CEOE16	HYDRO POWER ENGINEERING	OE	3 0 0	3

Internal: 50 Marks	End Term: 50 Marks	Total: 100 Marks

1. Introduction

Sources of power, estimation of water power, necessity and importance of harnessing small hydro power, flow duration and power duration curves, load curve, load factors, capacity factors, utilization factors, firm and secondary power.

2. Types of Hydro Power Plants

Elements of Hydro power, classification of hydro-power plants, run-of-river plants, storage plants diversion canal development, pumped storage plants, tidal power plants, base load and peak load plants in a power grid.

3. Intakes

Intake structures, functions and their types, components of intakes-forebay, trash racks, gates and valves, force required to operate gates.

4. Conveyance System

Penstocks, design criterion, economical diameter anchor blocks, cradles and footings, water hammer, instantaneous closure of power canal, surge tank, surges in canals.

5. Turbines

Types of turbines, specific speed and classification of turbines, synchronous speed, scroll casing, flumes and draft tubes, dimensions of scroll casing and draft tubes, setting of turbines

6. Power House

General layout and arrangements of hydro-power units, number and size of units, sub-structure, spacing of units, super-structure, underground power stations, tidal power.

Reference Books

1 Water Power Engineering, Dandekar, M.M., Sharma,K.N.
2 Hydro-Electric Engineering Practice Vol.I ,II & III Brown J.G.
3 Water Power Engineering, Borrows, H.K.
4 Water Power Development, Vol.I & II, Mosonyi,E.
5 Water Power Engineering, M.M.Deshmukh.

CEOE18	ADVANCED CONCRETE TECHNOLOGY	OE	3	0	0	3

Internal: 50 Marks	End Term: 50 Marks	Total: 100 Marks

Pre-requisites: Knowledge of Concrete and its ingredients.

Introduction - Concrete materials - Cement: Physical tests on cement - Concrete materials - Tests on aggregates - Quality of Water for mixing and curing - use of sea water for mixing concrete. Rheology of concrete- Introduction, Rheological behaviour, Factors affecting rheological properties, mixture adjustments.

Mix Design - factors influencing mix proportion - Mix design by ACI method and I.S. code method - Design of normal concrete, high strength concrete and self compacting concrete. Admixtures - accelerating admixtures - Retarding admixtures - water reducing admixtures - Air entraining admixtures - coloring agent - Plasticizers. Batching - Mixing -Transportation - Placing of concrete - curing of Concrete.

Strength of Concrete - Shrinkage and temperature effects - creep of concrete - permeability of concrete - durability of concrete - Corrosion - Causes and effects - remedial measures- Thermal properties of concrete - Micro cracking of concrete, microstructure of concrete. Classification of causes of concrete deterioration – Permeability of concrete – Chloride penetration – Acid attack - Sulfate attack – Alkali-aggregate reaction – Concrete in sea water – AC impedance test - Corrosion of embedded steel in concrete – Case histories..

Special Concrete - High Performance Concrete (HPC) Introduction – Principles of HPC – Ingredients used for HPC – Production of HPC – Curing of HPC – Mechanism of HPC – Properties of HPC during the fresh and hardened state. Durability of HPC - Acid Attack – Permeability – Scaling resistance – Chloride penetration – Resistance to sea water – sulfate attack – Alkali-aggregate reaction – Fire resistance – Mix design methods of HPC. Special High Performance Concrete-Air-entrained HPC Reactive powder Concrete-Bio concrete-Geo polymer, Fiber reinforced concrete Quality control - Sampling and testing-Acceptance criteria.

