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

Sr. No.	Year	Sem.	Course Code	Course Name	Offering Department	Eligible Branch
1	III	V	PHUL560	Introduction to Nanotechnology	Physics	ALL
2	III	V	EEUL560.2	Energy Audit and Demand Side Management	EE	CS/AI/ DS/IOT/ IT/ CE/ EC/ ME
3	III	V	CEUL560.1	Climate Change Science	CE	CS/AI/ DS/IOT/ IT/ EC/ EE/ ME
4	III	V	MEUL560.1	Fundamentals of Robotics	ME	CS/AI/ DS/IOT/ IT/ CE/ EC/ EE
5	III	V	MEUL560.2	Electric Vehicle Fundamentals	ME	CS/AI/ DS/IOT/ IT/ CE/ EC/ EE
6	III	V	ECUL560.1	Introduction to Sensors and Actuators	EC	CS/AI/ DS/IOT/ IT/ CE/ EE/ ME
7	III	V	ECUL560.2	Semiconductor Technology and Applications	EC	CS/AI/ DS/IOT/ IT/ CE/ EE/ ME
8	III	V	ECUL560.3	Fundamentals of Communication Systems	EC	CS/AI/ DS/IOT/ IT/ CE/ EE/ ME
9	III	V	CSUL560.1	AI for Everyone	CS	IT/ CE/ EC/ EE/ ME

Syllabus

Name of the Programme: B. Tech. (Common to all)	**Year**: III	**Semester**: V
Course Name: Introduction to Nanotechnology	**Course Code**: PHUL560	**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	**Unit–1: Fundamentals of Nanoscience and Nanotechnology:** Introduction to nanoscience and nanotechnology, Historical background and scientific revolutions leading to nanotechnology, Size scale and classification of nanomaterials, Surface-to-volume ratio and its significance, atomic structure, molecules, and phases at nanoscale, Energy considerations at atomic and molecular scale, Quantum effects in nanomaterials, Dimensionality (0D, 1D, 2D, 3D nanostructures), Size and shape dependent properties: Electronic, electrical, Magnetic, dielectric, Optical, ferroelectric and Mechanical properties	8
3	**Unit–2: Basic Synthesis Techniques for Fabrication of Nanomaterials** Top-down Approaches: Ball milling, Physical vapor deposition (PVD), Sputtering techniques: DC, RF, Magnetron sputtering, Pulsed laser deposition (PLD), Ion sputtering, E-beam lithography. Bottom-up Approaches: Sol-gel method, Solvothermal synthesis, Photochemical synthesis, Electrochemical synthesis, Chemical reduction methods (metal nanocrystals)	8
4	**Unit–3: Basic Characterization Techniques of Nanomaterials** Structural Characterization: X-ray diffraction (XRD), Electron diffraction, Neutron diffraction, Microscopy Techniques: Optical microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Tunneling Microscopy (STM), Spectroscopic Techniques: UV–Visible spectroscopy, Infrared (IR) and Fourier Transform Infrared (FTIR) spectroscopy, Raman spectroscopy, Photoluminescence (PL) spectroscopy.	9

5	**Unit–4: Functional Nanomaterials and Nanostructures** Hybrid nanomaterials: core-shells, nanoshells, Self-assembled nanostructures and superlattices, Nanocomposites: polymeric and ceramic, Nanoporous materials and nanofluids, Nanolayers and thin films Carbon-based Nanomaterials: Fullerene: structure, properties, applications, Carbon nanotubes (CNTs): types, properties, applications, Graphene: structure, properties, applications Bio-inspired Nanomaterials: Biomimetic and bioinspired nanomaterials, Self-assembly in biological systems	10
6	**Unit–5: Nanomaterials, Devices, and Applications** Nanomaterials in healthcare and drug delivery, Biosensors and nanosensors, Coatings and surface engineering, Environmental applications (water purification, pollution control), Catalysis and green chemistry, Applications in agriculture, Automotive and aerospace applications, Nanoelectronics and photonics, Information technology and quantum computing, Energy applications (solar cells, batteries, supercapacitors)	9
	Total	**45**

Text Books:

