and review”, Tata McGraw-Hill, New Delhi, 2010.
2. Chitkara, “Construction Project Management” ,Tata McGraw-Hill, New Delhi.
3. Harold Kerzner, “Project Management”, Wiley, NewYork.

**Online Resources:**

- https://www.youtube.com/watch?v=BOU1YP5NZVA
- https://www.simplilearn.com/project-selection-methods-article
- https://www.youtube.com/watch?v=DFL9FkIrXLI
- https://www.techtarget.com/searchcio/definition/project-planning
- https://www.ecosys.net/knowledge/scheduling-project-management-project-scheduling/
- https://www.workbreakdownstructure.com/
- https://docs.oracle.com/en/cloud/saas/project-management/22a/oapjs/how-project-progress-iscalculated.html
- https://www.youtube.com/watch?v=ljtGERVLF5U.

| Course Code: BME654F | Course: Introduction to Mechatronics |
|---|---|
| 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 Mechatronics and Control Systems.<br>2. To apply the concepts of Electro Mechanical Systems 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 | Illustrate various components of Mechatronics systems. | Understand |
| CO2 | Assess various control systems used in automation. | Understand |
| CO3 | Design and conduct experiments to evaluate the performance of a mechatronics system or component with respect to specifications, as well as to analyse and interpret data. | Apply |
| CO4 | Apply the principles of Mechatronics design to product design. | Apply |
| CO5 | Function effectively as members of multidisciplinary teams. | 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 | 2 | 2 | | 2 | | 3 | | 3 | | 2 | 2 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | | 3 | | 3 | | 2 | 2 |
| CO3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | | 3 | | 3 | | 2 | 2 |
| CO4 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | | 3 | | 3 | | 2 | 2 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | | 3 | | 3 | | 2 | 2 |

**3 – Strong 2 – Medium 1 – Low**

## Course Content

| | Module(s) | No. of Lecture Hours | No. of Tutorial Sessions |
|---|---|---|---|
| | **Module – 1** | | |
| 1.1 | Introduction: Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle. Basic elements of feedback control systems, Classification of control system. | 2 | - |
| 1.2 | Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system. Antilock braking system (ABS) control, Automatic washing machine. | 1 | - |
| 1.3 | Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors. | 2 | - |

| | | | |
|---|---|---|---|
| 1.4 | Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors. | 3 | - |
| | **Module – 2** | | |
| 2.1 | Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. | 2 | - |
| 2.2 | Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods. | 2 | - |
| 2.3 | Electro Mechanical Drives: Relays and Solenoids. | 1 | - |
| 2.4 | Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation. | 3 | |
| | **Module – 3** | | |
| 3.1 | Microprocessor & Microcontrollers:Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. | 4 | - |
| 3.2 | Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor. | 4 | - |
| | **Module – 4** | | |
| 4.1 | Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram. | 2 | - |
| 4.2 | Ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application. | 3 | - |
| 4.3 | Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc. | 3 | |
| | **Module – 5** | | |
| 5.1 | Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Machine Elements: Different types of guide ways, Linear Motion guideways. | 2 | - |
| 5.2 | Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. | 2 | - |
| 5.3 | Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. | 2 | |
| 5.4 | Mechatronics Design process:Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier. | 2 | |
| | ***Total No. of Lecture Hours*** | **40** | **-** |
| | ***No. of Tutorial Sessions*** | | **Nil** |

**Text Books:**

1. Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering, W.Bolton Pearson Education 1stEdition, 2005
2. Mechatronics-Principles Concepts and Applications Nitaigour Premchand Mahalik Tata McGraw Hill 1st Edition, 2003

**Reference Books:**

1. Mechatronics HMT Ltd Tata Mc Graw Hill 1st Edition, 2000 ISBN:978007 4636435
2. Mechatronics: Integrated Mechanical Electronic Systems K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram. Wiley India Pvt. Ltd. New Delhi 2008
3. Introduction to Mechatronics and Measurement Systems David G. Aldatore, Michael B. Histand McGraw-Hill Inc USA 2003.
4. Introduction to Robotics: Analysis, Systems, Applications. Saeed B. Niku, Person Education 2006.
5. Mechatronics System Design Devdas Shetty, Richard A. kolk Cengage publishers. second edition.

**Virtual Lab**:
https://sl-coep.vlabs.ac.in/Introduction.html

**Online resources:**

https://onlinecourses.nptel.ac.in/noc21_me27/preview

| Course Code: BME654G | Course: Engineering Computation using MATLAB |
|---|---|
| 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 | Nil |
|---|---|
| Learning objectives | To impart the students the knowledge of<br>1. Applying numerical techniques to find the roots of non-linear equations and solution of system of linear equations.<br>2. Understanding the use of curve fitting in analyzing problems in engineering and science.<br>3. Applying techniques for numerical differentiation, integration and solutions of ordinary differential equations.<br>4. Solving problems in engineering and science using MATLAB. |

## Course Outcomes:

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

| COs | | Bloom's level |
|---|---|---|
| CO1 | Make use of numerical techniques to find the roots of non-linear equations and solution of system of linear equations. | Apply |
| CO2 | Make use of curve fitting in analyzing problems in engineering and science. | Apply |
| CO3 | Perform numerical differentiation and integration and numerical solutions of ordinary differential equations. | Apply |
| CO4 | Solve problems in engineering and science using MATLAB. | 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 | 3 | 3 | 2 | 2 | - | - - | - | - | - | - | - | | 1 | - | 2 | - |
| CO2 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | | - | - | 2 | - |
| CO3 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | | - | - | 2 | - |
| CO4 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | - | | - | - | 2 | - |

**S – Strong (3) M – Medium (2) L – Low (1)**

## Course Contents

| Module – 1: Introduction, Error Analysis & Solving Nonlinear Equations | | No. of Lecture Hours | No. of Tutorial Sessions |
|---|---|---|---|
| 1.1 | Solving a problem in science and engineering: Problem statement, Formulation of the solution (Numerical and Analytical), Interpretation of the solution. | 1 | - |
| 1.2 | Round-Off Errors, Truncation Errors, Total Error, True error, Relative error, Tolerance. | 1 | |

| | | | |
|---|---|---|---|
| 1.3 | **Solving Nonlinear Equations:** Roots and Optimum in engineering and science, Newton-Raphson Method, | 1 | |
| 1.4 | Secant Method,Modified Secant Method, The ‘fzero’ and ‘roots’ Commands | 1 | |
| 1.5 | Newton-Raphson Method for Solving a System of Nonlinear Equations. | 1 | |
| **Module – 2: Solving a System of Linear Equations & Eigen Value Problems** | | | |
| 2.1 | Linear Algebraic Equations in Engineering and Science, Overview of Numerical Methods for Solving a System of Linear Algebraic Equations, | 1 | - |
| 2.2 | Gauss Elimination, Gauss-Jordan Elimination Method, LU Decomposition, Jacobi Iterative Method, Gauss-Seidel Iterative Method. Solving a System of Equations Using MATLAB’s Left and Right Division | 2 | |
| 2.3 | Inverse Operation, MATLAB's Built-In Function for LU Decomposition. | 1 | - |
| 2.4 | **Eigen Values and Eigen Vectors** Mathematical Background, Physical Interpretation of Eigen values and Eigen vectors, Eigen values and Eigen vectors with MATLAB | 1 | |
| **Module – 3: Curve Fitting and Interpolation** | | | |
| 3.1 | Curve Fitting and Interpolation in Engineering and Science. Curve Fitting with a Linear Equation, Linear Least-Squares Regression | 1 | - |
| 3.2 | Linearization of Nonlinear Relationships, Curve Fitting with Quadratic and Higher-Order Polynomials. | 1 | |
| 3.3 | Interpolation using a Single Polynomial, Lagrange Interpolating Polynomials, | 1 | - |
| 3.4 | Newton's Interpolating Polynomials, MATLAB Functions: polyfit and polyval. | 1 | |
| **Module – 4: Numerical Differentiation & Integration** | | | |
| 4.1 | **Numerical Differentiation**.Differentiation in Engineering and Science, The need for numerical differentiation, Approaches to numerical differentiation, | 1 | - |
| 4.2 | Forward Backward, and central difference formulas for the first and second derivative, MATLAB Function: diff, MATLAB Function: polyder.Numerical Partial Differentiation. | 1 | |
| 4.3 | Numerical Integration:Integration in Engineering and Science, The need for numerical integration, | 2 | |
| 4.4 | Single and Composite application of Rectangle, Mid-point, Trapezoidal, Simpson's 1/3, and 3/8 Rule, MATLAB builtin function for integration. | 1 | |
| **Module – 5: Ordinary Differential Equations** | | | |
| 5.1 | Overview of ODE, Euler's Explicit and Implicit Methods, | 1 | - |
| 5.2 | Runge-Kutta Methods, classical fourth order Runge-Kutta Methods. | 2 | |

| | | | |
|---|---|---|---|
| 5.3 | Use of MATLAB Built-in Function ODE for Solving a System of First-Order ODEs, | 2 | |
| 5.4 | Solving Higher-Order DEs. | 2 | |
| | ***Total No. of Class Hours*** | 40 | -- |
| | ***Total No. of Tutorial* Sessions** | | Nil |

**Textbooks:**

1. **Applied Numerical Methods with MATLAB for Engineers and Scientists,** Steven C. Chapra, McGraw Hill Education.
2. **Numerical Methods for Engineers and Scientists, An Introduction with Applications using MATLAB,** Amos Gilat and Vish Subramaniam, WILEY Publication.

**Reference Books:**

1. **Numerical Methods using MATLAB,** John H Mathews, Kurtis D Fink, Prentice Hall.
2. **Applied Numerical Methods Using MATLAB**, Won Young Yang, Wenwu Cao Tae-Sang Chung, John Morris, John Wiley & Sons, Inc.