Reference Books

1. Shetty, M.S., Concrete Technology, Theory & Practice, S.Chand and Co, 2004.
2. Gambhir, M.L., Concrete Technology, Tata McGraw Hill, 2004.
3. Nevile, Properties of Concrete, Longman Publishers, 2004.
4. Santakumar A.R., Concrete Technology, Oxford University Press, New Delhi, 2007.
5. P.-C.Aïtcin, High Performance Concrete, E &FN SPON, 1998
6. E.G.Nawy, Fundamentals of High Performance Concrete, John Wiley & Sons., 2nd edition, 2000
7. High Performance Concrete Structural Designers Guide published by FHWA, USA, 2005.
8. Geert De Schutter, Peter J.M. Bartos, Peter Domone, John Gibbs, Self Compacting Concrete, Whittles Publishing, 2008.

MICROCONTROLLERS

Course Code	:	ECOE80
Course Title	:	MICROCONTROLLERS
Number of Credits		03
Prerequisites (Course code)	:	ECPC34
Course Type	:	OE

Course Learning Objectives

Course will provide the understanding of the difference between microprocessor and microcontroller and basics of embedded System. Students will be able to apply the principles of logic design in understanding architecture and memory organization, understand different peripherals and their interfacing concepts with microcontroller.

Course Content

UNIT I

INTRODUCTION: Comparing Microprocessors and Microcontrollers. Technological trends in Microcontrollers development, Survey of microcontrollers- 4 bit, 8 bit, 16 bit, 32 bit microcontrollers, Applications of microcontrollers.

UNIT II

8051 ARCHITECTURE: Block diagram, pin diagram of 8051. Functional descriptions of internal units, registers, PSW, internal RAM, ROM, Stack, Oscillator and Clock. I/O Pins, Ports and Circuits Connecting external memory, Counters and timers. Serial data interrupt. Serial data transmission/reception and transmission modes, Timer flag interrupt. External interrupt, software generated interrupts. External memory and memory space decoding, expanding I/Os, memory mapped I/O Reset & CLK Circuits.

UNIT III

8051 INSTRUCTION SET AND PROGRAMMING: 8051 Instruction syntax, addressing modes, Data transfer instructions, logical instructions, arithmetic instructions, Jump and Call instructions. Interrupts and interrupt handler subroutines, Writing assembly Language programs, Time delays, Pure S/W time delays. S/W polled timer, Pure H/W delay. Lookup tables, Serial data transmission using time delays and polling. Interrupt driven serial transmission and reception.

UNIT IV

8051 APPLICATIONS: Interfacing Keyboards Programs for small keyboards and matrix keyboards. Interfacing multiplexed displays, numeric displays and LCD displays, Measuring frequency and pulse width, Interfacing ADCs & DACs. Hardware circuits for handling multiple interrupts, 8051 Serial data communication modes- Mode 0, Mode 1, Mode 2 and Mode 3.

Reference Books:

1. K. J. Ayala, The 8051 Microcontroller – 2nd ed. Penram International.
2. Intel's manual on "Embedded Microcontrollers"

Course outcomes

At the end of the course student will be able to

1. Apply knowledge of mathematics, engineering to understand concepts in microcontroller based system.
2: Analyze a problem and formulate appropriate computing solution for microcontroller based applications.
3: Design experiments in microcontrollers analyze computer based process to meet desired needs
4: Work, document and present as an individual and as a team-member to design formulate and implement experiments using modern tools.
5: Select appropriate microcontroller for different application.
6: Write and execute assembly language programs (software) for given application

SENSOR TECHNOLOGY

Course Code	:	ECOE81
Course Title	:	Sensor Technology
Number of Credits		3
Prerequisites(Course code)	:	ECPE70
Course Type	:	OE

Course Learning Objectives

Course will provide the understanding of the right sensors for a given application and design basic circuit buildi ng blocks. Also help to simulate, synthesize, and layout a complete sensor and sensor system.

Course Content

Unit I

Principles of Sensing, Classification and Terminology of Sensors, Measurands. Sensors types and classification – mechanical, acoustic, magnetic, thermal, chemical, radiation and biosensors.

