Open Electives for Semester-V of B.Tech. Program

Sr. No.	Year	Sem.	Course Code	Course Name	Offering Department	Eligible Branch
1	III	V	EEUL560.2	Energy Audit and Demand Side Management	EE	CS/AI/ DS/IOT/ IT/ CE/ EC/ ME
2	III	V	CEUL560	Climate Change Science	CE	CS/AI/ DS/IOT/ IT/ EC/ EE/ ME
3	III	V	MEUL561	Fundamentals of Robotics	ME	CS/AI/ DS/IOT/ IT/ CE/ EC/ EE
4	III	V	MEUL560.2	Electric Vehicle Fundamentals	ME	CS/AI/ DS/IOT/ IT/ CE/ EC/ EE
5	III	V	ECUL560.1	Introduction to Sensors and Actuators	EC	CS/AI/ DS/IOT/ IT/ CE/ EE/ ME
6	III	V	ECUL560.2	Semiconductor Technology and Applications	EC	CS/AI/ DS/IOT/ IT/ CE/ EE/ ME
7	III	V	CSUL560.1	AI for Everyone	CS	IT/ CE/ EC/ EE/ ME

Syllabus

Name of the Programme: B.Tech.	**Year**: III	**Semester**: V
Course Name: Climate Change Science	**Course Code**: CEUL560	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction**: Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Climate System**: Importance of climate change awareness for engineers, Difference between weather and climate, Overview of global climate system. Components of climate system, atmosphere, oceans, land, ice and biosphere, Solar energy and Earth's temperature, Basic concept of greenhouse effect, Greenhouse gases and their sources.	9
3	**Causes Of Climate Change:** Natural causes of climate variability, Human activities causing climate change, Industrialization, fossil fuel use and deforestation, Global warming trends, Climate change indicators (temperature rise, glacier melting, sea level rise).	9
4	**Past And Present Climate Change:** Evidence of past climate change, Ice ages and climate cycles, Climate change in the last 100–150 years, Climate change trends in India, Role of oceans and forests in regulating climate.	9
5	**Impacts Of Climate Change:** Impacts on water resources, agriculture, ecosystems and biodiversity, Effects on human health, Extreme weather events, Impacts on infrastructure and cities, Regional impacts	8
6	**Climate Change Mitigation And Adaptation:** Renewable energy and sustainable technologies, Energy efficiency, Carbon footprint and carbon sequestration, Climate policies and international agreements (IPCC, Kyoto Protocol, Paris Agreement), Individual and societal actions for climate change mitigation.	9
	Total	**45**

Text Books:

Sn.	Title	Author(s)	Publisher	Edition
1	Global Warming Science: A Quantitative Introduction to Climate Change	Eli Tziperman	Princeton University Press	2022
2	Climate Change: The Science of Global Warming and Our Energy Future	Edmond A. Mathez	Columbia University Press	2018

Reference Books:

Sn.	Title	Author(s)	Publisher	Edition
1	Introduction to Modern Climate Change	Andrew Dessler	Cambridge University Press	2016
2	Climate Change 2021: The Physical Science Basis	IPCC	Cambridge University Press	2021
3	Global Physical Climatology	Dennis L. Hartmann	Academic Press	2015
4	Climate Change and Sustainable Development	David E. Newton	Facts on File	2017

Syllabus

Name of the Programme: B. Tech.	**Year**: III	**Semester**: V
Course Name: AI for Everyone	**Course Code**: CSUL560.1	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 Hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite.	1
2	**Introduction to Artificial Intelligence and Intelligent Agents:** Definition and scope of AI, Approaches and Types of AI. Problem solving, Examples of problems, Blind Search: Depth first search, Breadth first search, Uniform cost search; Informed search: Heuristic function, A* and AO* search	9
3	**Introduction to Machine Learning:** Types of Machine Learning, Supervised learning models– regression (Linear Regression), classification (Navie Bayes, k-Nearest Neighbors (KNN), Logistic Regression, and Decision Tree); evaluation using confusion matrices. Unsupervised learning models– clustering (K-Means). **Introduction to Deep Learning:** Single Layer Perceptron and Multi-Layer Perceptron (MLP).	9
4	**Introduction to Computer Vision:** Introduction, image representation, acquisition, preprocessing and enhancement techniques, Image segmentation and feature extraction techniques, object detection and classification using Convolutional Neural Network (CNN)	9
5	**Introduction to Natural Language Processing (NLP):** Basic concepts of NLP, tokenization, part-of-speech tagging, named entity recognition (NER), and sentiment analysis	9
6	**Applications of AI and Ethics:** Expert Systems, Robotics, Recommendation Systems. Bias and Fairness in AI Systems, Privacy and Data Protection Concerns, The Ethics and Risks of Developing AI.	8
	Total	**45**

Text Books:

1. S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 4th ed. Noida, India: Pearson Education, 2020.
2. A. Géron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2022.

Reference Books:

1. S. Goswami, A. K. Das, and A. Chakrabarti, AI for Everyone: A Beginner's Handbook for Artificial Intelligence (AI), Pearson, 2024.
2. E. Rich and K. Knight, Artificial Intelligence, 3rd ed. New Delhi, India: Tata McGraw-Hill, 2017.
3. D. Khemani, A First Course in Artificial Intelligence, 1st ed. New Delhi, India: McGraw-Hill Education, 2013.

Prerequisite:

Basic knowledge of programming, mathematics (logic and statistics), and computer fundamentals is required.

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Syllabus

Name of the Programme: B. Tech.	**Year**: III	**Semester**: V
Course Name: Energy Audit & Demand Side Management	**Course Code**: EEUL560.2	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**INTRODUCTION:** Objective, scope and outcome of the course.	1
2	**Energy Scenarios:** Energy Conservation, Energy Audit, Energy Scenarios, Energy Consumption, Energy Security, Energy Strategy, Clean Development Mechanism. **Types of Energy Audits and Energy-Audit Methodology:** Definition of Energy Audit, Place of Audit, Energy – Audit Methodology, Financial Analysis, Sensitivity Analysis, Project Financing Options, Energy Monitoring and Training.	8
3	**Survey Instrumentation:** Electrical Measurement, Thermal Measurement, Light Measurement, Speed Measurement, Data Logger and Data – Acquisition System, Thermal Basis. **Electrical-Load Management:** Electrical Basics, Electrical Load Management, Variable- Frequency Drives, Harmonics and its Effects, Electricity Tariff, Power Factor, Transmission and Distribution Losses. **Energy Audit of Motors:** Classification of Motors, Parameters related to Motors, Efficiency of a Motor, Energy Conservation in Motors, BEE Star Rating and Labelling	10
4	**Energy Audit of Lighting Systems:** Fundamentals of Lighting, Different Lighting Systems, Ballasts, Fixtures (Luminaries), Reflectors, Lenses and Louvres, Lighting Control Systems, Lighting System Audit, Energy Saving Opportunities. **Energy Audit Applied to Buildings:** Energy Saving Measures in New Buildings, Water Audit, Method of Audit, General Energy Savings Tips Applicable to New as well as Existing Buildings.	9
5	**Demand side Management:** Scope of DSM, Evolution of DSM concept, DSM planning and Implementation, Load management as a DSM strategy, Applications of Load Control, End use energy conservation, Tariff options for DSM, customer acceptance, implementation issues, Implementation strategies, DSM and Environment.	8
6	**Energy Conservation:** Motivation of energy conservation, Principles of Energy conservation, Energy conservation planning, Energy conservation in industries, EC in SSI, EC in electrical generation, transmission and distribution, EC in household and commercial sectors, EC in transport, EC in agriculture, EC legislation.	9
	Total	45