**Online Resources:**

1. **https://onlinecourses.nptel.ac.in/noc24_ge46/preview**
2. **https://onlinecourses.nptel.ac.in/noc24_ma41/announcements?force=true**

| Course Code: BME654H | Course: Microgrids |
|---|---|
| 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. Describe and explain Micro Grid system and its integration to renewable energy sources.<br>2. Apply Engineering techniques to build a Micro Grid integrated with solar PV, Biofuel and Micro Hydro systems.<br>3. Handson experience to understand and learn the working of Micro Grid at a Installation. |

**Course Outcomes:**

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

| Course Outcomes | | Bloom's level |
|---|---|---|
| CO1 | Describe and explain Micro-grid system & its integration with RE sources. | Understand |
| CO2 | Apply engineering techniques to build a Micro-grid integrated with solar PV, wind turbine, biofuel ,Micro-hydro system, Fuel cells, Green Hydrogen. | Apply |
| CO3 | Demonstration of renewable energy integrated Micro-grid systems at the Lab/Field. | Apply |
| CO4 | Analyze performance of small micro – grid systems. | Analyze |
| CO5 | Demonstrate the use of micro – grid simulation software. | 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 | 2 | | - | - | - | - | | 2 | - | 1 | - |
| CO2 | 3 | 2 | 2 | 2 | 2 | - | 2 | - | - | - | 1 | - | | 2 | - | 1 | |
| CO3 | 3 | 2 | 1 | 2 | 1 | 2 | 2 | - | - | - | - | - | | 2 | - | 2 | - |
| CO4 | 2 | 2 | 2 | 2 | 2 | - | 2 | - | - | - | 1 | - | | 2 | - | 1 | |
| CO5 | 3 | 2 | 1 | 2 | 1 | 2 | 2 | - | - | - | - | - | | 2 | - | 1 | - |

**3 – Strong 2 – Medium 1 – Low**

**Course Content**

| | Module – 1<br>Introduction | No. of Lecture Hours | No. of Tutorial / lab Sessions |
|---|---|---|---|
| 1.1 | Renewable Energy sources and technology | 1 | - |
| 1.2 | Integration of Renewable energy to Microgrid- need and advantages | 1 | - |
| 1.3 | Micro-grids basics & its importance for remote locations. | 2 | - |
| 1.4 | **Integration of Renewable energy to Micro-Grid system-**Schemes to intergrate Renewable energy technologies – stand-alone systems, Hybrid systems. Integration of solar PV, wind turbine, bio diesel engine and micro hydro – principle. | 3 | - |
| | **Module – 2Energy storage** | | |

| | | | |
|---|---|---|---|
| 2.1 | Battery storage – working principle, AH rating, C-Rating, battery management. | 1 | - |
| 2.2 | Lithium ion , Lead acid batteries, Nickel Cadmium Batteries & Advanced Batteries (Basics). | 2 | - |
| 2.3 | Pumped storage – Introduction to pumped storage systems, Working Principal. | 2 | - |
| 2.4 | Application of Pump Storage in Micro Grid.- line diagram, components , | 2 | - |
| 2.5 | Case Study of a pump storage unit. Installed. | 2 | - |
| **Module – 3Micro Grid Features and Controllers** | | | |
| 3.1 | Micro-grid controller, fundamental of PCU (charge controller, MPPT) | 3 | - |
| 3.2 | Micro-grid architecture (basics) | 2 | - |
| 3.3 | micro-grid load manager (Any general micro controller, GSM load manager) | 3 | - |
| 3.4 | Micro-grid monitoring using internet and smart phones | 2 | - |
| 3.5 | Micro-grid central system software | 2 | |
| **Module – 4Analysing Case studies of Micro-Grid system** | | | |
| 4.1 | A small 1 kW to 50 kW microgrid systems installed anywhere in the world | 3 | - |
| 4.2 | Environmental benefits of Microgrid | 2 | - |
| 4.3 | Microgrid & Energy sustainability. | 2 | - |
| **Module – 5Simulation of Microgrid and Economics** | | | |
| 5.1 | Introduction to Microgrid simulation software like HOMER (Hybrid Optimization of Multiple Energy Resources). | 2 | - |
| 5.2 | Economic analysis of a small Microgrid unit -Case study | 2 | |
| 5.2 | Microgrid meeting the Sustainable development goals, and Net zero | 4 | - |
| | ***Total No. of Lecture Hours*** | **40** | **-** |

**Text Books:**


1. Fundamentals of Microgrids: Development and Implementation - by Stephen A. Roosa (Editor). ISBN-10 – 0367535394. Publisher : CRC Press; 1st edition (4 September 2020)
2. Renewable Energy resources by John W Twidell, Anthony D Weir, EL BS – 2005.- ISBN- 0419 14470 6
3. Design of Smart Power Grid Renewable Energy Systems by Ali Keyhani, Wiley-Blackwell (15 July 2011). ISBN-10: 0470627611 & ISBN-13: 978-0470627617.


**References:**


1. Microgrid Planning and Design: A Concise Guide (Wiley - IEEE) 1st Edition, by Hassan Farhangi , ASIN : B07QR2BFF6. Publisher : Wiley-IEEE Press; 1st edition (6 March 2019)

ESTD : 1946

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

for the students of:

B.E. VI Semester

Scheme: 2022

Academic Year: 2025-26

**Course Code: BEC654B** **Course: Vehicular Electronics**

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

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

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

| | |
|---|---|
| **Prerequisites if any** | Basic Circuit theory and mechanical dynamics |
| **Learning objectives** | Students will be able to learn:<br>1. Electronics Automotive systems.<br>2. Electronics Hybrid vehicles. |

**Course Outcomes:**

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

| CO's | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Understand constraints and opportunities of sensors and actuators used in the modern vehicle design. | L2 |
| CO2 | Use basic measurement tools to determine the real-time performance of vehicles and Automotive Instrumentation, Safety factors and diagnostics of Automobile systems. | L2 |
| CO3 | Analyse the implementation of the interconnected wireless embedded sensor networks and the Electronic Control Systems | L2 |

**Mapping with Pos and PSOs:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | | | | | | **1** | | | **1** |
| **CO2** | **3** | **2** | **3** | | | | | | **1** | | | **1** |
| **CO3** | **3** | **2** | **3** | | | | | | **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-Introduction** | | | | |
| 1.1 | Automotive fundamentals overview: four stroke cycle, engine control | 2 | | |
| 1.2 | Ignition system, spark plug, sparks pulse generation, ignition timing | 3 | | |
| 1.3 | Drive train, transmission, brakes, steering system, Power Brakes,Anti-Lock Brake System (ABS), Electronic Steering Control, Power Steering, Traction Control, Electronically controlled suspension, starting system. | 3 | | |
| **Module-2-** Sensors | | | | |
| 2.1 | Oxygen (O2/EGO) Sensors, Throttle Position Sensor (TPS), Engin Crankshaft Angular Position (CKP) Sensor, magnetic reluctance, position sen speed sensor, ignition timing sensor, hall effect position sensor | 3 | | |
| 2.2 | Shielded field sensor, optical crankshaft position, sensor, Manifold Absolute Pressure (MAP) Sensor - strain gauge and capacitor capsule, Engine Coolant Temperature (ECT) sensor, Intake Air Temperature (IAT) sensor, knock sensor, airflow ratesensor, Operating Principles of Fuel Cells, Electrode Potential and Current–Voltage Curve. | 3 | | |
| 2.3 | Actuators: Automotive Engine Control Actuators, Fuel Injection, Exhaust Gas Recirculation Actuator, Variable Valve Timing, Electric Motor Actuators, fuel metering actuator, Ignition actuator, catalytic converter. | 2 | | |
| **Module-3-**Electronic Engine Control and Automotive Networking | | | | |
| 3.1 | Electronic Engine Control: Engine parameters, variables, engine performance terms, electronic fuel control system, electronic ignition control, idle speed control, air/fuel systems fuel handling, air intake system, Protection, Remote Keyless Entry, | 4 | | |
| 3.2 | Automotive communication/networking: Automotive networking, cross system function, Requirements for bus systems, Classification of bus systems, Applications in the vehicle, Coupling of networks, Examples of networked vehicles. Bus systems: CAN, LIN. | 4 | | |

| | | | | |
|---|---|---|---|---|
| **Module 4:** Diagnostics and Battery systems | | | | |
| 4.1 | On and Off board diagnostics: Electronic Control System Diagnostics, Service Bay Diagnostic Tool, Onboard Diagnostics,Model-Based Sensor Failure Detection, Expert Systems in Automotive Diagnosis, Occupant Protection Systems. | 4 | | |
| 4.2 | Battery Systems: Energy Storages: Batteries in Electric andHybrid Vehicles, Battery Basics, Battery Parameters, Electrochemical Cell Fundamentals, Battery Modelling, Electrochemical Batteries, Ultra capacitors, Battery Pack Management. | 4 | | |
| **Module 5:** Electric and Hybrid Vehicles | | | | |
| 5.1 | Electric Vehicles: Configurations of Electric Vehicles, Performance of Electric Vehicles, Tractive Effort in Normal Driving. | 3 | | |
| 5.2 | Hybrid Electric Vehicles: Concept of Hybrid Electric Drive Trains, Architectures of Hybrid Electric Drive Trains. | 3 | | |
| 5.3 | Fuel Cell Vehicles: Fuel and Oxidant Consumption, Fuel CellSystem Characteristics, Fuel Cell Technologies, Fuel Supply, Non Hydrogen Fuel Cells. | 2 | | |
| ***Total No. of Theory*** | | **40** | | |
| ***Total No. of Tutorial Hours*** | | | **0** | **-** |
| ***Total No. of Practical Hours*** | | | | **-** |

**Text Books:**


1. William B. Ribbens, "Understanding Automotive Electronics," 6th Edition,SAMS / Elsevier Publisher, 2010.
2. Robert Bosch GMBH, "Automotive Electrics Automotive Electronics Systems and Components," 5th Edition, John Wiley& Sons Ltd., 2007.
3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles- Fundamentals, Theory, and Design," CRC Press, 2004.
4. Iqbal Husain, "Electric and Hybrid Vehicles Design Fundamentals," 2nd edition,CRC press.