Unit II

PHYSICAL PRINCIPLE OF SENSING: Electric charges, field and potential, capacitance, magnetism and induct ion, resistance, piezeoelectric effect, hall effect, temperature and thermal properties of materials, heat transfer, l ight, dynamic models of sensor elements.

Unit III

Wireless Sensors and its applications**,** Modeling and simulation of microsensors and actuators, Sensors and sm art structures. Micro-opto-electro-mechanical sensors and system, Interworking with IoT.

Unit IV

SENSORS IN DIFFERENT APPLICATION AREAS: occupancy and motion detectors, position displacement an d level, velocity and acceleration, force, strain and tactile sensors, pressure sensors and temperature sensors.

Reference Books:

1. J. Fraden, Handbook of Modern Sensors:Physical, Designs, and Applications, AIP Press, Springer.
2. Sze S.M “Semiconductor Sensors”, John Wiley, New York, 1994.
3. Ristic L,“Sensor Technology and Devices”, Artech House, London, 1994.
4. Gerard Meijer, Kofi Makinwa, “Smart Sensor Systems: Emerging Technologies and Applications”, ISBN: 978-0-470-68600-3, April 2014.

Course outcomes

1. understand the concept of sensors and it's characteristics.
2. understand the practical approach in design of technology based on different sensors
3. learn various sensor materials and technology used in designing sensors
4. synthesis and analyze wireless sensors for advanced applications
5. understand the software and hardware designing aspects of sensors co-existing with other systems
6. propose new applications for sensors.

DEPARTMENT OF PHYSICS

(B. TECH: VII Sem.)
(OPEN ELECTIVE)

PHOE403: LASER TECHNOLOGY

L	T	P	Credits	Total contact hours
3	0	0	3	36

Pre-requisite: PHIC101

Brief Description about the course: This course elaborates the interaction of light with matter and physical principles underlying the fabrication of laser systems, necessary conditions laser active materials and their applications in different fields of science and technology.

Course Content

UNIT-I (9 Hours)

Laser Fundamentals: Concept of Laser emission, Characteristics of Lasers, Main components of Laser system, Necessary and sufficient conditions for Laser action, Einstein coefficients, population inversion, laser pumping, two, three and four level laser systems.

UNIT-II (9 Hours)

Laser Beam Propagation and Transformation: Optical cavities, Types of optical resonator, Stability criterion (stable and unstable resonator), Threshold gain coefficient, Resonator modes (longitudinal and transverse modes), Threshold condition of laser oscillation, Q-switching and mode locking.

UNIT-III (9 Hours)

Types of Laser: Solid State laser (Ruby laser, Nd: YAG, Nd: Glass etc), Gas laser (CO_2 and Argon ion laser) and Dye laser, Excimer laser, Free electron laser, Chemical laser and Semiconductor laser, Homojunction Laser (Laser Diode) and Heterojunction Laser.

UNIT-IV (9 Hours)

Laser Applications: Laser in materials processing and industry, Lasers in Micro- and Nano-fabrication and metrology, Lasers in spectroscopy, Lasers in communication and Holography, Lasers induced fusion, Laser systems for biomedical and remote sensing applications.

Text Books/Reference Books

T-1: W.T. Silfvast, **"Laser Fundamentals"**, Cambridge University Press, 2004

T-1: B.B. Laud, **"Lasers and Non-linear Optics"**, Wiley Eastern Limited, 2nd Edition 1991

R-1: Orazio Svelto, **"Principle of Lasers"**, 5th Edition, Springer New York 2010

R-2: K Thyagarajan and Ajoy Ghatak, **"Lasers: Fundamentals and Applications"**, Springer, USA, 2010.

R-3: Ajoy Ghatak and K. Thyagarajan, **"Fiber Optics and Lasers: The two revolutions"**, Macmillan India, 2006, Reprint 2008-09.

R-4: G. Kaur and Gary R. Pickrell, **"Modern Physics"**, McGraw Hill education, 2014.