Textbooks:

1. Handbook on Energy Audit, Sonal Desai, 2nd Edition (2019), McGraw Hill Education.
2. Energy Management and Conservation, Amit Kumar Tyagi, 2nd Edition (2018), CRC Press / Taylor & Francis.
3. Energy Conversion Systems, Rakosh Das Begamudre, 2nd Edition (2018), New Age International Publishers.
4. Energy Economics: Concepts, Issues, Markets and Governance, Subhes C. Bhattacharyya, 2nd Edition (2019), Springer.
5. Energy Efficiency and Management in Industry, Mohan Munasinghe and Wilfrido Castillo, 1st Edition (2018), Elsevier.
6. Electrical Energy Utilization and Conservation, C. L. Wadhwa, 3rd Edition (2016), New Age International Publishers.

Reference Books:

1. Energy Auditing and Management, Y. P. Abbi and Shashank Jain, 2nd Edition (2021), CRC Press.
2. Handbook of Energy Audits, Albert Thumann, William J. Younger, Terry Niehus, 10th Edition (2020), CRC Press.
3. Guide to Energy Management, Barney L. Capehart, Wayne C. Turner, William J. Kennedy, 8th Edition (2020), Fairmont Press.
4. Energy Management Systems: ISO 50001 and Beyond, Giovanni Petrecca, 1st Edition (2014), Springer.
5. Industrial Energy Management, K. C. Arora and S. Domkundwar, 2nd Edition (2017), Khanna Publishers.
6. Sustainable Energy Systems Engineering, Francis Vanek and Louis Albright, 2nd Edition (2016), McGraw Hill Education.

Prerequisite:

1. Basic understanding of electrical and mechanical systems.
2. Knowledge of electrical circuits, power systems, and energy generation.
3. Familiarity with measurements and instrumentation.
4. Awareness of industrial processes and building energy usage.
5. Fundamental knowledge of mathematics for energy analysis and financial calculations

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Syllabus

Name of the Programme: B.Tech	**Year**: III	**Semester**: V
Course Name: Fundamentals of Robotics	**Course Code**: MEUL560.1	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite.	1
2	**Introduction to robotics :** Brief History, Basic Concepts of Robotics such as Definition , Three laws, Elements of Robotic Systems i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc., Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.	10
3	**Grippers and Sensors for Robotics:** Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system. **Sensors for Robots -** Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision system in the working and control of a robot.	10
4	**Drives and Control for Robotics:** Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control	8
5	**Programming and Languages for Robotics:** Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to languages such as Python and ROS etc.	8
6	**Related Topics in Robotics:** Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.	8
	TOTAL	**45**

Text Books:

1. S. K. Saha, Introduction to Robotics 3e, TATA McGraw Hills Education (2024)
2. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)

Reference Books:

1. S. B. Niku, Introduction to Robotics – Analysis, Contro, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
2. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms, Springer (1997)

Pre-requisites:

1. Basic mathematics and physics
2. Basic programming skills (Python/C/C++)
3. Basics of electrical and electronics engineering

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Syllabus

Name of the Programme: B.Tech.	**Year**: III	**Semester**: V
Course Name: Electric Vehicle Fundamentals	**Course Code**: MEUL560.2	**Credit**: 03
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hours	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1.	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	**1**
2.	**Introduction to Electric Vehicles:** Evolution of transportation and need for EVs; Types of electric vehicles: BEV, HEV, PHEV, FCEV; Comparison with internal combustion engine (ICE) vehicles; Global EV market trends and policies; Environmental impact and sustainability	9
3.	**Electric Vehicle Architecture:** Overview of EV powertrain components; Electric motors (DC, BLDC, PMSM, induction motor); Power electronics: inverters, converters, controllers Transmission systems in EVs; Regenerative braking systems	9
4.	**Energy Storage Systems:** Battery fundamentals: chemistry and working principles Types of batteries (Li-ion, NiMH, solid-state, etc.); Battery Management Systems (BMS); Charging methods and standards (AC, DC fast charging); Battery life, safety, and thermal management	9
5.	**Charging Infrastructure & Grid Integration**: EV charging infrastructure types and layout Smart charging and load management; Vehicle-to-Grid (V2G) technology; Impact of EVs on power grids; Renewable energy integration with EVs	9
6.	**Performance, Control & Future Trends:** Vehicle dynamics and performance parameters Energy efficiency and range estimation; Control strategies for EV systems; Autonomous and connected EV technologies; Future trends: solid-state batteries, wireless charging, policy outlook.	8
	Total	**45**

Text Books:

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory & Design by Mehrdad Ehsani et. al., CBC Press, 1st Edition, 2004.

Reference Books:

1. Advanced Concepts and Technologies for Electric Vehicles by Akshay Kumar Rathore, Arun Kumar Verma, CRC Press, 2025.
2. Electric Vehicle Powertrains (Design Fundamentals, Components, and Applications) by B. Ashok, V. Indragandhi, Elsevier Publications, 1st Edition , 2026.

Prerequisite:

1. Introductory physics and mathematics
2. Basic electrical and electronics engineering

Syllabus

Name of the Program: B. Tech.	**Year**: III	**Semester**: V
Course Name: Introduction to Sensors and Actuators	**Course Code**: CUP560.1	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite	1
2	**Fundamentals of Sensors and Actuators:** Basics of energy transformation: Transducers, Sensors, and Actuators**,** Classification and performance parameter of sensors	9
4	**Resistive and Inductive Sensor Technologies:** Principle of operation, construction and applications of resistive potentiometers, strain gauges, thermistors, piezo-resistive sensors, inductive potentiometers, LVDT, Displacement sensor (Joystick), Gradiometer, Metal detector, Photoelectric sensors	13
5	**Capacitive and Special Purpose Sensors:** Variable permittivity capacitive sensors, capacitor microphone, piezoelectric sensors, Hall Effect sensors, humidity sensor, light sensor, rain sensor, optical biosensors	10
6	**Actuator Systems and Applications:** Definition and classification of actuators; selection criteria for linear and rotary actuators; pneumatic and electro-pneumatic actuators; hydraulic actuators and control valves; electrical actuators: solenoids, DC motors, single-phase and three-phase induction motors, stepper motors, piezoelectric actuators, Smart and Intelligent Actuators, relay	12
	Total	**45**

Text Books:

1. **D. Patranabis**, "Sensors and Transducers", 2nd Edition, PHI Learning Private Limited, 2011.
2. **W. Bolton**, "Mechatronics", 4th Edition, Pearson Education Limited, 2015.