**Course Code: BEC654C** **Course: Multicore Systems and Programming**

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

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

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

| | |
|---|---|
| **Prerequisites if any** | C Programming, Computer Architecture |
| **Learning objectives** | Students will be able to learn:<br>1. Limitation of single core systems and the need for multicore<br>2. To port multithreading to multicore and synchronize theoperations |

**Course Outcomes:**

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

| CO's | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Identify performance related parameters in the field of Computer Architecture and need for multicore architecture | L2 |
| CO2 | Apply the concept of multithreading and OPENMP to parallelise a process. | L3 |
| CO3 | Analyse the features of different multi-core architectures and how they apply parallelism. | L4 |

**Mapping with POs and PSOs**:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **2** | **1** | | | | **1** | | | | | **1** |
| **CO2** | **2** | **2** | **1** | | **3** | | **1** | | | | | **1** |
| **CO3** | **3** | **2** | **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: Module 1: Introduction To Multi-Core Architecture:** | | | | |
| 1.1 | Motivation For Concurrency In Software, Parallel Computing Platforms, Parallel Computing In Microprocessors | 2 | - | - |
| 1.2 | Differentiating Multi-Core Architectures From Hyper Threading Technology, Multi-Threading On Single-Core Versus Multi-Core Platforms, Understanding Performance, Amdahl's Law, Growing Returns: Gustafson's Law. | 2 | - | - |
| 1.3 | Defining Threads, System View Of Threads, Threading Above The Operating System, Threads Inside The OS, Threads Inside The Hardware, What Happens When A Thread Is Created | 2 | - | - |
| 1.4 | Application Programming Models and Threading, Virtual Environment: VMs And Platforms, Runtime Virtualization | 2 | | |
| **Module – 2: Concepts Of Parallel Programming** | | | | |
| 2.1 | Designing For Threads, Task Decomposition, Data Decomposition, Decomposition, Implications Of Different Decompositions | 3 | - | - |
| 2.2 | Challenges, Parallel Programming Patterns, Motivating Problem: An Error Diffusion Algorithm | 3 | - | - |
| 2.3 | Alternate Approach: Parallel Error Diffusion and other alternatives | 2 | | |
| **Module – 3: Module 3:Threading and Parallel Programming Constructs** | | | | |
| 3.1 | Synchronization, Critical Sections, Deadlock, Synchronization Primitives, Semaphores, Locks, Messages, Flow Control- Based Concepts, Fence, Barrier, Implementation-Dependent Threading Features. | 3 | - | - |
| 3.2 | Threading APIS For Microsoft Windows, Win32/MFC Thread APIS, Threading APIS For Microsoft. NET Framework | 2 | - | - |
| 3.3 | Creating Threads, Managing Threads, Thread Pools, Thread Synchronization, POSIX Threads | 2 | | |
| 3.4 | Signalling, Compilation and Linking | 1 | | |

| | | | | |
|---|---|---|---|---|
| **Module – 4 :OpenMP - A Portable Solution For Threading** | | | | |
| 4.1 | Challenges In Threading A Loop, Loop-Carried Dependence, Data-Race Conditions, Managing Shared and Private Data, Loop Scheduling And Portioning | 2 | | |
| 4.2 | Effective Use Of Reductions, Minimizing Threading Overhead, Work-Sharing Sections, Performance-Oriented Programming | 2 | | |
| 4.3 | Using Barrier And No Wait, Interleaving Single-Thread And Multi-Thread Execution, Data Copy-In And Copy-Out, Protecting Updates Of Shared Variables | 2 | | |
| 4.4 | Intel Task Queuing Extension To OpenMP, OpenMP Library Functions, OpenMP Compilation, Debugging, Performance | 2 | | |
| **Module -5** | | | | |
| 5.1 | Too Many Threads, Data Races, Deadlocks, And Live Locks, Heavily Contended Locks, Priority Inversion, Solutions For Heavily Contended Locks, Non-Blocking Algorithms, ABA Problem | 2 | | |
| 5.2 | Cache Line Ping-Ponging, Memory Reclamation Problem, Recommendations, Thread-Safe Functions And Libraries, Memory Issues, Bandwidth, Working In The Cache, Memory Contention, Cache-Related Issues, | 3 | | |
| 5.3 | False Sharing, Memory Consistency | 1 | | |
| 5.4 | Current IA-32 Architecture, Itanium Architecture, High-Level Languages, Avoiding Pipeline Stalls On IA-32 | 2 | | |
| ***Total No. of Lecture Hours*** | | **40** | **-** | - |
| ***Total No. of Tutorial Hours*** | | | **-** | **-** |
| ***Total No. of Practical Hours*** | | | | **-** |

**Suggested Learning Resources:**

- https://www.youtube.com/playlist?list=PLwdnzlV3ogoU0TR333JyxG8T3HDg52 S0h (John Jose)

**Text Books:**

1. Multicore Programming, Increased Performance through Software Multithreading, by Shameem Akhter and Jason Roberts, Intel Press, 2006
2. Computer Architecture A Quantitative Approach, by Hennessey and Patterson, 4thEdition, Elsevier, 2012
3. Advanced Computer Architecture - Parallelism, Scalability, Programmability byKai Hwang, Naresh Jotwani, Tata McGraw Hill, 2nd Edition, 2011.

**Course Code: BEC654D** **Course: Introduction to VLSI**

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

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

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

| Prerequisites if any | NIL |
|---|---|

**Course Outcomes:**

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

| COs | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Summarize on Digital system design | L1 |
| CO2 | Understand the construction, Design, Analyse the Digital circuit through testing and verification in different phases of the design cycle | L2 |
| CO3 | Verify the design of combinational and sequential circuits using Verilog HDL | L2 |

**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** | **1** | **1** | | | | | | | | **2** | | **2** | | **2** |
| **CO2** | **3** | **2** | **1** | **1** | | | | | | | | **2** | | **2** | | **2** |
| **CO3** | **3** | **2** | **1** | **1** | | | | | | | | **2** | | **2** | | **2** |
| **CO4** | **3** | **2** | **1** | **1** | | | | | | | | **2** | | **2** | | **2** |

3 – Strong 2 – Medium 1 – Low

## Course Structure

| | Module – 1:Review of Digital Circuits | No. of Lecture Hours | No. of Tutorial Hours | No. of Practical Hours |
|---|---|---|---|---|
| 1.1 | Digital system design options and trade-offs, Number System, Boolean Algebra, | 2 | 0 | 0 |
| 1.2 | Demorgan's Theorem, Logic Gates, SOP and POS forms, MVP techniques, | 2 | 0 | 0 |
| 1.3 | Combinational circuits: Adders, Mux & Demux, | 2 | 0 | 0 |
| 1.4 | Sequential design: Latches, Flip-Flops, Counters (Synchronous and Asynchronous), state machine design: FSM, | 2 | 0 | 0 |
| | **Module – 2 :Introduction** | | | |
| 2.1 | VLSI design Flow, Analog and Digital design flow, ASIC and FPGA design Flow and Y chart | 2 | 0 | 0 |
| 2.2 | Fabrication: Wafer Processing, oxidation, Epitaxial, deposition, Ion-implantation and Diffusion, Silicon gate process, n-well & p-well process, Twin-tube process. | 4 | 0 | 0 |
| 2.3 | Design of digital circuits using Switch & Gate logic and CMOS logic | 2 | 0 | 0 |
| | **Module – 3 : Introduction to Verilog** | | | |
| 3.1 | Introduction to Verilog and Dataflow descriptions: Program structure, Logic systems | 2 | 0 | 0 |
| 3.2 | Nets, Variables and Constants, Vectors and Operators, Arrays, Logical operators, and expressions | 2 | 0 | 0 |
| 3.3 | Dataflow Design elements: Continuous assignments, delay specification | 2 | 0 | 0 |
| 3.4 | expressions, rise, fall, and turn-off delays, Structural description | 2 | 0 | 0 |
| | **Module – 4 : Behavioural Description** | | | |
| 4.1 | Behavioural Design elements: Structured procedures, initial and always | 2 | 0 | 0 |
| 4.2 | blocking and non-blocking statements, | 1 | 0 | 0 |
| 4.3 | Delay control, generate statement, event control | 1 | 0 | 0 |
| 4.4 | Conditional statements, multiway branching, loops, sequential and parallel blocks, Simulation, Test benches | 2 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| 4.5 | ASM charts, FSM code development, | 2 | | |
| | **Module – 5 : VLSI design Verification** | | | |
| 5.1 | Introduction to Verification and Verification Plan, Verification Tools, Stimulus and Response | 2 | 0 | 0 |
| 5.2 | Introduction to UVM: UVM Classes, UVM Factory, Sequence Item, Sequencer, Virtual Sequences, Transaction Level Modeling, UVM Reporting Methods, Development of Reusable Verification Environment | 3 | 0 | 0 |
| 5.3 | Introduction to formal methods for design verification, Introduction and Basic Operations on Temporal Logic, Syntax and Semantics of CLT, Equivalences checking, Introduction to Model Checking, Introduction to Binary Decision Diagram. | 3 | 0 | 0 |
| ***Total No. of Lecture Hours*** | | **40** | | |
| ***Total No. of Tutorial Hours*** | | | **0** | |
| ***Total No. of Practical Hours*** | | | | **0** |

**Text Books:**


1. Neil H E Weste and Kamran Eshraghian, "Principles of CMOS VLSI design, A system perspective," 2nd edition, Addison Wesley.(Module 2)
2. UVM reference Manual (Module 5)
3. M. Morris Mano, Michael D. Ciletti, "Digital Design with an Introduction to the Verilog HDL", 5th Edition. (Module-1)
4. Samir Palnitkar, "Verilog HDL", Published by Pearson Education 2003.(Module 3 & 4)


**Suggested Learning Resources:**

**https://www.youtube.com/watch?v=H34hLpUU9PA**

**Course Code: BEC654E**

**Course: Introduction to Radar Systems for Autonomous Driving**

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

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

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

| | |
|---|---|
| Prerequisites if any | |
| Learning objectives | • Learn principles of radar systems.<br>• To use radar techniques for target detection and tracking in autonomous driving scenario.<br>• To understand real-world case studies and applications of radar and Lidar systems in autonomous cars, including adaptive cruise control (ACC), collision avoidance, pedestrian detection, and intersection management.<br>• To learn principles of LiDAR systems. |