Course Outcomes:

At the end of the course students will be able to:

CO1: Know latest developments in laser technology and their applications in science, technology and research.

CO2: Utilize laser technology in modern devices and technologies based on lasers.

CO3: Apply laser technology in spectroscopic and industrial applications.

DEPARTMENT OF PHYSICS

(B. TECH: VIII Sem.)
(OPEN ELECTIVE)

PHOE404: ULTRASONICS AND APPLICAITONS

L	T	P	Credits	Total contact hours
3	0	0	3	36

Pre-requisite: PHIC101

Brief Description about the course: This course provides knowledge about the physics of ultrasonic waves, ultrasonic instruments their applications in industries.

UNIT- I (9 Hours)

Concept of Ultrasonics: Physics of ultrasonics-wave motion, velocity of propagation, characteristic impedance, reflection, attenuation and transmission through layers, Acousto-optic effect, Acoustic Grating, Ultrasonic velocity and thickness measurement.

Unit II (9 Hours)

Production of Ultrasonics: Ultrasonic transducers: piezoelectric and magnetostrictive transducers, Equivalent circuits, Impedance matching, High and low power devices.

Unit III (9 Hours)

Ultrasonic Instrumentation: Detection of Ultrasonic, Instrumentation and applications: Ultrasonic sensing using plus echo and Doppler techniques, SONAR, Industrial processing units, Ultrasonic measurement and control; Limitation of Ultrasonics.

Unit IV (9 Hours)

Ultrasonic Industry Application: Industrial Ultrasonic: Drilling, welding and soldering, Ultrasonic testing, Cavitation, Ultrasonic cleaning, Flaw detection diagnostic: Pulse–echo and Transmission technique, Echocardiogram, Laser Ultrasonics, Ultrasonic Microscopy, Ultrasonic imaging and therapy.

Text Books/Reference Books

T-1: J. David & N. Checke, **"Fundamental and Applications of Ultrasonics"**, 2nd Edition, CRC Press, 2017.

T-2: Ensminger, **"Ultrasonics Fundamental, Technology & Applications"**, CRC Press, 2011.

R-1: K C Srivastava, **"Ultrasonic Testing"**, 2003.

Course Outcome

At the end of the course Students will be able to:

CO1: Realize the concept of ultrasonics and its industrial applications.

CO2: Design and develop ultrasonic instrumentations for potential applications.

CO3: Solve industrial problems and design instruments on ultrasonics.

Course Code	**:**	**CSOE40**
Course Title	**:**	**Database Systems**
Number of Credits	**:**	**3**
Prerequisites	**:**	
Course Type	**:**	**OE**

Course Learning Objectives:

1. To understand fundamentals of data models and to conceptualize a database system for user requirement.
2. To study the fundamental of Database query language, like SQL and relational algebra.
3. To learn the concept of normalization in database design.
4. To learn fundamental concepts of transaction processing, concurrency control techniques and database recovery procedure.
5. Understand the professional, ethical and security issues and responsibilities in database design.

Course Outcomes

1. To understand fundamental concepts, principles and applications of database system.
2. To demonstrate database related programming languages and perform the basics of commercial relational systems.
3. To apply the concepts of normalization on database design.
4. To Design and Implement a small database project, considering the issues like concurrency control, recovery and security.
5. Comprehend contemporary issues related to industry and government related to database domain.

Course Content

1. **Introduction:** Overview of file systems and Database Systems , Software Architecture of a typical DBMS, Data Models, Relational Data Model, Network Data Model, Hierarchical Data Model, Schemas and Instances, Database Administration and Control.

2. **Relational Model and Query Language**: Overview of Relational Database, Key Integrity constraint, Relational Algebra, Relational Calculus: Domain Relational Calculus, Tuple Relational Calculus, SQL Fundamentals, Basic operators, Missing Information, Null Values, Additional Operations, Advanced SQL features, Embedded SQL, Dynamic SQL, Database Views.