Reference Books:

1. **D. Patranabis, "**Sensors and Actuators", 2nd Edition, PHI Learning Private Limited, 2013.
2. **Robert H. Bishop**, "The Mechatronics Handbook: Mechatronic Systems, Sensors and Actuators, Fundamentals and Modelling", 2nd Edition, CRC Press, 2002.
3. **Massood Tabib-Azar,** "Micro-actuators: Electrical, Magnetic, Thermal, Optical, Mechanical, Chemical and Smart Structures", 1st Edition, Kluwer Academic Publishers (Springer), 1997.

Prerequisite:

1. Knowledge of basic electronic components.
2. Basic Circuit analysis

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Syllabus

Name of the Program: B. Tech.	**Year**: III	**Semester**: V
Course Name: Semiconductor Technology and Applications	**Course Code**: ECUP560.2	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Course Foundations:** Objective, scope, prerequisites, and expected outcomes.	**1**
2	**Semiconductor & IC Technology Basics:** Semiconductor fundamentals, intrinsic/extrinsic carriers, simple band concepts, silicon wafer fabrication, cleanroom and contamination control, wafer safety, IC process flow, thermal oxidation, RTP and laser annealing, diffusion & ion implantation, and the idea of device scaling.	**10**
3	**Lithography & Thin-Film Manufacturing:** Optical lithography essentials, photoresists, mask alignment, pattern transfer, intro to e-beam/direct-write lithography, wet & dry etching, plasma etching basics, thin-film deposition (sputtering, evaporation), CVD/PECVD fundamentals, elementary epitaxy, ALD introduction, metal interconnects, wire bonding basics, and yield/process monitoring.	**12**
4	**Material Characterization & Analytical Tools:** Crystal structure & defects, XRD for phase ID, Scherrer & Williamson–Hall concepts, SEM & TEM imaging, AFM for surface profiling, UV–Vis for optical bandgap, PL for emission studies, FTIR for chemical bonding, ellipsometry for film thickness and optical properties.	**11**
5	**Nanotech Innovations & Emerging Applications:** Nano-computing and ultra-fast processors, advanced nano-electronics, quantum-dot display technology, next-gen nano-memory (PCM/MRAM/RRAM), nano-photonics for high-speed communication, smart IoT nano-sensors, nano-medicine & targeted therapies, bio-nano diagnostics, nano-agriculture & food protection, and recent breakthrough nanotechnologies.	**11**
	Total	**45**

Text Books:

1. Neamen, D. A., Semiconductor Physics and Devices: Basic Principles, 4th Edition, McGraw-Hill, 2012.
2. Campbell, S. A., Fabrication Engineering at the Micro- and Nanoscale, 4th Edition, Oxford University Press, 2013.
3. Roy, S., Ghosh, C. K., Dey, S., Pal, A. K., Solid State & Microelectronics Technology, 1st Edition, Bentham Science Publishers, 2023.
4. Aritome, S., NAND Flash Memory Technologies, Wiley-IEEE Press, 2016. (1st Edition)

Reference Books:

1. Tsividis, Yannis & McAndrew, Colin, Operation and Modeling of the MOS Transistor, 3rd Edition, Oxford University Press, 2010.
2. Fahrner, W. R., Nanotechnology and Nanoelectronics: Materials, Devices and Measurement Techniques, 1st Edition, Springer, 2004.
3. Pierret, R. F., Semiconductor Device Fundamentals, 1st Edition, Pearson Education India, (latest Indian reprint), 1996.
4. Yoon, S. M., Ferroelectric-Gate Field-Effect Transistor: Device Physics and Applications, 1st Edition, Springer, 2020.

Prerequisite:

1. Basic understanding of high-school physics (electricity, materials)
2. General familiarity with electronic components (diodes, transistors etc.)

Open Electives for Semester-VI of B.Tech. Program

Sr. No.	Year	Sem.	Course Code	Course Name	Offering Department	Eligible Branch
1	III	VI	CHUL660	Energy and Environment Science	Chemistry	ALL
2	III	VI	MAUL660	Advanced Optimization Techniques	Mathematics	ALL
3	III	VI	HSUL660	Critical Thinking	English	ALL
4	III	VI	EEUL660.1	Elements of Smart Grid System	EE	CS/AI/ DS/IOT/ IT/ CE/ EC/ ME
5	III	VI	EEUL 660.2	Non-conventional Energy Sources	EE	CS/AI/ DS/IOT/ IT/ CE/ EC/ ME
6	III	VI	CEUL660	Remote Sensing and GIS Techniques	CE	CS/AI/ DS/IOT/ IT/ EC/ EE/ ME
7	III	VI	CEUL661	Solid Waste Management	CE	CS/AI/ DS/IOT/ IT/ EC/ EE/ ME
8	III	VI	MEUL660.1	Energy Management	ME	CS/AI/ DS/IOT/ IT/ CE/ EC/ EE
9	III	VI	MEUL560.2	Introduction to 3D Printing	ME	CS/AI/ DS/IOT/ IT/ CE/ EC/ EE
10	III	VI	ECUL660.1	Microcontrollers and Embedded Systems	EC	CS/AI/ DS/IOT/ IT/ CE/ EE/ ME
11	III	VI	ECUL660.2	Nanoelectronics Technology and Devices	EC	CS/AI/ DS/IOT/ IT/ CE/ EE/ ME
12	III	VI	ECUL660.3	Antenna Theory and Design	EC	CS/AI/ DS/IOT/ IT/ CE/ EE/ ME
13	III	VI	CSUL660.1	Cybersecurity and Ethical Hacking	CS	IT/ CE/ EC/ EE/ ME
14	III	VI	CSUL660.2	Principles of Programming Languages	CS	IT/ CE/ EC/ EE/ ME

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Syllabus

Name of the Programme: B.Tech.	**Year**: 2026-27	**Semester**: VI
Course Name: Energy and Environmental Science	**Course Code**: CHUL660	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** 3L+1T	

Module No.	Contents	Hours
1	**Basics of Environment:** Environmental Pollution, Environmental Acts and Regulations, Environmental Impact Assessment (EIA), Necessity and methodology of EIA.	5
2	**Energy Resources:** Present energy resources in India and its sustainability, energy demand scenario in India, growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources; *Power plants:* Different types of conventional power plants, advantages and disadvantages of conventional power plants, Potential & present status of renewable sources of energy in India.	10
3	**Ecology, Structure and functioning of natural ecosystems:** Functional concepts of Ecology, Basics of species, Ecosystem, Hydrological and chemical cycles, Energy flow in ecosystems. Biodiversity, population dynamics.	10
4	**Environment pollution, global warming and climate change:** ***Air pollution-*** Sources and effects of pollutants, primary and secondary pollutants, control measures. *Acid rain*: Impacts on human communities and agriculture. *Green-house effect*: Definition, causes and consequences. *Depletion of ozone layer*: CFC, destruction of ozone layer by CFC, consequences, the effect of ozone modification, **Water Pollution:** Water pollution, Harmful effects of water pollution, control of water pollution.	10
5	**Waste Management**-Waste water management, Treatment & disposal of wastewater. Reuse of wastewater. Solid waste Management, Classification of solid waste, Collection, transportation, treatment, and disposal of solid waste. The economic recovery of solid waste.	10
	Total	**40**