**Course Outcomes:**

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

| COs | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Explain working principle of radar systems | L2 |
| CO2 | Understand radar techniques for target detection and tracking in autonomous driving scenario. | L2 |
| CO3 | Understand real-world case studies and applications of radar systems in autonomous cars, including adaptive cruise control (ACC), collision avoidance, pedestrian detection and intersection management. | L2 |
| CO4 | Explain working principles of LiDAR systems | L2 |

**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 | PO1 2 | | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **3** | **3** | **2** | **2** | | | | | **3** | | **2** | | | **3** | **2** | |
| **CO2** | **3** | **3** | **2** | **2** | | | | | **3** | | **2** | | | **3** | **2** | |
| **CO3** | **3** | **3** | **2** | **2** | | | | | **3** | | **2** | | | **3** | **2** | |
| **CO4** | **3** | **3** | **2** | **2** | | | | | **3** | | **2** | | | **3** | **2** | |

3 – Strong 2 – Medium 1 – Low

## Course Structure

| | Module – 1 : Fundamentals of Radar Systems | No. of Lecture Hours | No. of Tutorial Hours | No. of Practical Hours |
|---|---|---|---|---|
| 1.1 | Introduction, Essential Functions of Radar, Radar System Fundamentals, | 2 | 0 | 0 |
| 1.2 | Antennas for Radar Measurements, Challenges for Automotive Radar Developers (Basic level) | 2 | 0 | 0 |
| 1.3 | Mathematical model of Radar Range Equation (Basic level) | 2 | 0 | 0 |
| 1.4 | Radar Equation for Automotive Applications. (Basic level) | 2 | 0 | 0 |
| | **Module – 2 : FMCW Radars** | | | |
| 2.1 | Fundamentals, Block diagram of FMCW radars, Range and Velocity measurement using FMCW radars, (Basic level) | 4 | 0 | 0 |
| 2.2 | Range resolution, velocity resolution, Application of FMCW radars for Autonomous driving, Case Study: TI FMCW Radar. (Basic level) | 4 | 0 | 0 |
| | **Module – 3 : LiDAR for Autonomous Driving** | | | |
| 3.1 | Introduction to LiDAR, Types of LiDAR, Components and architecture of a typical LiDAR system, Role of LiDAR in autonomous vehicles (Basic level) | 4 | 0 | 0 |

| | | | | |
|---|---|---|---|---|
| 3.2 | Object detection and classification using LiDAR, Range measurement using LiDAR, Current limitations and challenges in LiDAR technology | 4 | 0 | 0 |
| | **Module – 4 : Modern Radar Sensors** | | | |
| 4.1 | **Modern Radar Sensors in Advanced Automotive Architectures*:*** Motivation for Advanced Systems, The Evolving Automotive Radar Landscape, Vehicle Network and Compute Considerations, Design Considerations for Automotive Radar. (Fundamentals level) | 4 | 0 | 0 |
| 4.2 | Vehicle Network and Compute Considerations, Design Considerations for Automotive Radar. (Fundamentals) | 4 | 0 | 0 |
| | **Module – 5 : Automotive Radar Applications** | | | |
| 5.1 | Introduction, Short-Range Radar (SRR, Long-Range Radar (LRR), Trends in Automotive Applications (Basics) | 4 | 0 | 0 |
| 5.2 | Future Roadmaps Automotive Applications, Future Contributions of Automotive Applications (Basics) | 4 | 0 | 0 |
| ***Total No. of Lecture Hours*** | | **40** | | |
| ***Total No. of Tutorial Hours*** | | | **0** | |
| ***Total No. of Practical Hours*** | | | | **0** |

**Suggested Learning Resources:**

**Text Books:**

1. **Jonah Gamba "Radar Signal Processing for Autonomous Driving",** Springer, 2020
2. **Matt Markel" Radar for Fully Autonomous Driving",** Artech House, 2022.

**Reference Books:**

1. Merrill I. Skolnik Handbook of Radar Systems, McGraw Hill; 3rd edition, 2008.
2. **Pinliang Dong LiDAR Remote Sensing and Applications,** CRC Press, 2017.

**E-Resources:**

1. https://www.coursera.org/specializations/self-driving-cars
2. https://www.edx.org/course/self-driving-cars-with-duckietown


ESTD : 1946

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

for the students of:

B.E. VI Semester

Scheme: 2022

Academic Year: 2025-26

**Course Code: BEE654A**
**Credits: 3**
**CIE: 50% Marks**
**SEE Hours: 3**

**Course Name: Sensors and Signal Conditioning**
**L:T:P:S - 3:0:0:0**
**SEE: 50% Marks**
**Total Marks: 100**

| | |
|---|---|
| **Prerequisites if any** | Nil |
| **Learning objectives** | Understanding the basic concepts and principles of different sensors and the signal conditioning circuits used for the same. |

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

| **COs** | | **Bloom's level** |
|---|---|---|
| CO1 | Explain the principle of operation of different sensors and their applications. | Understand |
| CO2 | Discuss the recent trends in sensor technologies. | Understand |
| CO3 | Describe the concept of signal conditioning circuits. | Understand |

**Mapping with POs and PSOs**:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | 1 | | To be mapped by the respective department | | |
| CO2 | 3 | - | - | - | - | - | - | - | - | - | - | 1 | | | | |
| CO3 | 3 | - | - | - | - | - | - | - | - | - | - | 1 | | | | |

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

**Course Structure**

| **Module – 1: Introduction to sensor-based measurement system** | | **No. of Lecture Hours** | **No. of Tutorial Hours** |
|---|---|---|---|
| 1.1 | General concepts and terminology, sensor classification. | 2 | Nil |
| 1.2 | Material for sensors, micro sensor technology | 3 | Nil |
| 1.3 | Resistive gas sensors, Liquid conductivity sensors | 2 | |
| 1.4 | Selection of sensor. | 1 | Nil |
| **Module – 2: Reactance variation and Electromagnetic sensors** | | | |
| 2.1 | Capacitive Sensors, Inductive Sensors, Electromagnetic Sensors | 3 | Nil |
| 2.2 | Signal Conditioning for Reactance Variation Sensors and Specific Signal Conditioners for Capacitive Sensors | 2 | Nil |
| 2.3 | Industrial applications of electromagnetic sensor | 2 | Nil |
| **Module – 3: Self-generating sensors** | | | |
| 3.1 | Thermoelectric sensors, Piezoelectric sensors | 2 | Nil |
| 3.2 | Pyroelectric sensors, Photovoltaic sensors, Electrochemical sensors. | 3 | Nil |
| 3.3 | Signal conditioning for self-generating sensors and Electrochemical sensors | 3 | Nil |
| 3.4 | Industrial applications of self-generating sensors | 1 | Nil |
| **Module – 4: Recent developments in sensors** | | | |
| 4.1 | Smart sensor, Intelligent sensor | 2 | Nil |
| 4.2 | MEMS sensor, Nano sensors | 2 | Nil |
| 4.3 | Design of smart sensor | 2 | Nil |
| 4.4 | Smart sensor technology for IoT. | 2 | Nil |
| 4.5 | Industrial applications of smart sensor. | 1 | Nil |
| **Module – 5: Signal Conditioning** | | | |
| 5.1 | Concept of signal conditioning, analogue-digital sampling | 2 | Nil |
| 5.2 | Interference, grounding, shielding, minimizing noise. | 1 | Nil |
| 5.3 | Plug in data acquisition board, RS-232 and RS-485 standards | 3 | Nil |
| 5.4 | 20mA current loop. IEEE 488 standard. | 1 | Nil |

| | | |
|---|---|---|
| ***Total No. of Lecture Hours*** | 40 | |
| ***Total No. of Tutorial Hours*** | | Nil |

**Textbooks:**

1. S Ramón Pallas-Areny, John G. Webster, **"Sensors and Signal Conditioning",** Wiley,2012.
2. Analog Devices Inc. (Norwood, Mass.), **"Practical Design Techniques for Sensor Signal Conditioning",** 1999.

**Reference Books:**

1. E.O. Doebelin, **"Measurement Systems – Application and Design",** Tata McGraw Hill publishing company, 2019.
2. Patranabis,D, **"Principles of Industrial Instrumentation",** 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.

**Course Code: BEE654B** **Course Name: Introduction to Electric Vehicle Technology**
**Credits: 3** **L:T:P:S - 3:0:0:0**
**CIE: 50% Marks** **SEE: 50% Marks**
**SEE Hours: 3** **Total Marks: 100**

| | |
|---|---|
| **Prerequisites if any** | Nil |
| **Learning objectives** | 1. Learn the modeling of Electric Vehicle dynamics.<br>2. Analyze the operation of power Controllers in Electric Traction Machines.<br>3. Apply basics of power converters for developing battery charging systems |

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

| **COs** | | **Bloom's level** |
|---|---|---|
| CO1 | Understand the fundamentals of Electric Vehicles, Battery management systems, battery recycling technologies and Charging stations | Understand |
| CO2 | Model and analyse the dynamics of Electric Vehicles | Analyze |
| CO3 | Understand the basics of electric drives and batteries and apply for EV 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 | - | - | - | - | 2 | 2 | - | - | - | - | 1 | | To be mapped by the respective department | | |
| CO2 | 3 | 2 | 2 | - | - | 2 | 2 | - | - | - | - | 1 | | | | |
| CO3 | 3 | - | 2 | - | - | 2 | 2 | - | - | - | - | 1 | | | | |