3. **Database Design**: Overview of Normalization, Database Anomalies, Functional Dependencies, Candidate and Super Key, Non-loss Decomposition, Dependency Preservation, Normal forms: First, Second, Third Normal, Boyce Codd Normal Form, Multi-valued Functional Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Denormalization.

4. **Transaction Processing**: Overview of Database Transactions, Transaction states, Transaction Recovery, ACID Properties, Transaction Recovery: Two Phase Commit, Commit Points, Serializability, Concurrency control: Need for Concurrency, Locking Protocols: Binary lock, Two Phase Lock, Deadlock, Starvation, Transaction Timestamp.

Reference Books:

1. A Silberschatz, H.F. Korth & S. Sudarshan: Data Base System Concepts, TMH, 1997.
2. A.K. Majumdar and Bhattacharyya: Database Management Systems, THM, 1996.
3. C.J. Date: An Introduction to Database systems 7th Ed. Addison Wesley, Indian Edition, 2000.
4. Elmasri & Navathe : Fundamentals of Database Systems/Oracle 9i Programming 5th Ed. Pearson, 2009

Course Code	**:**	**CSOE42**
Course Title	**:**	**Soft Computing**
Number of Credits	**:**	**3**
Prerequisites	**:**	
Course Type	**:**	**OE**

Course Learning Objectives:

1. Motivation and historical background of Soft Computing.
2. Application of Fuzzy logic.
3. Biologically inspired algorithm such as neural networks, genetic algorithms, ant colony optimization, and bee colony optimization.
4. Hybrid systems of neural network, genetic algorithms and fuzzy systems.

Course Outcomes

1. Understand various biologically inspired algorithms.
2. Apply different intelligent algorithms in classification, prediction, optimization, pattern recognition applications.
3. Design hybrid system incorporating neural network, genetic algorithms, fuzzy systems.

Course content

1. **Soft Computing and Artificial Intelligence:** Introduction of Soft Computing, Soft Computing vs. Hard Computing, Various Types of Soft Computing Techniques, Applications of Soft Computing, AI Search Algorithm, Predicate Calculus, Rules of Interference, Semantic Networks, Frames, Objects, Hybrid Models.

2. **Artificial Neural Networks and Paradigms:** Introduction to Neuron Model, Neural Network Architecture, Learning Rules, Perceptrons, Single Layer Perceptrons, Multilayer Perceptrons, Back propagation Networks, Kohnen'sself organizing networks, Hopfield network, Applications of NN.

3. **Fuzzy Logic:** Introduction, Fuzzy sets and Fuzzy reasoning, Basic functions on fuzzy sets, relations, rule based models and linguistic variables, fuzzy controls, Fuzzy decision making, applications of fuzzy logic.

4. **Genetic Algorithms and Swarm Optimizations:** Introduction, Genetic Algorithm, Fitness Computations, Cross Over, Mutation, Evolutionary Programming, Classifier Systems, Genetic Programming Parse Trees, Variants of GA, Applications, Ant Colony Optimization, Particle Swarm Optimization, Artificial Bee Colony Optimization.

Reference Books:

1. Simon S. Haykin, Neural Networks, Prentice Hall, 2nd edition.
2. B. Yegnanrayana , “Artificial Neural Networks” , PHI.
3. Jacek M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House,1994
4. Zimmermann, “Fuzzy Set Theory and its Application”, 3rd Edition.
5. Jang J.S.R., Sun C.T. and Mizutani E, "Neuro-Fuzzy and Soft computing", Prentice Hall, 1998.
6. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill, 1997.
7. D.E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y, 1989.

Course Code	**:**	**ITOE40**
Course Title	**:**	**Database Systems**
Number of Credits	**:**	**3**
Prerequisites	**:**	
Course Type	**:**	**OE**

Course Learning Objectives:

1. To understand fundamentals of data models and to conceptualize a database system for user requirement.
2. To study the fundamental of Database query language, like SQL and relational algebra.
3. To learn the concept of normalization in database design.
4. To learn fundamental concepts of transaction processing, concurrency control techniques and database recovery procedure.
5. Understand the professional, ethical and security issues and responsibilities in database design.