Text and Reference Books

- Chemistry of water treatment, Samuel Faust & Osman M Aly, CRC Press
- Atmospheric pollution, by W Buch , Tata McGraw Hill(TMH)
- Introduction to Environmental Science, by G Tyler Miller and Scott Spoolman, Cengage Learning
- Introduction to Environmental Engineering, by Mackenzie L Davis and David A Cornwell, Tata McGraw Hill(TMH)

- Environmental Studies: A. Basak, Pearson Education; 1st edition (2009).
- Environmental Studies For Undergraduate Courses of all Branches of Higher Education by Erach Bharucha for University Grants Commission
- Text Book of Environmental Studies: D. Dave and S.S. Katewa, Cenage Learning.
- Fundamentals of Environmental Studies: S. Somvanshi and R. Dhupper, S. K. Kataria&Sons.
- Environmental Chemistry: Anil K De, New Age International, 2007.
- Environmental Studies: R. Daniels, Wiley India Private. Ltd.
- Environmental Studies: Benny Joseph, McGraw-Hill Education,2nd edition.

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Department of Mathematics
Proposed Syllabus for Open Elective

Name of the Program : B.Tech.	**Year: III**	**Semester : VI**
Course Name: Advanced Optimization Techniques	**Course Code:** MAUL660	**Credit:** 3
Max. Marks : 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI(45)+TW&SL(45)=90 hrs. per semester	

Module No.	Contents	Hours
1	Objective. Scope, outcome of the course and prerequisite	1
2	**Linear Programming :**Graphical method, Simplex method, Big-M method, Two phase method, Duality	11
3	**Applications of Linear Programming:** Transportation Problem, Assignment Problem	10
4	**PERT & CPM:** Objectives of PERT & CPM, Elements of network, Network rules, Errors in network, Critical Path analysis, Activity time & Floats, Optimization through CPM and PERT	11
5	**Non Linear Programming:** Unconstrained Optimization: Direct search method, Steepest Descent Method. Constrained Optimization: Kuhn-Tucker conditions, Wolfe's method.	12
	Total	45

Text Books:

1. Operation Research, Kanti Swarup, P. K. Gupta, Man Mohan, Sultan Chand & Sons Publication.
2. Operations Research - Theory, Methods & Applications, S.D. Sharma, Kedarnath Ramnath Publication, 2025.

Reference Books:

1. Fundamentals of Optimization Techniques with Algorithms, Nayak, Sukanta, Elsevier, Academic Press
2. Operations Research, Hira and Gupta, S. Chand Publishing
3. Optimization for Engineering Design: Algorithms and Examples, Kalyanmoy Deb, PHI Learning.

Prerequisite:

1. Basic concepts of Matrix
2. Fundamentals of Differential and Integral Calculus
3. Co-ordinate geometry

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Syllabus

Name of the Programme: B.Tech.	**Year**: III	**Semester**: VI
Course Name: Critical Thinking	**Course Code**: HSUL660	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI(45)+TW&SL(45) = 90hrs per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	2
2	**UNIT I- What is Critical Thinking** **I. Conceptual Foundations: Asking Questions and Thinking Clearly** Meaning of critical thinking; importance of critical thinking for engineers; asking the right questions. **II. Basic Understanding of Philosophical Ideas:** •SocraticQuestioning – through research article "Socratic Questioning:A Philosophical Approach in DevelopingCritical Thinking Skills" by Norillah binti Abdullah et. al.(Al-Hikmah: International Journal of Islamic Studies and HumanSciences)	7
3	UNIT II - Logic Made Easy **I. Conceptual Foundation-** Avoiding wrong thinking Meaning of logic, Common thinking errors (bias, assumptions),Logical Fallacy **II. Film-Based Inquiry** • The Matrix (Dir. Lana Wachowski&Lilly Wachowski)–What is real vs illusion **III. Basic Understanding of Philosophical Ideas:** • Discussing the concept of Maya (Vedanta tradition) –Concept of illusion and reality – through research article "The Concept of Maya in the Bhagavad Gita: Illusion andTranscendence"by Samuel Debbarma(International Journal of Sanskrit Research)	9
4	UNIT III - Media, Language & Influence **I. Conceptual Foundations: Understanding Fake News and Bias** Media influence on thinking; fake news and misinformation; language and perception; bias and stereotypes. **II. Literary Exploration** • *The Free Voice* by Ravish Kumar: fake news, media influence, and misinformation.	9

	III. Film-Based Inquiry • *The Social Dilemma* (Dir. Jeff Orlowski): algorithms, manipulation, and digital misinformation.	
5	UNIT IV - Ethics & Decision-Making **I. Conceptual Foundations-** Understanding and evaluating *right vs. wrong decisions* in personal, professional, and societal contexts. Ethical thinking, Decision-making and Responsibility – using the concepts of Utilitarianism, Deontology, Virtue Ethics. **II. Literature and Ethical Exploration** • *Frankenstein*by Mary Shelley–Ethical responsibility and Misuse of scientific knowledge **III. Film-Based Ethical Inquiry** • *The White Tiger* (Dir. Ramin Bahrani): morality, ambition, and systemic inequality.	9
6	UNIT V - Expressing Your Ideas **I. Conceptual Foundations: Developing Clarity, Confidence, and Responsibility in Speaking and Writing Arguments** Opinion versus argument; building strong arguments; respectful disagreement; debate and discussion skills using the basic concepts of: • Gibbs' Reflective Cycle • I–Thou Relationship (Martin Buber) • Hegelian Dialectic (G. W. F. Hegel) **II. Literary Exploration** • *The Uses of Argument* by Stephen Toulmin: practical model of argumentation (Claim–Data–Warrant structure); the layout of an argument. **III. Film-Based Inquiry** • The Great Debaters (Dir. Denzel Washington): power of rhetoric, persuasion, and ethical argumentation.	9
	Total	**30**

Reference Books:

- Prasad, A. S., and Shailja Agarwal. *Critical and Analytical Thinking*. Pearson Education India, 2018.
- Sen, Amartya. *The Argumentative Indian: Writings on Indian History, Culture and Identity*. Penguin Books, 2005.
- Chatterjee, Satischandra, and Dhirendramohan Datta. *An Introduction to Indian Philosophy*. University of Calcutta, 1984.
- Matilal, Bimal Krishna. *Perception: An Essay on Classical Indian Theories of Knowledge*. Oxford University Press, 1986.
- Mohanty, Jitendra Nath. *Reason and Tradition in Indian Thought: An Essay on the Nature of Indian Philosophical Thinking*. Oxford University Press, 1992.
- Chatfield, Tom. *Critical Thinking: Your Guide to Effective Argument, Successful Analysis and Independent Study*. SAGE Publications, 2018.
- Cottrell, Stella. *Critical Thinking Skills: Effective Analysis, Argument and Reflection*. Palgrave Macmillan, 2017.

