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| **Course Code** | **Course Title** | Credits | **Teaching Hours** |
| ECED01 | **Nanoscience and Technology** | 4 | 52 Hours |
| **Course assessment method:** | | | |
| Semester End Exam : 100 Marks | | | Duration:3 Hours |

## Syllabus

**UNIT: 1 -Introduction:** Overview of nano science and engineering. Classification of Nanostructures, Bonding of atoms and electronic conduction, Electronic properties of atoms and solids, Fabrication methods, Top down processes, Bottom up processes methods for templating the growth of nanomaterials. **10 Hours**

**UNIT: 2 - Characterization**: Classification, Microscopic techniques, Field ion microscopy, scanning probe techniques, diffraction techniques: bulk, surface, spectroscopy techniques: photon, radiofrequency, electron, surface analysis, Reflection High Energy Electron Diffraction (RHEED), Position-sensitive Atom Probe (POSAP) Spectroscopy. **10 Hours**

**UNIT: 3 - Inorganic semiconductor nanostructures**: overview of semiconductor physics, Quantum confinement in semiconductor nanostructures: quantum wells, quantum wires, quantum dots, super lattices, band offsets, electronic density of states. Semiconductor nano crystals, colloidal quantum dots, Light emitting semiconductor quantum dots, nano cuboids, graphene, carbon quantum dots, single crystalline silicon, self-assembly techniques. Optical, electrical and structural characterization of semiconductor nanostructures. **12 hours**

**UNIT: 4 - Properties of nanoparticles:** metal nano clusters, semiconducting nanoparticles, rare gas and molecular clusters, methods of synthesis. Carbon nanostructures and its applications. Self-assembling nano structured molecular materials and devices, methods to prepare and pattern nanoparticles, templated nanostructures. Nanomagnetism in technology and challenges. **10 Hours**

**UNIT: 5 - Applications of Nanomaterials:** Nano-electronics, Micro- and Nano-electromechanical systems (MEMS/NEMS), Nanosensors, Nanocatalysts, Food and Agriculture Industry, Cosmetics and Consumer Goods, Structure and Engineering, Automotive Industry, Water Treatment and the Environment, Nano-medical Applications Textiles, Paints, Energy, Defense and Space Applications, Structural Applications. **10 Hours**

**Text books / References:**

**Text books:**


1. Ed Robert Kelsall, Ian Hamley, Mark Geoghegan, “Nanoscale science and technology”, John Wiley and Sons Pvt. Ltd., 2007.
2. B S Murty P Shankar Baldev Raj B B Rath James Murday, “Textbook of Nanoscience and Nanotechnology”, Universities press, Springer publications, 2013.
3. Charles P Poole, Jr, Frank J Owens “Introduction to Nanotechnology”, John Wiley and Sons Pte. Ltd., Copyright 2006, Reprint 2011.

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| **Course Code** | **Course Title** | Credits | **Teaching Hours** |
| ECED02 | **Smart Materials** | 4 | 52 Hours |

**Course assessment method:**

Semester End Exam : 100 Marks Duration:3 Hours

## Syllabus

**Unit1: General Introduction** to Smart Materials, Review of Piezoelectric Materials,Piezoresistive Materials as Smart Sensors, Electrostrictive Materials, Self-healing Materials, Dielectric Elastomers (DEs) as Smart Materials, Shape Memory Polymers (SMPs) as Smart Materials,Conductive Polymers as Smart Materials, Smart Materials for Controlled Drug Release, Smart Nanogels for Biomedical Applications. **12 Hours**

**Unit2: Fullerene:** Prediction and discovery, variations, buckyball, properties of Fullerene. Carbon Nanotubes: Types of carbon nanotubes and related structures, properties and applications, Boron Nitride nanotubes, selective chemistry of single walled nanotubes Nanowire:Synthesis of nanowires, physics, molecular wires and fabrication, solar nanowires.**10 Hours**

**Unit3: Self assembly:** Mechanism and examples of self-assembly, Nanophotonics:Components of nanophotonic system, Nanomaterial Synthesis and Application: Introduction, uniformity, properties, nanoscale and nanoshell particles, nanotoxicity.**10 hours**

**Unit4: Properties of Smart materials**: Electrical properties, optical properties, the coloredglasses. Other nanomaterials: Importance of nanomaterials, nano-Optics, nano-Magnetics, nano-Electronics materials, shape memory alloys etc. **10 Hours**

**Unit5: Nanocomposites and their applications:** Nanocomposites clay based, nanoceramiccomposites, metal and oxide nanocomposites, processing and characterization, nanotechnology in electronics and allied industries. **10 Hours**

**Text books / References:**

**Text Books:**


1. Mohsen Shahinpoor (2020), Fundamentals of Smart Materials, Royal society of Chemistry, 2020.
2. Breck, W. (2016). NANOTECHNOLOGY VOL.1. CBS Publishers and Distributors Private Limited.
3. Breck, W. (2018). NANOTECHNOLOGY VOL.2. CBS Publishers and Distributors Private Limited.
4. V Raghavan. (2015). Materials science and engineering : a first course. Phi Learning Private Limited.
5. Kulkarni, S. K. (2019). Nanotechnology: Principles and Practices. Springer.