Course Outcomes

1. To understand fundamental concepts, principles and applications of database system.
2. To demonstrate database related programming languages and perform the basics of commercial relational systems.
3. To apply the concepts of normalization on database design.
4. To Design and Implement a small database project, considering the issues like concurrency control, recovery and security.
5. Comprehend contemporary issues related to industry and government related to database domain.

Course Content

1. **Introduction:** Overview of file systems and Database Systems , Software Architecture of a typical DBMS, Data Models, Relational Data Model, Network Data Model, Hierarchical Data Model, Schemas and Instances, Database Administration and Control.

2. **Relational Model and Query Language**: Overview of Relational Database, Key Integrity constraint, Relational Algebra, Relational Calculus: Domain Relational Calculus, Tuple Relational Calculus, SQL Fundamentals, Basic operators, Missing Information, Null Values, Additional Operations, Advanced SQL features, Embedded SQL, Dynamic SQL, Database Views.

3. **Database Design**: Overview of Normalization, Database Anomalies, Functional Dependencies, Candidate and Super Key, Non-loss Decomposition, Dependency Preservation, Normal forms: First, Second, Third Normal, Boyce Codd Normal Form, Multi-valued Functional Dependencies and Fourth Normal Form, Join Dependencies and Fifth Normal Form, Denormalization.

4. **Transaction Processing**: Overview of Database Transactions, Transaction states, Transaction Recovery, ACID Properties, Transaction Recovery: Two Phase Commit, Commit Points, Serializability, Concurrency control: Need for Concurrency, Locking Protocols: Binary lock, Two Phase Lock, Deadlock, Starvation, Transaction Timestamp.

Reference Books:

1. A Silberschatz, H.F. Korth & S. Sudarshan: Data Base System Concepts, TMH, 1997.
2. A.K. Majumdar and Bhattacharyya: Database Management Systems, THM, 1996.
3. C.J. Date: An Introduction to Database systems 7th Ed. Addison Wesley, Indian Edition, 2000.
4. Elmasri & Navathe : Fundamentals of Database Systems/Oracle 9i Programming 5th Ed. Pearson, 2009

Course Code	**:**	**ITOE42**
Course Title	**:**	**Soft Computing**
Number of Credits	**:**	**3**
Prerequisites	**:**	
Course Type	**:**	**OE**

Course Learning Objectives:

1. Motivation and historical background of Soft Computing.
2. Application of Fuzzy logic.
3. Biologically inspired algorithm such as neural networks, genetic algorithms, ant colony optimization, and bee colony optimization.
4. Hybrid systems of neural network, genetic algorithms and fuzzy systems.

Course Outcomes

1. Understand various biologically inspired algorithms.
2. Apply different intelligent algorithms in classification, prediction, optimization, pattern recognition applications.
3. Design hybrid system incorporating neural network, genetic algorithms, fuzzy systems.

Course content:

1. **Soft Computing and Artificial Intelligence:** Introduction of Soft Computing, Soft Computing vs. Hard Computing, Various Types of Soft Computing Techniques, Applications of Soft Computing, AI Search Algorithm, Predicate Calculus, Rules of Interference, Semantic Networks, Frames, Objects, Hybrid Models.

2. **Artificial Neural Networks and Paradigms:** Introduction to Neuron Model, Neural Network Architecture, Learning Rules, Perceptrons, Single Layer Perceptrons, Multilayer Perceptrons, Back propagation Networks, Kohnen'sself organizing networks, Hopfield network, Applications of NN.

3. **Fuzzy Logic:** Introduction, Fuzzy sets and Fuzzy reasoning, Basic functions on fuzzy sets, relations, rule based models and linguistic variables, fuzzy controls, Fuzzy decision making, applications of fuzzy logic.