Texts Books/Articles and Films:

1. Abdullah, Norillah Binti, et al. "Socratic Questioning: A Philosophical Approach in Developing Critical Thinking Skills." *Al-Hikmah: International Journal of Islamic Studies and Human Sciences*, vol. 10, no. 2, 2018, pp. 1–15.
2. Debbarma, Samuel. "The Concept of Maya in the Bhagavad Gita: Illusion and Transcendence." *International Journal of Sanskrit Research*, vol. 5, no. 2, 2019, pp. 45–49.
3. Kumar, Ravish. *The Free Voice: On Democracy, Culture and the Nation*. Speaking Tiger Books, 2018.
4. Shelley, Mary. *Frankenstein; or, The Modern Prometheus*. Penguin Classics, 2003.
5. Toulmin, Stephen. *The Uses of Argument*. Cambridge University Press, 2003.
6. Buber, Martin. *I and Thou*. Translated by Walter Kaufmann, Scribner, 1970.
7. Hegel, G. W. F. *Phenomenology of Spirit*. Translated by A. V. Miller, Oxford University Press, 1977.
8. Gibbs, Graham. *Learning by Doing: A Guide to Teaching and Learning Methods*. Oxford Polytechnic, 1988.
9. *The Matrix*. Directed by Lana Wachowski and Lilly Wachowski, Warner Bros., 1999.
10. *The Social Dilemma*. Directed by Jeff Orlowski, Netflix, 2020.
11. *The White Tiger*. Directed by Ramin Bahrani, Netflix, 2021.
12. *The Great Debaters*. Directed by Denzel Washington, Metro-Goldwyn-Mayer, 2007.

Syllabus

Name of the Programme: B.Tech.	**Year**: III	**Semester**: VI
Course Name: Remote Sensing and GIS Techniques	**Course Code: CEUL660**	**Credit: 3**
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI)
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Photogrammetry:** Definition of Photogrammetric Terms, Geometry of aerial and terrestrial photographs, Aerial camera and phototheodolite, Scale of a Photograph, Tilt and Height displacements, Stereoscopic vision and stereoscopes, Height determination from parallax measurements, Flight planning, Maps and Map substitutes and their uses.	9
3	**Remote Sensing:** Basic concepts of remote sensing data and collection, Remote Sensing advantages and limitations, Remote Sensing System, Electromagnetic radiation and spectrum, Spectral signature, Atmospheric windows, energy interactions with atmosphere and with earth surface features (soil, water and vegetation). Different types of platforms, sensors and their characteristics, Orbital parameters of a satellite, Multi concept in Remote Sensing.	12
4	**Image Interpretation:** Principles of interpretation of aerial and satellite images, equipments and aids required for interpretation, resolution, image and false colour composite. Ground truth – collection and verification, advantages of multidate and multiband images. Digital Image Processing concept. Elements of visual and digital interpretation techniques	11
5	**Geographic Information System (GIS):** Introduction to GIS, components of GIS, Geographical referenced data. Spatial data-attribute data. Applications of GIS in map revision, Land use, Agriculture, Forestry, Archaeology, Municipal, Geology, water resources, Soil Erosion, Land suitability analysis, and traffic management.	12
	Total	**45**

Text Books:

Sn.	Title	Author(s)	Publisher	Edition(year)
1	Remote Sensing and GIS	Bhatta B	Oxford University Press	2011
2	Basics of Remote sensing & GIS	S. Kumar	Laxmi Publications	2005
3	Remote Sensing and its Applications	Narayan LRA	Universities Press	2012

Reference Books:

Sn.	Title	Author(s)	Publisher	Edition(year)
1	Remote Sensing and GIS	Bharat Nagar & Pramod Kumar	Priya Tech Publications	2013
2	Introduction to Geographic Information Systems	Kang-tsung Change	Mc Graw Hill Educations	2017

Prerequisite:

1. Elementary knowledge of advanced surveying techniques.

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Syllabus

Name of the Programme: B.Tech.	**Year**: III	**Semester**: VI
Course Name: Solid Waste Management	**Course Code: CEUL661**	**Credit: 03**
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	01
2	**Introduction to Solid Waste and Environmental Impact:** Importance of solid waste management; effects of waste on water, soil, and air; ecosystem role in waste assimilation; urban vs rural waste; overview of national initiatives (Swachh Bharat, National Urban Sanitation Policy)	07
3	**Types, Sources and Generation of Solid Waste:** Definition and types of solid waste (municipal, industrial, biomedical, e-waste); sources: household, commercial, institutional; factors affecting waste generation; MSW generation in India	08
4	**Safety, Ethics, and Regulations in Solid Waste Management:** Health and environmental hazards from waste; safety measures and PPE; ethical considerations in waste handling; Municipal Solid Waste Rules and Plastic Waste Management Rules; case studies; responsibilities of engineers	10
5	**Solid Waste Treatment Technologies:** Composting; vermicomposting; biogas production; pyrolysis; incineration; engineered landfills; handling and recycling of e-waste and plastics.	10
6	**Sustainability, Circular Economy, and Innovative Practices:** Circular economy; 3R concept (Reduce, Reuse, Recycle); material recovery; segregation at source; zero-waste initiatives; smart city waste solutions; community participation; case studies	09
	Total	**45**

Text Books:

Sn.	Title	Author(s)	Publisher	Edition(year)
1	Solid Waste Management	K Sasikumar and Sanoop Gopi Krishna	PHI Learning Pvt. Ltd.	1 (2013)
2	Textbook of Solid Wastes Management	Iqbal H Khan and Naved Ahsan	CBS Publisher & Distributor Pvt. Ltd.	1 (2017)
3	Ecology, environmental Science & Conservation	S P Singh and J S Singh, S R Gupta	S.Chand (G/L) & Company Ltd	1 (2017)

Reference Books:

Sn.	Title	Author(s)	Publisher	Edition(year)
1	Sustainable Solid Waste Management: A Systems Engineering Approach	Ni-Bin Chang, Ana Pires	Wiley India Pvt Ltd	1 (2018)
2	Municipal Solid Waste Management	N N Bandela and DG Tare	BR Publishing Corporation.	1 (2009)
3	Energy Environment Ecology and Society	Preeti Jain, Shankar Lal Garg, K. G. Garg	Variety Books Publishers Distributors.	1 (2014)
4	Solid Waste Management Rules	MoEF&CC		2016