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| **Course Code** | **Course Title** | Credits | **Teaching Hours** |
| ECED03 | **Advanced Wireless Communication** | 4 | 52 Hours |

**Course assessment method:**

Semester End Exam : 100 Marks Duration:3 Hours

## Syllabus

**Unit 1:** Introduction to Wireless Communication Systems: Evolution,2G,4G.5G,6G, Mobile Radio Systems Around the World, Examples, Cellular Telephone Systems, Comparison of Common Wireless Communication Systems, Trends in Cellular Radio and Personal Communications. Modern Wireless Communication Systems: Wireless Local Loop (WLL) and LMDS, Wireless Local Area Networks (WLANs), Bluetooth and Personal Area Networks (PANs) **10 hours**

**Unit 2:** The Cellular ConceptSystem Design Fundamentals: Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Prioritizing Handoffs, Interference and System Capacity, Co-channel Interference and System Capacity, Adjacent Channel Interference, Power Control tor Reducing Interference, Trunking and Grade of Service, Improving Coverage and Capacity in Cellular Systems, Sectoring. Mobile Radio Propagation: Large-Scale Path Loss: Free Space Propagation Model, Relating Power to Electric Field, The Three Basic Propagation Mechanisms, Reflection, Ground Reflection (Two-Ray) Model, Scattering, Indoor Propagation Models, Signal Penetration into Buildings **10 hours**

**Unit 3:** Mobile Radio Propagation: Small-Scale Fading and Multipath, Small-Scale Multipath Propagation, Factors Influencing Small-Scale Fading, Doppler Shift, Fading Effects Due to Multi path Time Delay Spread, Fading Effects Due to Doppler Spread, Rayleigh and Ricean Distributions, Rlcean Fading Distribution, Statistical Models for Multipath Fading Channels, Capacity of Cellular Systems **12 hours**

**Unit 4:** Wireless Networking: Differences Between Wireless and Fixed Telephone Networks, Development of Wireless Networks, Fixed Network Transmission Hierarchy, Traffic Routing in Wireless Networks, Circuit Switching, Packet Switching, Wireless Data Services, Common Channel Signaling (CCS), Integrated Services Digital Network (ISDN). Signaling System No.7 (SS7). Protocols for Network Access, Network Databases, Universal Mobile Telecommunication System (UMTS) **10 hours**

**Unit 5:** Wireless Systems and Standards: AMPS, United States Digital Cellular (IS-54 and IS-136), Global System for Mobile (GSM), COMA Digital Cellular Standard (IS-95), CT2 Standard for Cordless Telephones, Digital European Cordless Telephone (DECT), Noise Figure Calculation for Link Budgets **10 hours**

**Text books / References:**


1. Wireless communication : Principal and practices by Theodore S Rappaport, second edition , Pearson Publication,2010
2. Vijay Garg, “Wireless Communications and networking”, First Edition, Elsevier 2007.
3. Wireless communication by Andrea Goldsmith ,2009

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| **Course Code** | **Course Title** | Credits | **Teaching Hours** |
| ECED04 | **Biomedical Signal Processing** | 4 | 52 Hours |

**Course assessment method:**

Semester End Exam : 100 Marks Duration:3 Hours

## Syllabus

**Unit 1: Introduction To Biomedical Signals** - Significance of bio electric potentials,Examples of Biomedical signals - ECG, EEG, EMG etc., Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - Fourier Transform and Time Frequency Analysis (Wavelet) of biomedical signals- Processing of Random & Stochastic signals – spectral estimation – Properties and effects of noise in biomedical instruments The Brain and its potentials. Electrophysiological origin of brain waves. EEG signal and its characteristic- ECG signal origin and characteristics. **10 Hours**

**Unit 2: Filtering in biomedical instruments.** Concurrent, Coupled and Correlated Processes - Illustration with case studies – Adaptive and optimal filtering - Modeling of Biomedical signals - Detection of biomedical signals in noise -removal of artifacts of one signal embedded in another - Maternal-Fetal ECG – Musclecontraction interference. Event detection - case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals. **10 Hours**