4. **Genetic Algorithms and Swarm Optimizations:** Introduction, Genetic Algorithm, Fitness Computations, Cross Over, Mutation, Evolutionary Programming, Classifier Systems, Genetic Programming Parse Trees, Variants of GA, Applications, Ant Colony Optimization, Particle Swarm Optimization, Artificial Bee Colony Optimization.

Reference Books:

1. Simon S. Haykin, Neural Networks, Prentice Hall, 2nd edition.
2. B. Yegnanrayana , “Artificial Neural Networks” , PHI.
3. Jacek M. Zurada, Introduction to Artificial Neural Systems, Jaico Publishing House,1994
4. Zimmermann, “Fuzzy Set Theory and its Application”, 3rd Edition.
5. Jang J.S.R., Sun C.T. and Mizutani E, "Neuro-Fuzzy and Soft computing", Prentice Hall, 1998.
6. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill, 1997.
7. D.E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y, 1989.

Course Code	**:**	**CHOE11**
Course Title	**:**	**Functional Materials**
Number of credits	**:**	**3 (3L)**
Prerequisites (Course code)	**:**	**Nil**
Course Type	**:**	**Elective**
Total Marks	**:**	**100 (Int. 50 + Ext. 50)**

Course Learning Objectives:

- To enable the students to acquire knowledge of the importance and significance of materials for engineering applications.
- To bring adaptability to new developments in materials chemistry and a knowledge of contemporary issues relevant to engineering.
- To make them apply the knowledge of fundamental chemistry for synthesis new materials, applications and analysis of complex engineering problems that meet the specified needs with appropriate consideration for the industrial applications.

Course Content:

UNIT 1: High energy materials

Introduction, classification (explosives, propellants and pyrotechnics), historical overview, short introduction to detonation, density, deflagration, combustion, heat of formation, heat of detonation, stability and sensitivity, thermodynamics (detonation parameters, combustion parameters), new primary explosives, polymer bonded explosives (PBXs), secondary explosives and newly developed materials, oxidizers, experimental characterization of energetic materials (sensitivities, long-term stabilities, Gap test, etc.), significance of high nitrogen content, heterocycles, explosophoric groups, energetic salts, nitration reactions, energetic materials of the future. (10 L)

UNIT 2: Magnetic and photovoltaic materials

Introduction to magnetic materials, magnetic fields, magnetization and magnetic moment, magnetic measurements, magnetic properties, magnetism in materials, magnetic domains, domain walls, domain processes, magnetic order and critical phenomena, electronic magnetic moments, magnetics technological applications, soft magnetic materials, hard magnetic materials, magnetic recording, magnetic evaluation of materials, photovoltaic materials and phenomena, III-V materials, cadmium telluride, copper indium gallium selenide and other I-III-VI materials, recent development for solar cells, dye sensitized solar cells and hybrid perovskites. (10 L)

UNIT 3: Nanomaterials and biomaterials

Introduction and synthetic strategy of nanomaterials, applications of nanoparticle in various fundamental research, industries, medical field and environmental issue, toxicity, biosafety and ethical issue in application of nanoparticle, composites and nano-composite, organic materials, Introduction to biomaterials, performance of biomaterials, historical background, metallic biomaterials, ceramic biomaterials, polymeric and biodegradable biomaterials, composite biomaterials, biofuctional hydrogels, biomaterial interactions, wound healing biology, materials-host interactions, statistics, regulatory considerations, standardized materials testing. (10 L)

UNIT 4: Catalysts

Introduction, mechanism, homogeneous catalysis, heterogeneous catalysis, industrial homogeneous processes: hydrogenation reaction, hydroformylation reaction, carbonylation reaction, heterogeneous processes by zeolite and metal-organic frameworks, advantages and disadvantages.