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Syllabus

Name of the Programme: B. Tech.	**Year**: III	**Semester**: VI
Course Name: Cybersecurity and Ethical Hacking	**Course Code**: CSUL660.1	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 Hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite.	1
2	**Introduction to Cybersecurity and Ethical Hacking:** Cybersecurity – concept and purpose, CIA Triad; Ethical Hacking – concept and purpose, types of hackers (white hat, black hat, grey hat), types of cyber-attacks. **Digital Footprint and Online Privacy:** Digital identity and digital footprint, risks of oversharing, privacy settings on social media, personal data protection.	9
3	**Passwords and Authentication:** Strong password practices, password attack concepts, multi-factor authentication (MFA), password managers. **Social Engineering and Phishing:** Human psychology in hacking, phishing, vishing, smishing, QR scams, identifying fake emails, malicious links, and fraudulent calls.	9
4	**Network Security Basics:** Networks – Wi-Fi and Internet basics; types – home, public, and mobile networks. Wi-Fi security – WPA2/WPA3; common threats – man-in-the-middle attacks, fake Wi-Fi hotspots, unauthorized access. Safe practices – avoiding sensitive work on public Wi-Fi, securing routers and passwords, and using VPNs (conceptual).	10
5	**Safe Internet and Browsing Practices:** HTTP vs HTTPS, safe browsing habits, cookies and tracking, secure downloads. **Malware and Protection:** Malware types – viruses, worms, trojans, ransomware, spyware, adware, and rootkits; malware spreading methods, malware detection techniques, malware prevention techniques, real-world examples.	8
6	**Ethical Hacking Concepts and Cyber Laws:** Vulnerability assessment, common attacks – phishing and password attacks, penetration testing	8

	lifecycle, basics of IT Act 2000, cyber crimes, and penalties.	
	Total	**45**

Text Books

1. C. J. Brooks, C. Grow, P. Craig, and D. Short, Cybersecurity Essentials, 1st ed. Indianapolis, IN, USA: Wiley, 2018.
2. M. E. Whitman and H. J. Mattord, Principles of Information Security, 7th ed. Boston, MA, USA: Cengage Learning, 2022.

Reference Books

1. W. Stallings, Computer Security: Principles and Practice, 5th ed. Hoboken, NJ, USA: Pearson, 2023.
2. R. Anderson, Security Engineering: A Guide to Building Dependable Distributed Systems, 3rd ed. Indianapolis, IN, USA: Wiley, 2021.

Prerequisite:

1. Awareness of Internet and Web Technologies.
2. Elementary knowledge of Information Technology Concepts.

Syllabus

Name of the Programme: B. Tech.	**Year**: III	**Semester**: VI
Course Name: Principles of Programming Languages	**Course Code**: CSUL660.2	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI (45) + TW & SL (45) = 90 Hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**Introduction:** Objective, scope, and outcome of the course;	1
2	**Programming Languages:** Definition, history, and features of programming languages. Issues in language design including the structure and operation of computers, programming paradigms, efficiency, and regularity. Issues in language translation: syntax and semantics.	10
3	**Data Types:** Specification and implementation of elementary and structured data types. Type equivalence, type checking, and type conversion. Study of vectors, arrays, lists, structures, sets, and files.	8
4	**Control Structures and Subprograms:** Sequence control using expressions, conditional statements, loops, and exception handling. Subprogram definition and activation, simple and recursive subprograms, and subprogram environments.	8
5	**Scope and Parameter Passing:** Static and dynamic scope, block structures, local and shared data. Parameters and parameter transmission mechanisms. Local and common environments, tasks, and shared data management.	9
6	**Abstract Data Types and Storage Management:** Abstract data types, information hiding, encapsulation, and type definition. Static and stack-based storage management, fixed and variable-size heap storage management, and garbage collection.	9
	Total	**45**

Text Books:

1. T. W. Pratt and M. V. Zelkowitz, *Programming Languages: Design and Implementation*, 4th ed. Noida, India: Pearson Education, 2017.
2. K. C. Louden and K. A. Lambert, *Programming Languages: Principles and Practices*, 3rd ed. Boston, MA, USA: Cengage Learning, 2026.

Reference Books:

1. R. W. Sebesta, *Concepts of Programming Languages*, 12th ed. Hoboken, NJ, USA: Pearson, 2024.
2. M. L. Scott and J. Aldrich, *Programming Language Pragmatics*, 5th ed. Cambridge, MA, USA: Morgan Kaufmann, 2025.

Prerequisite: Basic understanding of programming concepts

Syllabus

Name of the Programme: B.Tech.	**Year**: III	**Semester**: VI
Course Name: Elements of Smart Grid System	**Course Code**: EEUL660.1	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, Scope and Outcome of the Course	1
2	**Introduction to Smart Grid**: Basics of power systems, definition & need of smart grid, domains & enablers, priority areas, regulatory challenges, smart grid initiatives and activities in India.	8
3	**Smart Grid Architecture & Automation**: Smart grid architecture, standards & policies, control layers & elements, network architectures, IP-based systems, PLC, SCADA, AMI, transmission & distribution automation, renewable integration.	9
4	**Tools & Computational Techniques**: Static & dynamic optimization for power applications, economic load dispatch, computational intelligence, evolutionary algorithms, and AI applications in smart grid.	9
5	**Distributed Generation & Emerging Technologies**: Distributed energy sources, renewable energy integration, microgrids, storage technologies, electric vehicles & plug-in hybrids, environmental & economic issues.	9
6	**Communication & Smart City Applications**: Two-way digital communications, Phasor Measurement Units (PMUs), Wide Area Monitoring System (WAMS), IoT applications in smart grid, smart city pilot projects, active distribution networks, reliability & resiliency, decentralized operations, cyber security and resiliency.	9
	Total	**45**

Textbooks:

1. Smart Grid Fundamentals: Theory, Technologies, and Applications, Anurag K. Srivastava and SayonsomChanda, 1st Edition (2023), McGraw-Hill Education
2. Smart Grids for Smart Cities – Volume 1, O. V. GnanaSwathika, K. Karthikeyan, and SanjeevikumarPadmanaban, 1st Edition (2023), Wiley
3. Smart Grids for Smart Cities – Volume 2, O. V. GnanaSwathika, K. Karthikeyan, and SanjeevikumarPadmanaban, 1st Edition (2023), Wiley
4. Smart Grid: Fundamentals, Design, Technology, Applications, Communication and Security (Indian Adaptation), Wiley Editorial Team, 1st Edition (2021), Wiley India

Reference Books:

1. Smart Grids: Infrastructure, Technology and Solutions, Stuart Borlase, 1st Edition (2013), CRC Press
2. Smart Grid Resilience: Extreme Weather, Cyber-Physical Security, and System Interdependency, Junjian Qi, 1st Edition (2023), Springer
3. Smart Grids—Renewable Energy, Power Electronics, Signal Processing, and Communication Systems Applications, Alfeu J. SguareziFilho et al., 1st Edition (2023), Springer
4. Artificial Intelligence Applications in Smart Grid, Shahid Hussain and Ankit Goel (Editors), 1st Edition (2024), Elsevier