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

**Course Structure**

| **Module – 1: Introduction to Electric Vehicles** | | **No. of Lecture Hours** | **No. of Tutorial Hours** |
|---|---|---|---|
| 1.1 | Electro mobility and the Environment, History of Electric Vehicle, Types of energy sources for propulsion and emissions. | 2 | Nil |
| 1.2 | Carbon emissions, greenhouse gases and pollutants, Basic architecture of battery and fuel-cell electric vehicles | 2 | Nil |
| 1.3 | Introduction to Electric and Hybrid vehicles: Configuration, Performance and Energy consumption of electric vehicles, Concept and Architecture of Hybrid electric vehicles, economic aspects of EV. | 3 | Nil |
| **Module – 2: Vehicle Dynamics** | | | |
| 2.1 | EV advantage, Efficiency comparison with conventional vehicles, Roadway fundamentals, Laws of motion and vehicle kinetics. | 3 | Nil |
| 2.2 | Vehicle load forces: aerodynamic drag, rolling resistance, grading resistance, Mathematical Model of vehicle to describe vehicle performance, | 2 | Nil |
| 2.3 | Battery Electric Vehicle Range at Constant Speed, Gradability, Vehicle acceleration, Traction motor characteristics, Drive cycles, | 3 | Nil |
| | EV Motor Sizing: Rated Vehicle Velocity, Initial Acceleration, Maximum Velocity, Maximum Gradability | 2 | |
| **Module – 3: Electric drive for EV** | | | |
| 3.1 | Basic concept of electric traction, introduction to various electric drive-train topologies. | 3 | Nil |
| 3.2 | Power flow control in electric drive-train topologies | 2 | Nil |
| 3.3 | Overview of EV Technologies: Motor Drive Technology, Energy Source Technology, Battery Charging Technology, Vehicle-to-Grid Technology | 3 | Nil |
| **Module – 4: Batteries for EV** | | | |
| 4.1 | Development Background of the Battery, Principles and Classification of the Lithium-Ion Battery. | 2 | Nil |
| 4.2 | Basic Battery Operation, Battery Parameters, Comparisons of battery technologies | 3 | Nil |
| 4.3 | Charger architectures, EV battery charging system, charger functions, charging | 3 | Nil |

| | | | |
|---|---|---|---|
| | standards and technologies. | | |
| **Module – 5: Battery management, Recycling & charging stations.** | | | |
| 5.1 | Battery Management Systems (BMS): Fundamentals of battery management systems and controls | 2 | Nil |
| 5.2 | Battery Recycling Technologies: Technology and economic aspects of battery recycling Battery Applications for Stationary and Secondary Use | 2 | Nil |
| 5.3 | Electric Vehicles charging station: Type of Charging station, Selection and Sizing of charging station, Components of charging station | 3 | Nil |
| | ***Total No. of Lecture Hours*** | 40 | |
| | ***Total No. of Tutorial Hours*** | | Nil |

**Textbooks:**

1. J Iqbal Hussein, Electric and Hybrid Vehicles: "**Design Fundamentals"**, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, **"Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design",** CRC Press, 2004
3. Rui Xiong **"Battery Management Algorithm for Electric Vehicles",** Springer Publisher, 2020
4. Gregory L. Plett , **"Battery Management Systems Volume II-Equivalent Circuit Methods"** , ARTECH house,2016

**Reference Books:**

1. James Larminie, John Lowry**," Electric Vehicle Technology Explained",** Wiley, 2003


ESTD : 1946

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

for the students of:

B.E. VI Semester

Scheme: 2022

Academic Year: 2025-26

**Code: BCS654E** **Course: Introduction to Data Science**

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

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

**SEE Hours:3** **Max.Marks:50**

| | |
|---|---|
| Prerequisites if any | Linear Algebra, Probability and Statistics |
| Learning objectives | 1. To understand the significance of Data Science in Industry and Academia.<br>2. Learn basics of R language |

**Course Outcomes:**

*On the successful completion of the course, the student twill be able to*

| **COs** | **Course Outcomes** | **Bloom's level** |
|---|---|---|
| CO1 | Describe the importance of Data Science and learn Statistical modeling, probability distributions, fitting a model, Overfitting | Understanding |
| CO2 | Demonstrate EDA and illustrate few machine learning algorithms and implement using R language. | Apply |
| CO3 | Apply Bayesian law and Use Machine learning algorithms as spam filters | Apply |
| CO4 | Explore Feature Generation, Feature Selection, recommended system and Data engineering. | Apply |

**Mapping with POs and PSOs**:

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | - | - | - | - | - | 2 | - | - | 3 | | - | - |
| CO2 | 2 | 2 | 2 | - | 2 | - | - | - | 2 | - | 2 | 3 | | 2 | 2 |
| CO3 | 2 | 3 | 2 | - | 2 | - | - | - | 2 | - | 2 | 3 | | 2 | 2 |
| C04 | 3 | 2 | - | - | 3 | 2 | - | - | 2 | - | 2 | 3 | | 2 | 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: Introduction** | | | |
| 1.1 | **Introduction**: What is Data Science? | 1 | - | - |
| 1.2 | Big Data and Data Science hype –and getting past the hype, | 1 | - | - |
| 1.3 | Why now?–Data fiction, Current land scape of perspectives, A Data Science Profile, Thought Experiment: Meta-Definition, OK, So What Is a Data Scientist, Really? | 1 | - | - |
| 1.4 | Needed Statistical Inference: Statistical Thinking in the Age of Big Data, Statistical Inference, Populations and samples, Populations and Samples of Big Data, Big Data Can Mean Big Assumptions | 1 | - | - |
| 1.5 | Modeling: What is a model? Statistical modeling, Probability distributions, Fitting a model, Overfitting | 2 | - | - |
| 1.6 | R Programs for the algorithms | 1 | - | - |
| | **Module–2:Exploratory Data Analysis and Data Science Process** | | | |
| 2.1 | **Exploratory Data Analysis and the Data Science Process:** Basic tools(plots, graphs and summary statistics) of EDA | 1 | - | - |
| 2.2 | Philosophy of EDA | 1 | - | - |
| 2.3 | The Data Science Process, A Data Scientist's Role in This Process | 1 | - | - |
| 2.4 | Algorithms: Machine Learning Algorithms, Three Basic Algorithms: Linear Regression | 2 | - | - |
| 2.5 | k-Nearest Neighbors( kNN) | 1 | - | - |
| 2.6 | k-means Clustering | 1 | - | - |
| 2.7 | Comparison of these three algorithms | 1 | - | - |
| | **Module–3:MachineLearning Algorithm and Usage in Applications** | | | |
| 3.1 | **Machine Learning Algorithm and Usage in Applications:** Spam Filter, Linear Regression and Spam Filter, Filtering Spam, | 1 | - | - |
| 3.2 | K-NN and spam Filter | 2 | - | - |
| 3.3 | Naïve Bayes Algorithm, Spam Filter using Naïve Bayes , Laplace Smoothing, Comparing Naïve Bayes to K-NN Motivating application. | 3 | - | - |
| 3.4 | Data Wrangling: APIs and other tools for scrapping the Web | 2 | - | - |
| 3.5 | introduction to Logical Regression and M6D case study | 1 | | |
| | **Module -4 : Extracting Meaning from Data** | | | |
| 4.1 | **Extracting Meaning from Data:**T heKaggle Model | 1 | - | - |
| 4.2 | Example: User(customer) retention. | 1 | - | - |
| 4.3 | Feature Generation( brain storming, role of domain expertise, and place for imagination) | 1 | - | - |
| 4.4 | Feature Selection algorithms: Filters; Wrappers | 1 | - | - |
| 4.5 | Decision Trees; | 1 | - | - |
| 4.6 | Random Forests | 1 | - | - |

| | | | | |
|---|---|---|---|---|
| | **Module -5: Recommended system and Data Engineering** | | | |
| 5.1 | Recommendation Systems: A Real-World Recommendation Engine, Some Problems with Nearest Neighbors | 1 | | |
| 5.2 | Beyond Nearest Neighbor: Machine Learning Classification | 1 | | |
| 5.3 | The Dimensionality Problem | 1 | | |
| 5.4 | Singular Value Decomposition. | 1 | | |
| 5.5 | Data Engineering, Map reduce, , | 1 | | |
| 5.6 | Word Frequency Problem | 1 | | |
| 5.7 | Map Reduce Solution | | | |
| 5.8 | Other Examples of Map Reduce, Pregel-An Introduction. | 1 | | |
| 5.9 | Data Visualization: Basic principles. | 1 | | |
| 5.10 | Ideas and tools for data visualization. | 1 | | |
| | ***Total No. of Lecture Hours*** | **40** | | |
| | ***Total No. of Tutorial Hours*** | | **00** | |
| | ***Total No. of Practical Hours*** | | | **00** |

**Text book:**

1. Doing Data Science, Cathy O'Neil and Rachel Schutt, Straight Talk from The Frontline O'Reilly, 2014

**Reference books:**

1. Data Mining: Concepts and Techniques Jiawei Han, Micheline Kamber and Jian Pei Morgan Kauffman, Third Edition, 2012
2. Mining of Massive DatasetsV2.1 Jure Leskovek, AnandRajaraman and Jeffrey Ullman, Cambridge University Press, 2nd Edition, 2014

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc21_cs69
2. https://www.coursera.org/programs/projects/getting-started-with-kaggle?
3. https://www.coursera.org/learn/r-programming?

**Code:BCS654F** **Course: Introduction to Blockchain Technology**

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

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

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

| | |
|---|---|
| **Prerequisites if any** | Computer networks, Cryptography |
| **Learning objectives** | • Impart strong technical understanding of Blockchain technologies.<br>• Develop familiarity of current technologies<br>• Introduce application areas and current practices |

**Course Outcomes:**

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

| Cos | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Describe the operational aspects of the Blockchain ecosystem | Understand |
| CO2 | Identify the cryptographic primitives behind Blockchain | Apply |
| CO3 | Compare the consensus algorithm used in Blockchain technology | Understand |
| CO4 | Discuss the functional aspects of Bitcoin network, Ethereum and SMART Contract | Understand |

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 3 | 2 | - | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 2 |
| CO 2 | 3 | 2 | - | 2 | 2 | 1 | - | - | - | - | - | - | 2 | 2 |
| CO 3 | 3 | 2 | - | 2 | 2 | - | - | - | - | - | - | - | 2 | 2 |
| CO 4 | 3 | 2 | - | 2 | 3 | - | - | - | - | - | - | - | 2 | 2 |