1. W. D. Callister Jr. and D. G. Rethwisch, *Materials Science and Engineering: An Introduction*, 9th ed. New York, NY, USA: John Wiley & Sons, 2014.
2. C. P. Poole Jr. and F. J. Owens, *Introduction to Nanotechnology*. New York, NY, USA: John Wiley & Sons, 2003.
3. L. M. Liz-Marzán and P. V. Kamat, *Nanoscale Materials*. Boston, MA, USA: Springer/Academic Press, 2003.
4. C. N. R. Rao, A. Müller, and A. K. Cheetham, Eds., *The Chemistry of Nanomaterials: Synthesis, Properties and Applications*. Weinheim, Germany: Wiley-VCH Verlag GmbH & Co. KGaA, 2004.
5. L. L. Shaw, Ed., *Processing and Properties of Structural Nanomaterials*. Hoboken, NJ, USA: Wiley/Elsevier, 2008.
6. G. Cao, *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*. London, U.K.: Imperial College Press, 2004.
7. V. V. Novikov and V. L. Novikov, *Grain Growth and Control of Microstructure: Lectures in Polycrystalline Materials*. Boca Raton, FL, USA: CRC Press, 1997.
8. G. Cao, *Nanostructures and Nanomaterials: Synthesis, Properties and Applications*. London, U.K.: Imperial College Press, 2004.
9. P. Sheng, Ed., *Nanoscience and Technology: Novel Structures and Phenomena*. Berlin, Germany: Springer, 2003.
10. M. Rieth, *Nano-Engineering in Science and Technology: An Introduction to the World of Nano Design*. Singapore: World Scientific Publishing, 2003.
11. B. D. Cullity and S. R. Stock, *Elements of X-ray Diffraction*, 3rd ed. Upper Saddle River, NJ, USA: Prentice Hall, 2001.
12. H. H. Willard, L. L. Merritt Jr., J. A. Dean, and F. A. Settle Jr., *Instrumental Methods of Analysis*, 7th ed. Belmont, CA, USA: Wadsworth Publishing, 1986.
13. C. R. Brundle, C. A. Evans Jr., and S. Wilson, Eds., *Encyclopedia of Materials Characterization*. Boston, MA, USA: Butterworth-Heinemann, 1992.

Prerequisite:

1. Basic knowledge of materials' physical properties

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Syllabus

Name of the Programme: B.Tech. in Civil Engineering	**Year**: III	**Semester**: V
Course Name: Climate Change Science	**Course Code**: CEUL560.1	**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.

Syllabus

Name of the Programme: B. Tech. in Electrical Engineering	**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

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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.)

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Syllabus

Name of the Program: B. Tech.	**Year**: III	**Semester**: V
Course Name: Fundamental of Communication System	**Course Code**: ECUP560.3	**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	**AMPLITUDE MODULATION**: Concept of frequency translation. Amplitude Modulation: Description of full AM, DSBSC, SSB and VSB in time and frequency domains, methods of generation & demodulation, frequency division multiplexing (FDM).	8
3	**Angle Modulation:** Phase and frequency modulation. Descriptions of FM signal in time and frequency domains, methods of generation & demodulation, pre- emphasis & de-emphasis, PLL.	9
4	**PULSE ANALOG MODULATION**: Ideal sampling, Sampling theorem, aliasing, interpolation, natural and flat top sampling in time and frequency domains. Introduction to PAM, PWM, PPM modulation schemes.	9
5	**PCM & DELTA MODULATION SYSTEMS**: Uniform and Non-uniform quantization. PCM and delta modulation, Signal to quantization noise ratio in PCM and delta modulation. DPCM, ADM	9
6	**DIGITAL MODULATION**: Baseband transmission: Line coding (RZ, NRZ), inter symbol interference (ISI), pulse shaping, ASK PSK, FSK modulation techniques, coherent detection and calculation of error probabilities.	9
	Total	**45**

Text Books:

1. Principles of communication systems- Taub & Schilling, Gautam Sahe, TMH, 4th Ed., 2017.
2. Principles of communication systems- Simon Haykin, John Wiley, 4th Ed., 2016.
3. Analog and Digital Communication system- Sanjay Sharma, Katson Publication, 7th Ed. 2022.

Reference Books:

1. Communication Systems- 2nd Ed- R.P. Singh, SP Sapre, TMH 3rd ED. 2017.

2. Communication Systems- B.P. Lathi, BS Publications, 4th ED., 2017
3. Analog Communication- K.N. Hari Bhat & Ganesh Rao, Pearson Publication, 2nd Ed., 2010.

Prerequisite:

1. Basic knowledge of Signal System
2. Basic Electronics