Prerequisite:

1. Basics of Analog and Digital Circuits
2. Basics of Electrical Engineering

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Syllabus

Name of the Programme: B. Tech.	**Year**: III	**Semester**: VI
Course Name: Non-conventional Energy Sources	**Course Code**: EEUL660.2	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs.	**Teaching Scheme:** CI (45) + TW & SL(45) =90 hrs. per semester	

Module No.	Contents	Hrs.
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction & Solar Radiation Principles:** Role and potential of new and renewable energy sources, Environmental impact of solar power, solar constant, Extra-terrestrial and terrestrial solar radiation, Solar radiation on tilted surfaces, Instruments for measuring solar radiation and sunshine, Interpretation of solar radiation data.	9
3	**Solar Energy Collection, Storage & Applications:** Flat plate and concentrating collectors, Classification of concentrating collectors, Orientation and thermal analysis, Advanced solar collectors, Energy storage methods: Sensible, latent heat, stratified Solar ponds, Solar applications: Solar heating and cooling techniques, Solar distillation and drying, Photovoltaic energy conversion.	9
4	**Wind and Biomass Energy** **Wind Energy**: Sources and potential, Horizontal and vertical axis wind turbines, Performance characteristics, Betz's limit **Biomass Energy**: Bio-conversion principles, Anaerobic/aerobic digestion, Biogas digesters – types and gas yield Combustion characteristics, Applications: cooking, IC engine operations, Economic considerations	9
5	**Geothermal and Ocean Energy** **Geothermal Energy**: Resource availability, Types of geothermal wells, Methods of energy extraction, Geothermal potential in India **Ocean Energy**: OTEC – Principles, plant setup, thermodynamic cycles, Tidal and wave energy – Conversion techniques, Mini-hydel plants – Overview and economic feasibility.	9
6	**Direct Energy Conversion** Need for direct energy conversion (DEC), Limitations of Carnot cycle, Principles and types of DEC systems, hermoelectric converters, Thermionic converters, Fuel cells, Magneto-hydrodynamic generators.	8
Total		**45**

Textbooks:

1. Renewable Energy Resources, Tiwari and Ghosal, 2nd Edition (2008), McGraw Hill Company, New Delhi
2. Non-Conventional Energy Sources, G.D. Rai, 4th Edition (2009), Khanna Publishers, New Delhi

Reference Books:

1. Renewable Energy Sources, Twidell & Weir, 4th Edition (2009), Tata McGraw Hill Education Pvt. Ltd., New Delhi
2. Solar Energy, S.P. Sukhatme, 3rd Edition (2010), Tata McGraw Hill Education Pvt. Ltd., New Delhi

Prerequisite:

1. A strong understanding of basic thermodynamics enables analysis of energy conversion efficiency and system performance.
2. Engineering Physics: Physical principles behind energy generation and material selection.

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Syllabus

Name of the Programme: B.Tech.	**Year**: III	**Semester**: VI
Course Name: Energy Management	**Course Code**: MEUL660.1	**Credit**: 03
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hours	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	Energy Basics, Energy Scenario, sector-wise energy consumption - Global and Indian, history of rate of consumption of various conventional fuel, their availability in future, Energy generation and Distribution, Uneven distribution of energy resources, Load curves, types of power plants, Base load, Intermediate load, Peak load plant, Energy displacement – Energy storage plants. Impact of energy on economy, development and environment, Energy policies, Energy strategy for future	12
3	Energy Management: supply side and demand side, Energy Auditing, Conservation & Resource Development, utilization of energy for Sustainable Development	10
4	Sector-wise Energy Management - Industry, commercial and domestic Buildings, Transport, Agriculture	8
5	Energy forecasting techniques; future rate of consumption of fossil fuels, need for renewable energy resources, Energy Integration, Energy Matrix	8
6	Energy management for cleaner production, application of renewable energy, Case study	6
	Total	**45**

Text Books:

1. Amlan Chakrabarti, Energy Engineering and Management, Prentice Hall India, 2011.
2. Eastop T. D. and D. R. Croft, Energy Efficiency for Engineers & Technologists, Longman, 1990.
3. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 2005

Reference Books:

1. General Aspects of Energy Management and Audit, Bureau of Energy Efficiency
2. Energy Management, P. Venkataseshaiah and K.V. Sharma, Wiley Publication
3. Energy Management, WR Murphy and C McKay, Elsevier Publication

Prerequisite:

1 Basic Knowledge of energy technology.

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Syllabus

Name of the Programme: B.Tech.	**Year**: III	**Semester**: VI
Course Name: Introduction to 3D Printing	**Course Code**: MEUL660.2	**Credit**: 03
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hours	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	**Introduction:** Objective, Scope, Outcome of the Course and Prerequisite	1
2	**Fundamentals of 3D Printing:** Introduction to additive manufacturing; History and evolution of 3D printing; Comparison with traditional manufacturing methods; Types of 3D printing technologies: FDM (Fused Deposition Modeling); SLA (Stereolithography) SLS (Selective Laser Sintering); Applications in various industries (automotive, healthcare, aerospace, consumer products).	9
3	**3D Modeling and Design for Printing:** Basics of 3D modeling; Introduction to CAD software (e.g., AutoCAD, Fusion 360, Tinkercad); File formats: STL, OBJ, AMF, Design considerations for additive manufacturing (DfAM), Scaling, orientation, and support structures.	9
4	**3D Printing Materials and Processes:** Types of materials-Thermoplastics (PLA, ABS, PETG); Resins and powders; Material properties and selection criteria; Printer components: Extruder, nozzle, build plate; Process parameters: Layer height, infill, print speed, temperature.	9
5	**Printer Operation and Post-Processing:** Introduction to slicing software (e.g., Cura, PrusaSlicer); Converting CAD models into G-code; Printer setup and calibration, Printing workflow and troubleshooting; Post-processing techniques: Support removal, Sanding and finishing, Painting and curing.	9
6	**Applications, Maintenance, and Future Trends:** Industrial and consumer applications Rapid prototyping and product development; Maintenance of 3D printers; Safety guidelines; Emerging trends: Bioprinting, Metal 3D printing, 4D printing, Sustainability in additive manufacturing.	8
	Total	**45**

Text Books:

1. 3D Printing and Design by Sabrie Soloman, Khanna Publishing House, 2023.

Reference Books:

1. Additive Manufacturing and 3D Printing Technology: Principles and Applications by G.K.Awari et. al.; Taylor & Francis, 2025
2. 3D Printing Technology: Fundamentals and Applications by H.N. Pandya, Studera Press, 1st Edition.2021.