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

## Course Structures

| Sl. No. | Module Name | No. of Lecture Hours | No. of Tutorial Hours | No. of Practical Hours |
|---|---|---|---|---|
| **Module – 1: Introduction t**o Blockchain | | | | |
| 1.1 | History of Bitcoin and Blockchain | 2 | - | - |
| 1.2 | Digital Ledger Technology (DLT), Peer-to-Peer (P2P) Network, | 1 | - | - |
| 1.3 | Centralized, Decentralized and Distributed Networks | 2 | | |
| 1.4 | Public Blockchain, Private Blockchain. | 1 | | |
| 1.5 | Applications of Blockchain | 2 | | |
| | **Module – 2: Decentralized System & Hash Functions** | | | |
| 2.1 | Cryptographic Hash Functions | 1 | | |
| 2.2 | Cryptographic Nonce | 1 | | |
| **2.3** | Transactions, Asymmetric Key Cryptography | 1 | | |
| 2.4 | Address and Address Derivation – Private Key Storage, Ledgers | 1 | | |
| 2.5 | Blocks, Chaining Blocks | 1 | | |
| 2.6 | Zero Knowledge System | 1 | | |
| 2.7 | Attacks – 51% attack, Sybill attack. | 1 | | |
| 2.6 | Different types of SHA , SHA-256 | 2 | | |
| | **Module-3: Consensus algorithm** | | | |
| 3.1 | Proof of Work Consensus Algorithm | 1 | | |
| 3.2 | Proof of Stake Consensus Algorithm, Delegated Proof of Stake (DPoS) | 2 | | |
| 3.3 | Proof of Burn, Practical Byzantine Fault tolerance | 2 | | |
| 3.4 | Proof of elapsed time | 1 | | |
| | **Module – 4: Blockchain Mining and Forking** | | | |
| 4.1 | Permission Blockchain, Permissionless Blockchain, | 1 | | |
| 4.2 | Forking – Soft forking, Hard Forking | 2 | | |
| 4.3 | Cryptographic changes forking, Merkle Tree | 1 | | |
| 4.4 | Bitcoin Mining, Mining Incentives Strategies. | 2 | | |
| 4.5 | Bitcoin Cryptocurrencies - Double Spending problem and its avoidance in Blockchain | 1 | | |

| | Module-5: Blockchain platforms | | | |
|---|---|---|---|---|
| 5.1 | Ethereum Platform | 1 | | |
| 5.2 | Transactions in Ethereum – Ether wallet, Ether Accounts | 1 | | |
| 5.3 | Ether Gas, Gas Price, Gas Limit, Ether Tokens | 1 | | |
| 5.4 | ERC20 Ethereum stands for Tokens | 1 | | |
| 5.5 | Mining in Ethereum and Awards | 1 | | |
| 5.6 | Smart Contract | 1 | | |
| 5.7 | Hyperledger Platform –Hyperledger Fabric Architecture, Membership services, Blockchain services | 2 | | |
| | **Total hours** | **40** | **0** | **0** |

**TEXT B0OK**

1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, “Bitcoin and Crypto currency Technologies: A Comprehensive Introduction”, Princeton University Press, Edition illustrated, 2016

2. Imran Bashir, “Mastering Blockchain: Distributed ledgers, Decentralization and Smart Contracts explained”. PACKT PUBLICATION, 2nd edition, 2018

**REFERENCE BOOKS**

1. Malcolm Campbell-Verduyn, “Bitcoin and Beyond Crypto currencies, Blockchains,
And Global Governance”, publisher Routledge; 1st edition 2017.
2. Kumar Saurabh, Ashutosh Saxena ,Blockchain Technology: Concepts and Applications Kindle Edition, Wiley , 2020
3. Daniel Lincoln, “Blockchain Evolution Explained: A Beginners Guide to Understanding Blockchain Technology”, Kindle Edition.
4. Andreas M. Antonopoulos , David A. Harding, “ Mastering Bitcoin: programming the open Blockchain”, O’Reilly publication, third edition.
5. Andreas M. Antonopoulos , Gavin Wood , “Mastering Ethereum: Building Smart Contracts and DApps” , O’Reilly publication, 1st Edition,


ESTD : 1946

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

B.E. VI Semester

Scheme: 2022

Academic Year: 2025-26

**Code: BCl654D** **Course: Introduction to AI**

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

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

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

| | |
|---|---|
| **Prerequisites if any** | Probability , Statistics and Linear Algebra |
| **Learning objectives** | To gain insights on different concepts and methods used in Artificial intelligence to solve real world problems. |

**Course Outcomes:**

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

| **COs** | **Course Outcomes** | **Bloom's level** |
|---|---|---|
| CO1 | Explain Artificial Intelligence concepts and methods. | Understand |
| CO2 | Use knowledge representation to solve real world problems | Apply |
| CO3 | Use neural networks to solve real world problems | Apply |
| CO4 | Solve problems using classification and clustering techniques. | Apply |

**Mapping with POs and PSOs**:

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

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

## Course Structure

| Sl. No. | Module Name | No. of Lecture Hours | No. of Tutorial Hours | No. of Practical Hours |
|---|---|---|---|---|
| | **Module – 1: Introduction** | | | |
| 1.1 | Introduction | 1 | | |
| 1.2 | Characteristics | 1 | | |
| 1.3 | Exhaustive Searches | 1 | | |
| 1.4 | Heuristic Search Techniques | 1 | | |
| 1.5 | Interative Deepening | 1 | | |
| 1.6 | Constant satisfaction | 1 | | |
| 1.7 | General problem solving | 1 | | |
| | **Module – 2: Problem reduction and Logic concepts** | | | |
| 2.1 | Bounded look ahead strategy | 1 | | |
| 2.2 | Alpha-Beta Pruning | 1 | | |
| 2.3 | Propositional calculus | 1 | | |
| 2.4 | Propositional logic | 1 | | |
| 2.5 | Natural Deduction system | 1 | | |
| 2.6 | Axiomatic system | 1 | | |
| 2.7 | Semantic tableau system in propositional logic | 1 | | |
| 2.8 | resolution refutation in propositional logic and Predicate logic | 2 | | |
| | **Module – 3: Advanced problem-solving paradigm** | | | |
| 3.1 | Planning- types of planning systems | 2 | | |
| 3.2 | Linear planning using a goal stack | 1 | | |
| 3.3 | Non –linear planning strategies | 1 | | |
| 3.4 | Means-ends analysis | 1 | | |
| 3.5 | Knowledge representation using semantic network | 1 | | |
| 3.6 | Extended semantic networks for KR | 1 | | |
| 3.7 | Knowledge representation using frames | 1 | | |

| | | | | |
|---|---|---|---|---|
| **Module – 4: Uncertainty Measure** | | | | |
| 4.1 | Probability Theory | 2 | | |
| 4.2 | Bayesian Belief Networks | 3 | | |
| 4.3 | Machine Learning Paradigms | 3 | | |
| **Module – 5: Support vector Machine, case-based reasoning and learning ANN** | | | | |
| 5.1 | Single Layer and Multilayer | 1 | | |
| 5.2 | RBF | 1 | | |
| 5.3 | Design issues in ANN | 1 | | |
| 5.4 | Recurrent Network | 1 | | |
| 5.5 | Deductive learning, | 2 | | |
| 5.6 | Clustering | 2 | | |
| | ***Total No. of Lecture Hours*** | **40** | | |
| | ***Total No. of Tutorial Hours*** | | **00** | |
| | ***Total No. of Practical Hours*** | | | **00** |

**Textbook:**

1. Artificial Intelligence, Saroj Kaushik Cengage Learning 2014 Editio

**Reference Book:**

1. Artificial Intelligence: Structures and Strategies for Complex Problem Solving, George F Luger Pearson Addison Wesley 6 th Ed, 2008.
2. Artificial Intelligence, E Rich, K Knight, and S B Nair Tata Mc-Graw Hill 3rd Ed, 2009.
3. Artificial Intelligence: A Modern Approach, Stuart Russell and Peter Norvig Prentice Hall 3rd, 2009


ESTD : 1946

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

for the students of:

B.E. VI Semester

Scheme: 2022

Academic Year: 2025-26

**Course Code: BIS654B**
**Credits:** 3
**CIE:** 50 Marks
SEE Hours: 3

**Course:** Fundamentals of Operating Systems
**L: T:P3:0:0**
**SEE:** 50 Marks
Max. Marks: 100

| | |
|---|---|
| Prerequisites if any | Nil |
| Learning objectives | 1. Understand the services provided by and the operating system<br>2. Discuss suitable techniques for management of different resources by the operating system |

**Course Outcomes:**

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

| Cos | Course Outcomes | Bloom's Level |
|---|---|---|
| CO1 | Explain the structure and functionality of the operating system. | L2 |
| CO2 | Analyse the basics of the operating systems, mechanisms of OS to handle processes, threads, and Inter process communication. | L3 |
| CO3 | Illustrate different conditions for deadlock and their possiblesolutions. | L2 |
| CO4 | Analyze the memory management and its allocation policies. | L3 |
| CO5 | Discuss the storage management policies with respect todifferent storage management technologies. | L2 |

**Mapping with POs and PSOs**:

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

3 – Strong 2 – Medium 1 – Low

## Course Structure

| | Module – 1 | No. of Lecture Hours | No. of Tutorial Hours | Self-Learning Hours |
|---|---|---|---|---|
| 1.1 | Introduction to operating systems, System structures: What operatingsystems do; Computer System organization; Operating System structure;Operating System operations; | 2 | - | - |
| 1.2 | Process management; Memory management; Storage management;Protection and Security; Operating System Services; | 2 | - | - |
| 1.3 | User – OperatingSystem interface;System calls; Types of system calls; | 2 | - | - |
| 1.4 | Operating System structure; Virtual machines; Operating Systemgeneration; System boot. | 2 | - | - |
| | **Module – 2** | | | |
| 2.1 | Process Management: Process concept; Process scheduling; Operations on processes. | 2 | - | - |
| 2.2 | Multi-threaded Programming: Overview; Multithreading models;Thread Libraries; Threading issues | 2 | - | - |
| 2.3 | Process Scheduling: Basic concepts; Scheduling Criteria; | 1 | - | - |
| 2.4 | Scheduling Algorithms; | 2 | - | - |
| 2.5 | Thread scheduling;Multiple-processor scheduling. | 1 | - | - |
| | **Module – 3** | | | |
| 3.1 | Process Synchronization: Synchronization: The critical section problem; Semaphores; | 2 | - | - |
| 3.2 | Peterson's solution; Synchronization hardware | 2 | - | - |
| 3.3 | Classical problems of synchronization; | 1 | - | - |
| 3.4 | Deadlocks: System model; Deadlock characterization; Methods for handling deadlocks; Deadlock prevention; | 1 | - | - |
| 3.5 | Deadlock avoidance; Deadlock detection and recovery from deadlock. | 2 | - | - |
| | **Module – 4** | | | |
| 4.1 | Memory Management: Memory management strategies: Background; Swapping. | 2 | - | - |
| 4.2 | Contiguous memoryallocation; Paging; Structure of page table; Segmentation. | 2 | - | - |
| 4.3 | Virtual Memory Management: Background; Demand paging; Copy-on-write; | 2 | - | - |
| 4.4 | Page replacement;Allocation of frames; Thrashing. | 2 | - | - |

| Module – 5 | | | | |
|---|---|---|---|---|
| 5.1 | File system: File concept; Access methods; | 2 | | - |
| 5.2 | File-System Operations; Directory implementation; Allocation methods; | 2 | | - |
| 5.3 | Free space management-Bit Vector;Linked List; Grouping;Counting | 1 | | - |
| 5.4 | Disk structure; Disk attachment; | 2 | | - |
| 5.5 | Disk scheduling-FCFS Scheduling;SCAN Scheduling;C-SCAN Scheduling; | 1 | | - |
| | *Total No. of Lecture Hours* | 40 | | |
| | *Total No. of Tutorial Hours* | | - | - |