**Unit 3: Cardio Vascular Applications:** Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multi-scale analysis for ECG parameters estimation - Noise & Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis **10 hours**

**Unit 4: Data Compression:** Lossless & Lossy- Heart Rate Variability – Time Domain measures - Heart Rhythm representation - Spectral analysis of heart rate variability - interaction with other physiological signals. **10 Hours**

**Unit 5: Neurological signal Applications:** The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models – Non-linear modeling of EEG - artifacts in EEG & their characteristics and processing – Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis – correlation analysis of EEG channels - coherence analysis of EEG channels. Parametric modelling – Linear prediction theory; Autoregressive (AR) method; Recursive estimation of AR parameters. **12 Hours**

**Text books / References:**

**Text Books:**


1. D. C Reddy, “Biomedical Signal Processing, Principles and Techniques”, Tata McGraw Hill Publishing Company Limited, First Edition, 2005
2. Willis J Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall India Private Limited, First Edition, 2006.
3. Rangaraj M Rangayyan “Biomedical Signal Analysis – A case study approach” IEEE press series in biomedical engineering, First Edition, 2002.
4. John G Proakis, Dimitris and G. Manolakis, “Digital Signal Processing Principles algorithms, applications” PHI Third Edition. 2006
5. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley,2001

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| **Course Code** | **Course Title** | Credits | **Teaching Hours** |
| ECED05 | **Machine Learning** | 4 | 52 Hours |

**Course assessment method:**

Semester End Exam : 100 Marks Duration:3 Hours

## Syllabus

**Unit 1: Introduction:** Learning Problems – Designing Learning systems, Perspectives and Issues – Concept Learning – Version Spaces and Candidate Elimination Algorithm – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search **10 Hours**

**Unit 2: Regression:** Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM Clustering: k-means, Adaptive hierarchical clustering, Gaussian mixture model. **10 Hours**

**Unit 3: Neural networks and genetic algorithms:** Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evolution and Learning**. 12 Hours**

**Unit 4: Bayesian and computational learning:** Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier– Bayesian Belief Network – EM Algorithm – Probably Learning – Sample Complexity for Finite and Infinite Hypothesis Spaces – Mistake Bound Model. **10 Hours**

**Unit 5: Instant based learning:** K- Nearest Neighbor Learning – Locally Weighted Regression – Radial Basis Functions –Case-Based Reasoning – Sequential Covering Algorithms – Learning Rule Sets – Learning First Order Rules – Learning Sets of First Order Rules – Induction as Inverted Deduction – Inverting Resolution **10 Hours**

**Text books / References:**


1. Tomm. Mitchell "Machine Learning" McGraw Hill Education, 22nd reprint 2018.
2. EthemAlpaydin "Introduction to Machine Leaning" PHI Learning Pvt. Ltd, 2 nd Ed., 2013
3. Cheistopher M. Bishop "Pattern Recognition and Machine Learning" Springer, Second Indian Reprint, 2015.
4. T. Hastie, R. Tibshirani, J. H. "The Elements of Statistical Learning" Springer, 1st edition, 2001

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| **Course Code** | **Course Title** | Credits | **Teaching Hours** |
| ECED06 | **Microelectronics** | 4 | 52 Hours |

**Course assessment method:**

Semester End Exam : 100 Marks Duration:3 Hours

## Syllabus

**Unit 1: Semiconductor electronics:** Physics of Semiconductor Materials, Band Model of Solids, Thermal-Equilibrium Statistics, Carriers in Semiconductors, Drift Velocity, Mobility and Scattering, Drift & Diffusion Current, Hall-Effect. **10 hours**

**Unit 2: Metal Semiconductor contacts and PN Junctions:** Metal Semiconductor junctions, Current-Voltage Characteristics, Surface Effects. The PN junction, Step Junction, Linearly Graded junction, Heterojunctions, Reverse-Biased PN junctions and breakdown mechanism. Generation and Recombination. **10 hours**

**Unit 3: Field Effect Transistor (MOSFETs): Physical effects and Models:** MOS Capacitor, Flat Band Voltage, Oxide and Interface Charge, High and Low Frequency C-V Characteristics: Origin and Experimental Determination. Charge- Coupled Devices, non-volatile memory. Basic MOSFET behaviour, MOSFET scaling and short channel behaviour. Devices: Complementary MOSFETs (CMOS), electric fields and velocity-saturation, basic leakage currents, channel length modulation, body bias effect, threshold adjustment, sub-threshold conduction. **12 hours**