Prerequisite:

1. Basic level mathematics and physics.
2. Basic computer literacy.

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Syllabus

Name of the Program: B. Tech.	**Year**: III	**Semester**: VI
Course Name: Microcontrollers and Embedded Systems	**Course Code**: ECUL660.1	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite	1
2	**FUNDAMENTALS OF MICROCONTROLLERS:** Basics of Microcontroller, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers, Role of microcontrollers in embedded Systems. Overview of the 8051 family.	9
3	**THE 8051 ARCHITECTURE:** Internal Block Diagram, CPU, ALU, address, data and control bus, Working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports & I/O Interfacing, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.	9
4	**BASICS OF EMBEDDED SYSTEM:** Definition, History of Embedded Systems, Classification, Major Application Areas, Characteristics and Quality Attributes of Embedded Systems, Embedded Cores, Embedded Memories, Memory Shadowing, Onboard and External Communication Interfaces, Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer	9
5	**COMPONENT INTERFACING & NETWORKS:** Memory Interfacing, I/O Device Interfacing, Interrupt Controllers, Networks for Embedded systems- USB, PCI,PCI Express, UART, SPI, I2C, CAN, Wireless Applications - Bluetooth, Zigbee, Wi-Fi	9
6	**RTOS BASED EMBEDDED SYSTEM DESIGN:** Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization, Device Drivers, How to Choose an RTOS.	8
	Total	**45**

Text Books:

1. The 8051 Microcontroller and Embedded Systems by Mazidi, Muhammad Ali, Pearson, 2nd edition (2009)
2. Embedded Systems: Architecture Programming & Design By Raj Kamal, McGraw Hill, 4th edition, 2023
3. Computers as Components : Principles of Embedded Computing System Design, 5th edition, Marilyn Wolf, Morgan Kaufmann Pub, 2022

Reference Books:

4. Embedded Systems: An Integrated Approach by Lyla B. Das, Pearson Education, India, 1st Edition, 2013
5. A Beginner's Guide to Designing Embedded System Applications on Arm Cortex-M Microcontrollers, Ariel Lutenberg, Pablo Gomez, Eric Pernia, Arm Education Media, ISBN: 978-1911531418, 2022.
6. Embedded Systems Architecture: Design and write software for embedded devices to build safe and connected systems by Daniele Lacamera, 2nd Edition, 2023

Prerequisite:

1. Digital Electronics
2. Computer Architecture
3. Microprocessors Basics
4. C/C++ programming language

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Syllabus

Name of the Program: B.Tech.	**Year**: III	**Semester**: VI
Course Name: Nanoelectronics Technology and Devices	**Course Code**: ECUL660.2	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3 Hrs	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite	1
2	**Introduction to Nanotechnology and Nanoelectronics:** Fundamentals, impacts, limitations of conventional microelectronics, transition from classical electronics to nanoelectronics	5
3	**Nanoelectronic Materials**: Semiconductors, crystal lattices, bonding in crystals, electron energy bands, electrons in low-dimensional structures (quantum wells, wires, dots), semiconductor heterostructures, inorganic-organic heterostructures, carbon nanomaterials	8
4	**Growth and Fabrication of Nanostructures:** Fabrication approaches, nano-layer fabrication (PVD, CVD, epitaxy, MBE, ion implantation, SiO_2 formation), nanoparticle fabrication (grinding, laser ablation, reduction, sol-gel, hydrothermal, self-assembly, precipitation of quantum dots)	10
5	**Characterization and Electron Transport in Nanostructures:** Characterization tools (STM, AFM, SEM, TEM, XRD, PL, UV), electron transport phenomena, diffusive vs ballistic transport, time and length scales, statistics and density of states, electron transport in nanostructures	11
6	**Nanoelectronics Devices-**MOSFET scaling limits and short-channel effects, quantum-dot devices and single-electron transistors (SETs), carbon nanotube (CNT) and graphene-based devices, spintronics and molecular transistors, emerging devices such as tunnel FETs, memristors, and neuromorphic devices.	10
	Total	**45**

Text Books:

1. Rainer Waser, Nanoelectronics and Information Technology, Wiley-VCH.
2. Charles P. Poole Jr. & Frank J. Owens, Introduction to Nanotechnology, Wiley.
3. K. Goser, P. Lugli, F. V. Stanojevic, Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum Devices, Springer.

Reference Books:

1. R. Fahrner, Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques, Springer.

2. M. Sze & Kwok K. Ng, Physics of Semiconductor Devices, Wiley.
3. T. Pradeep, Nano: The Essentials – Understanding Nanoscience and Nanotechnology, McGraw Hill.

Prerequisite:

1. Knowledge of basic electronic components and semiconductor physics
2. Fundamentals of quantum mechanics (wave-particle duality, energy quantization)
3. Basic circuit analysis and solid-state device concepts

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Syllabus

Name of the Programme: B.Tech.	**Year**: IV	**Semester**: VI
Course Name: Antenna Theory and Design	**Course Code**: ECUL660.3	**Credit**: 3
Max Marks: 100	**CIE:** 40	**SEE:** 60
End Term Exam Time: 3hrs	**Teaching Scheme:** CI (45) + TW & SL(45) = 90 hrs. per semester	

Module No.	Contents	Classroom Instruction (CI) Hours
1	**INTRODUCTION:** Objective, scope, outcome of the course and Prerequisite	1
2	Antenna Fundamentals: Electromagnetic theory, Maxwell's equation, Radiation mechanism, Basic antenna parameters – Radiation pattern, Radiation Density, Radiation Intensity, Gain, Directivity, Radiation Resistance, Band width, Beam width, Input Impedance, Effective aperture, Reciprocity theorem applied to antenna, Polarization.	12
3	Radiation from a small current element, half wave Dipole, and Loop antenna, Antenna used for mobile application, Construction, working and application of wire antenna – Dipole, folded dipole.	7
4	Construction, working and application of Broadband antenna, Yagi-Uda antenna, log periodic antenna, Aperture antenna- Horn antenna, reflector antenna, Slot antenna	8
5	Construction and working of Microstrip antenna, Feeding techniques, Design consideration of MSP antenna. Smart Antennas- Concept and benefits of smart antennas, reconfigurable antenna	9
6	Antenna Arrays: Antenna arrays of point sources, two element array, End fire and Broad side arrays, Principle of Pattern multiplication, Uniform linear arrays of N-elements, Synthesis methods: Schelkunhoff polynomial	8
	Total	**45**

Text Books:

1. Antenna Wave Propagation-K D Prasad, New Delhi: Satya Prakashan.
2. Antenna Theory - C.A. Balanis, John Wiley & Sons, 3rd Ed., 2005

Reference Books:

1. Raju.G.S.N, "Antennas and wave propagation", 1st Edition Pearson Education, 2012
2. Antenna theory- J.D. Kraus, 4th edition, Tata Mc-Graw Hill.
3. Robert S. Elliott, "Antenna Theory and Design", John Wiley and Sons, Revised Edition, 2007.
4. Yadava.R.L, "Antennas and Wave Propagation", PHI, 2011.

Prerequisite:

1. Higher Engineering Mathematics
2. Fundamental knowledge of Engineering Electromagnetics (Maxwell's equations)
3. Three basic coordinate systems and polarization.