**Textbooks:**

1. Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Principles 10th edition,Wiley-India, 2018

**Reference Books:**

1. McHoes and I. M. Flynn, Understanding Operating Systems, 8th ed. Boston, MA: Cengage Learning, 2018.
2. D. M. Dhamdhere, Operating Systems: A Concept-Based Approach, 3rd ed. New York, NY: McGraw-Hill, 2017.
3. P. C. P. Bhatt, An Introduction to Operating Systems: Concepts and Practice, 4th ed. New Delhi, India: PHI Learning, 2014.
4. W. Stallings, *Operating Systems: Internals and Design Principles*, 9th ed. Hoboken, NJ: Pearson, 2018.

**Online Resources:**

1. Introduction to Operating Systems by NPTEL
   https://www.youtube.com/watch?v=783KABtuE4&list=PLIemF3uozcAKTgsCIj82voMK3TMR0YE_f
2. Operating Systems IIT Delhi
   https://www.youtube.com/watch?v=3-ITLMMeeXY&list=PL3pGy4HtqwD0n7bQfHjPnsWzkeRn6mkO
3. Introduction to Operating Systems
   https://youtu.be/vBURTt97EkA
4. For Operating System ebooks
   https://codex.cs.yale.edu/avi/os-book/


ESTD : 1946

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

for the students of:

B.E. VI Semester

Scheme: 2022

Academic Year: 2025-26

## Open Elective for VI Semester Students

### Department – Physics

**Code: BPH654A**
**Credits: 3**
**SEE: 50 Marks**
**SEE Hours: 3**

**Course: Materials for Engineering Applications-1**
**L:T:P:S 3:0:0:0**
**CIE: 50 Marks**
**Max. Marks: 100**

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

| **Course Objectives** | 1. To realize the impact of the development of engineering materials on human civilization.<br>2. To enable students to establish a broad knowledge based on the structure and properties of materials for solving engineering problems.<br>3. To give an insight into complete systems where advanced materials can be used to improve our everyday life.<br>4. To enable students to understand the applications and selection of engineering materials based on the consideration of properties, cost, ease of manufacture, environmental issues. |
|---|---|

**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: Introduction to Materials Science |
| --- |
| The introduction to Materials Science and how it has evolved over the years, Structure – Density Computations, Classification of Materials - Different types of materials like ceramics, composites, polymers, and metals are explained along with their physical, chemical, electronic properties, and their applications, Importance of material science and engineering. |
| **Module 2: Advanced Materials** |
| Smart materials, materials exhibiting ferroelectric, piezoelectric, opto-electric, photoconductivity, super alloys, shape memory alloys. Super conducting materials: an account of mechanism of superconductors, penetration depth, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, superconductor motors, generators, SQUIDS etc. |
| **Module 3: Optical Materials** |
| Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, laser materials and applications. |
| **Module 4: Polymers & Biomaterials** |
| An introduction to biomaterials, Historical developments in polymeric biomaterials, Natural polymers, Raw material for synthetic polymers and their industrial applications, Biomaterials and biomedical applications. |
| **Module 5: Materials for Renewable Energy** |
| Materials in Fuel cells and Solar Cells: Electrocatalyst materials for low temperature fuel cells, Conductive membranes for low-temperature fuel cells, Materials for high temperature fuel cells, silicon, quantum dots for solar energy, nanomaterials for solar thermal energy.<br><br>Materials in Thermal Power Generation: Superalloys, steels, ceramics, TBC, hydrogen membrane materials, biomass, coal, fly ash, etc, Materials in Hydro Power Generation. |

**Suggested Learning Resources:**

**Text Books:**


1. Balasubramaniam R. (2014). Callister's Materials Science and Engineering, 2nd Ed., Wiley India Pvt.
   Ltd., New Delhi.
2. Raghavan V (2015). Materials Science and Engineering, 6th Ed., PHI Learning Pvt. Ltd., New Delhi.


**Reference Books:**


1. Van Vlack L. H. (1989). Elements of Material Science & Engineering, 6th Ed., Addison Wesley Publishing Co., New York.
2. Bhargava A.K. (2005). Engineering Materials, Prentice-Hall of India Pvt. Ltd.
3. Huda Z. and Bulpett R. (2012). Materials Science and Design for Engineers. Trans Tech Publications
   Limited, Switzerland.
4. Fundamentals of Materials Science and Engineering – An Integrated Approach, William D Callister Jr., David G Rethwisch, Wiley; 10th edition (20 January 2020)
5. Materials Characterization Techniques-Sam Zhang, Lin Li, Ashok Kumar, CRC Press, First Edition, 2008.
6. Handbook of Fuel Cells by Wolf Vielstich, Arnold Lamm, Hubert A. Gasteiger, and Harumi Yokokawa, John Wiley and Sons, Inc.
7. Structural Materials in Nuclear Power Systems by J. T. A. Roberts, Plenum Press.


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**Open Elective for VI Semester Students**

| | |
|---|---|
| **Code: BPH654B** | **Course: Quantum Computing** |
| **Credits: 3** | **L:T:P:S 3:0:0:0** |
| **SEE: 50 Marks** | **CIE: 50 Marks** |
| **SEE Hours: 3** | **Max. Marks: 100** |

**Course Objectives**

1. Learn about quantum teleportation, quantum computing, quantum error correction.
2. Explain the modern mathematical apparatus of quantum logic alogarithms and protocols for transmitting and processing quantum information and learn how to solve problems on these topics.
3. To apply quantum theory to describe concepts in quantum computing.

**Mapping with POs and PSOs**:

| COs | POs | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| CO1 | 3 | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | |
| CO3 | 3 | 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: Statistical aspects of quantum mechanics(**08 **hours of pedagogy)** |
|---|
| Qubit, Physical implementations of qubit, Qubit as a quantum unit of information. The Bloch sphere, Pure and mixed states of quantum systems, Density matrix and its properties, Qubit systems. Inseparability of quantum systems, Reduced density matrix. |
| **Module 2: Quantum mechanics(**08 **hours of pedagogy)** |
| Basics of quantum mechanics, modern look at quantum mechanics, basics of NMR, concepts in NMR quantum computing. Quantum mechanics and computers, measurements : single vs ensemble averaged, working of quantum computers: NMR QC, Academic development in quantum computing, |

| |
|---|
| commerical development in quantum computing implementation, use of atomic qubits in quantum computing, futuristic aspects in implementing auentum computing. |
| **Module 3: Quantum gates and algorithms (08 hours of pedagogy)** |
| Universal set of gates, quantum circuits, Solovay-Kitaev theorem, Deutsch-Jozsa algorithm, period-finding, factoring, Shor's algorithm, quantum search, Abelian quantum hidden subgroup problem. Optical implentation 'Linear Approach', Various apects of linear optical quantum computing, laser experimental implementation for Grover's algorithm, Optical implementation, Basics of ion traps, applications of ion traps in "QIQC". |
| **Module 4: Quantum correlations and entanglement (08 hours of pedagogy)** |
| Bell inequalities and entanglement, Schmidt decomposition, super-dense coding, teleportation, Peres-Horodecki criterion(PPT criterion). Shannon entropy, noiseless coding theorem, von Neumann entropy and properties, Schumacher compression, noisy-coding theorem. |
| **Module 5: Quantum cryptography, Quantum noise and error-correction (08 hours of pedagogy)** |
| Quantum key distribution, entropic uncertainty relations, Distance measures, Knill-Laflamme conditions, quantum error-correcting codes, Hamming bound. |

**Suggested Learning Resources:**

**Reference Books**


1. Michael A. Nielsen and Issac L. Chuang, "Quantum Computation and Information", Cambridge (2002).
2. Riley Tipton Perry, "Quantum Computing from the Ground Up", World Scientific Publishing Ltd (2012).
3. Scott Aaronson, "Quantum Computing since Democritus", Cambridge (2013).
4. P. Kok, B. Lovett, "Introduction to Optical Quantum Information Processing", Cambridge (2010).
5. Noson S. Yanofsky, Mirco A. Mannucci, "Quantum computing for computer scientists",Cambridge University Press 2008.
6. Peres, Asher. "Quantum Theory: Concepts and Methods". New York, NY: Springer, 1993.