**Unit 4:CMOS Process Technology:** Fabrication process flow- basic steps, the CMOS n-Well process, layout design rules, stick diagram, full-custom mask layout design with case studies. **10 hours**

**Unit 5: Sequential MOS logic circuits & Semiconductor Memories:** Behaviour of bi-stable elements, SR latch circuits, clocked latch and flip-flop circuits, CMOS D-latch and edge-triggered flip-flop. Timing path, Setup time and hold time static, example of setup and hold time static, setup and hold slack, clock skew and jitter, Clock, reset and power distributions. Memory Design, SRAM, DRAM structure and implementations. **10 Hours**

**Text books / References:**


1. Physics of Semiconductor Devices by S. M. Sze and Kwok K. Ng, 3rd Edition, (John Wiley & Sons, 2002).
2. Semiconductor Device Fundamentals by Robert F. Pierret, Addison-Wesley Publishing, 1996.
3. Semiconductor Physics and Devices by Donald A. Neamen, 3rd Edition, Mc Graw Hill, 2003.
4. Semiconductor Devices- Basic Principles", by Jasprit Singh, John Wiley and Sons Inc., 2001.
5. N. H. E. Weste and C. Harris, "Principles of CMOS VLSI Design: A System Perspective, 3rd Edition, Pearson Education 2007.
6. CMOS Digital Integrated Circuits, Sung-Mo Kang,YusufLeblebici, 3rd edition, Tata McGrawHill, 2003.

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| **Course Code** | **Course Title** | Credits | **Teaching Hours** |
| ECED07 | **AI and Robotics** | 4 | 52 Hours |

**Course assessment method:**

Semester End Exam : 100 Marks Duration:3 Hours

## Syllabus

**Unit 1: Introduction**: Intelligent Agents, Agents and environment, Rationality, the nature of environment, the structure of agents, Goal based agents, Utility based agents, Learning agents. **Problem-solving**: Problem space & search, defining the problem as state space search, production system, Problem characteristic, Issues in the design of search programs. **10 Hours**

**Unit 2: Search Techniques**: Searching for Solutions, Uninformed Search Strategies, Breadth First search, Depth First Search, Iterative deepening depth first search, Informed Search Strategies, Heuristic functions, Greedy best first search, A*search.
**Logical Agents:** Knowledge –based agents, The Wumpus world, Logic-Propositional logic, Propositional theorem proving, Effective propositional model checking Agents based on propositional logic. **10 Hours**

**Unit 3: Using predicate logic:** Representing simple facts in logic, Computable functions and predicates, Resolution, Forward reasoning, backward reasoning.
**Learning**: Forms of Learning; Inductive learning, Learning decision trees, Explanation based learning, learning using relevance information, Neural net learning & genetic learning.
**10 Hours**

**Unit 4: Introduction to Robotics:** Definitions, Laws of Robotics, Robot anatomy, Design and control issues, Manipulation and Control, Sensors and Vision, Programming Robots.
**Coordinate Frames, Mapping and Transforms:** Mapping Frames, Description of objects in Space, Transformation of Vectors, Inverting a Homogeneous Transform, Fundamental Rotation Matrices **10 Hours**

**Unit 5: Modelling of Robots:** Direct Kinematics, Mechanical Structures and Notations, Description of Links and Joints, Kinematic Modeling of Manipulator, Denavit-Hartenberg notation, Kinematic Relationship between Adjacent Links, Manipulator Transformation Matrix. Inverse Kinematics, Manipulator Workspace, Solvability of Inverse Kinematic Model, Solution Techniques and Closed form Solution.
**Manipulator Differential Motion and Statics:** Linear and Angular Velocity of a Rigid body, Relationship between Transformation Matrix and Angular Velocity, Mapping Velocity Vector, Velocity Propagation along Links, Manipulator Jacobian, Jacobian Inverse and Singularities, Static Analysis. **10 Hours**

**Text books / References:**


1. Stuart Russel, Peter Norvig, *Artificial Intelligence: A Modern Approach*, 3rd Edition, Pearson Education, 2010. (Twelfth Impression,2018)
2. Elaine Rich, Kevin Knight, Shivashankar B Nair, *Artificial Intelligence*, Tata MCGraw Hill 3rd edition. 2013.(24th Reprint 2018)
3. R. K. Mittal and I. J. Nagarath: *Robotics and Control*, 6th Reprint, Tata Mcgraw-Hill Education, Delhi2007.
4. John J. Craig, *Introduction to Robotics: Mechanics and Control*, 3rd Ed, Pearson Education, New Delhi 2006.