ESTD : 1946

# Blownup Syllabus of Open Elective Courses Offered by the **Department of Mathematics** for the students of:

B.E. VI Semester

Scheme: 2022

Academic Year: 2025-26

## OPEN ELECTIVES FOR VI SEMESTER

## [CSE stream]

**Course Code: BMA654A** **Course: Finite fields and their Applications**
**Credits: 3** **L:T:P:S 3:0:0**
**SEE: 100 Marks** **CIE: 50 Marks**
**SEE Hours: 3 Hrs** **Max. Marks: 100**

| | |
|---|---|
| Prerequisites if any | Elementary Number Theory and Group Theory |
| Learning objectives | Students will have the knowledge and skills to:<br>**1.** Solve problems in elementary number theory.<br>**2.** Apply elementary number theory to cryptography.<br>**3.** Develop a deeper conceptual understanding of the theoretical basis of number theory and cryptography. |

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

| COs | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Discuss the structure of finite fields and subfields | Understand |
| CO2 | Successfully factorize polynomials over a finite field | Understand |
| CO3 | Understand basic problems involved with cryptography and cryptographic schemes | 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 | - | - | - | - | - | - | - | - | - | 1 | | - | - | - | - |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | | - | - | - | - |
| CO3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | | - | - | - | - |

**Strong: 3** **Medium: 2** **Low: 1**

### Course Content

| | Module – 1 | No. of Lecture Hours | No. of Tutorial Hours | Self-Learning Hours |
|---|---|---|---|---|
| 1.1 | Groups, Rings, Fields: Definitions, Examples, problems | 4 | - | - |
| 1.2 | Finite fields, Classification of finite fields, Structure of finite fields-problems | 2 | - | - |
| 1.3 | Subfields of a finite field-examples and problems | 2 | - | - |
| | **Module – 2** | | - | - |
| 2.1 | Elementary number theory and applications to factoring-problems | 2 | - | - |
| 2.2 | Quadratic residues and reciprocity -problems | 2 | - | - |
| 2.3 | Some simple cryptosystems-examples and problems | 3 | - | - |
| | **Module – 3** | | - | - |
| 3.1 | Factorization over small finite fields | 2 | - | - |
| 3.2 | Factorization over large finite fields | 3 | - | - |
| 3.3 | Calculation of roots of polynomials over a finite field | 3 | - | - |
| | **Module – 4** | | - | - |
| 4.1 | Enciphering matrices-problems | 3 | - | - |
| 4.2 | The idea of public key cryptography, RSA | 3 | - | - |
| 4.3 | Discrete log and the digital signature | 2 | - | - |
| | **Module – 5** | | - | - |
| 5.1 | Psuedo primes, The rho method-problems | 2 | - | - |
| 5.2 | Fermat factorization and factor bases-problems | 2 | - | - |
| 5.3 | The continued fraction method-problems | 2 | - | - |
| 5.4 | The quadratic sieve method-problems | 2 | - | - |
| | ***Total No. of Lecture Hours*** | 40 | - | - |
| | ***Total No. of Tutorial Hours*** | | - | - |
| | ***Total No. of Self learning Hours*** | | | - |

**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 | | https://youtu.be/nHEWg2641Ig?feature=shared | - | Smart board, Moodle | - | Group Discussion & Presentation |
| 1.2 | 1 | | | - | | - | |
| 1.3 | 1 | | | - | | - | |
| 2.1 | 2 | | | - | | - | |
| 2.2 | 2 | | | - | | - | |
| 2.3 | 2 | | | - | | - | |
| 3.1 | 2 | | | - | | - | |
| 3.2 | 2 | | | - | | - | |
| 3.3 | 2 | | | - | | - | |
| 4.1 | 3 | | | - | | - | |
| 4.2 | 3 | | | - | | - | |
| 4.3 | 3 | | | - | | - | |
| 5.1 | 3 | | | - | | - | |
| 5.2 | 3 | | | - | | - | |
| 5.3 | 3 | | | - | | - | |
| 5.4 | 3 | | | - | | - | |

**Assessment Pattern:**

| Bloom's level | Continuous Internal Examination | | | End Semester Examination |
|---|---|---|---|---|
| | Test 1 | Test 2 | Assignment/Quiz/AAT | |
| Remember | ✓ | ✓ | ✓ | ✓ |
| Understand | ✓ | ✓ | ✓ | ✓ |
| Apply | ✓ | ✓ | | ✓ |
| Analyze | ✓ | ✓ | | ✓ |
| Evaluate | ✓ | ✓ | | ✓ |
| Create | | | | |

**Self-learning topics identified:**

1. Cyclic groups and its properties

2. Division Algorithms

3. Integral domains

4. Encyption and Decryption-Caesar Cipher

5. Fermat's and Wilson's theorem

**Textbooks:**

1. Neal Koblitz, A course in number theory and cryptography, Second edition, Springer-Verlag
2. Rudolf Lidl, Harald Niederreiter, Finite fields and their applications, Cambridge University press

**References:**

1. Joseph. A. Gallian, Contemporary Abstract Algebra, Eighth edition, Cengage Learning
**2.** David M Burton, Elementary Number Theory, Sixth edition, Mc Graw Hi

## OPEN ELECTIVES FOR VI SEMESTER

## [ECE stream]

**Course Code: BMA654B**
**Credits: 3**
**SEE: 100 Marks**
**SEE Hours: 3 Hrs**

**Course: Complex Analysis**
**L:T:P:S 3:0:0**
**CIE: 50 Marks**
**Max. Marks: 100**

| | |
|---|---|
| Prerequisites if any | Basic knowledge of Calculus and Trigonometry |
| Learning objectives | **1.** To study the functions of complex variables together with their derivatives, transformations and also Contour Integration.<br>**2.** To understand the complex power series expansions, Classification of singularities, calculus of residues and its applications to evaluate integrals. |

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

| COs | Course Outcomes | Bloom's level |
|---|---|---|
| CO1 | Understand the concepts of Complex variables, analytic functions and apply these Concepts in construction of analytic functions. | Apply |
| CO2 | Evaluate complex line integrals using contour integration via residue calculus. | Apply |
| CO3 | Discuss transformations and their applications in diverse situations of engineering and Other mathematical contexts. | 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 | - | - | - | - | - | - | - | - | - | 1 | | - | - | - | - |
| CO2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | | - | - | - | - |
| CO3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | | - | - | - | - |

**Strong: 3** **Medium: 2** **Low: 1**

**Course Content**

| | Module – 1 | No. of Lecture Hours | No. of Tutorial Hours | Self-Learning Hours |
|---|---|---|---|---|
| 1.1 | Basic concepts of complex numbers | 1 | - | - |
| 1.2 | Function of a complex variable- Limit, Continuity--problems | 2 | - | - |
| 1.3 | Differentiability-simple problems | 1 | - | - |
| 1.4 | Cauchy-Riemann equations in Cartesian and polar forms, | 2 | - | |
| 1.5 | harmonic functions, harmonic conjugate, properties of analytic functions-problems | 2 | - | - |
| | **Module – 2** | | | |
| 2.1 | Construction of analytic functions- problems( Cartesian form) | 2 | - | - |
| 2.2 | Applications to flow problems. | 2 | - | - |
| 2.3 | Complex line integrals, properties-problems | 2 | - | - |
| 2.4 | Cauchy's theorem and its consequences-proof and problems | 2 | - | - |
| | **Module – 3** | | | |
| 3.1 | Cauchy's integral formula-proof and problems | 1 | - | - |
| 3.2 | Generalized Cauchy's integral formula-proof and problems | 2 | - | - |
| | Expansion of analytic functions as power series: Taylor's and Laurent's series expansion, | 2 | - | - |
| 3.3 | Zeros of an analytic function, singularities, poles-types, | 1 | - | - |
| 3.4 | Maximum modulus principle, Schwarz Lemma-problems. Applications. | 2 | - | - |
| | **Module-4** | | | |
| 4.1 | Residues, Cauchy's residue theorem-proof and problems | 2 | - | - |
| 4.2 | Conformal Mapping-: definition and examples | 1 | - | - |
| 4.3 | Discussion of $W = e^z, W = z^2$- associated problems | 2 | - | - |
| 4.4 | Discussion of $W = z + (\frac{a^2}{z})$, where $z \neq 0$,-related problems. | 1 | - | - |
| 4.5 | Bilinear Transformations, cross ratio, properties and problems. Applications | 2 | - | - |
| | **Module – 5** | | | |
| 5.1 | Harmonic functions and mapping: definition and examples | 2 | - | - |
| 5.2 | Inverse mappings-problems, Schwarz's reflection principle, Analytic continuation | 2 | - | - |
| 5.3 | uniqueness of and analytic continuation, analytic continuation along a curve | 2 | - | - |
| 5.4 | power series method of analytic continuation-problems Homotopic curves | 2 | - | - |
| | ***Total No. of Lecture Hours*** | 40 | - | - |
| | ***Total No. of Tutorial Hours*** | | - | - |
| | ***Total No. of Self learning Hours*** | | | - |

**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 | | https://youtu.be/t9xW7UaZwZ0?feature=shared | - | Smart board. Moodle | - | Group Discussion & Presentation |
| 1.2 | 1 | | | - | | - | |
| 1.3 | 1 | | | - | | - | |
| 1.4 | 1 | | | - | | - | |
| 1.5 | 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 | 2 | | | - | | - | |
| 4.2 | 2 | | | - | | - | |
| 4.3 | 2 | | | - | | - | |
| 4.4 | 2 | | | - | | - | |
| 4.5 | 2 | | | - | | - | |
| 5.1 | 2 | | | - | | - | |
| 5.2 | 2 | | | - | | - | |
| 5.3 | 2 | | | - | | - | |

**Assessment Pattern:**

| Bloom's level | Continuous Internal Examination | | | End Semester Examination |
|---|---|---|---|---|
| | Test 1 | Test 2 | Assignment/Quiz/AAT | |
| Remember | ✓ | ✓ | ✓ | ✓ |
| Understand | ✓ | ✓ | ✓ | ✓ |
| Apply | ✓ | ✓ | | ✓ |
| Analyze | ✓ | ✓ | | ✓ |
| Evaluate | ✓ | ✓ | | ✓ |
| Create | | | | |

**Self-learning topics identified:**

1. nth roots of a complex number
2. Construction of analytic functions in polar form
3. Taylors series expansion of f(x,y)
4. Discussion of $w = \sin(Z)$ and $w = \cos(Z)$
5. Reflection principle

**Textbooks:**

1. Complex Analysis with Applications, Dennis G Zill and Patrick D Shanahan-Third edition.
2. S. Ponnuswamy: Foundation of Complex Analysis, Narosa Publication.

**Reference Books:**

1. Walter Ruddin, Real and Complex Analysis, McGraw-Hill International

Editions,3/e, 1987

2. Ahlfors. L. V., Complex Analysis., McGraw Hill, New York,2/e, 1983

**Online Resources:**

1. https://onlinecourses.nptel.ac.in/noc23_ma51/