(6 L)

UNIT 5: Materials and recent applications

Sustainable energy sources, energy applications of nanotechnology, industrial applications of nanotechnology, potential applications of carbon nanotubes, industrial applications of catalysts, soft tissue replacement, hard tissue replacement, drug delivery.

. (4 L)

Course Outcomes:

Upon successful completion of this curriculum students will be able to:

- Gain the basic knowledge of materials and their applications in day to day life.
- Learn the fundamental principles of new materials and developing strategy.
- Understand the importance of solid materials in various industrial applications.

Reference Books:

1. P. W. Cooper, Explosive Engineering, Wiley-VCH, New York, 1997
2. J. Akhavan, The Chemistry of Explosives, RSC Paperbacks, Cambridge, 1998.
3. S. Fordham, High Explosives and Propellents, Pergamon, Press, Oxford, 1980.
4. R. Meyer, J. Kohler, A. Homburg, Explosives, Wiley-VCH, Weinheim, 2002.
5. Thomas M. Klapötke, Chemistry of High-energy Materials, Walter de Gruyter, 2011.
6. Solar Photovoltaics: Fundamentals Technologies and Applications, Solanki PHI Learning Pvt. Ltd., 2009.
7. A. K. Cheetham, Solid state chemistry: compounds; Oxford University Press: Oxford, 1992 (ISBN: 0198551665, 9780198551669).
8. J. N. Lalena, D. A. Cleary, Principles of Inorganic Materials Design ; Wiley: New York, 2010 (ISBN: 978-0-470-40403-4).

Course Code	**:**	**CHOE13**
Course Title	**:**	**Bio- and Chemical sensors**
Number of credits	**:**	**4 (4L)**
Prerequisites (Course code)	**:**	**Nil**
Course Type	**:**	**Elective**

Course Learning Objectives:

- To enable the students to acquire knowledge in the field of Sensor and biosensor
- To introduce new developments in chemical sensors and biosensor in various field related energy, environment, medicine and engineering.
- To make them apply the knowledge that meet the specified needs with appropriate consideration for the industrial applications.

Course Content:

Unit I: Principle and fundamentals of Chemical Sensors: Definition and Components, Recognition Methods, Transduction Methods, Selectivity and Specificity, Detection and Quantification, Response Time. **Classification**: Optical, Chemical and Biological Sensors. Cation-binding sensors: Basic concepts, cation receptors, synthesis and structure of crown ethers, cryptands, calixarenes, Macrocyclic and template effects. Anion-binding sensor: Basic Concepts, anion host design, anion receptors, Shape and selectivity. Important applications in environment and engineering. (10 L)

Unit 2: Fundamental of Biosensors; Different types electrochemical, optical, piezoelectric and colorimetric biosensors; bio-recognition Elements in a Biosensor, Nanomaterial based biosensor (Qunatum dots, carbon nanotubes and metal nanoparticles). Elementary idea of Lab-on-a-chip devices and MEMS Technology for biosensor. (8 L)

Unit 3: Testing*:* UV-Vis, Fluorescence, FT-IR Spectrometers, Cyclic Voltameter, Optical Microscopes (SEM, TEM and AFM), Block diagram, working principle and Interpretation of results. Measurement: Method of limit of detection (LOD), limit of quantification(LOD), binding constant calculations. (8 L)

Unit 4: Sensor Applications and limitation in Defence Industries, Medical Diagnostic and Patient monitoring, Environmental monitoring, agriculture industries, Food safety, water safety, electrical and electronics. Future prospects in: Paper based sensors, wearable sensor, Smartphone based sensor and bio-marker for medical therapeutics (8 L)

Course Outcomes:

Upon successful completion of this curriculum students will be able to:

- Learn the fundamental principles and design of chemical and bio-sensors
- Gain the basic knowledge of sensor and bio-sensor and their applications
- Understand the importance sensors in different research areas

Reference Books:

1. Florinel-Gabriel Bănică, Chemical Sensors and Biosensors: Fundamentals and Applications (Wiley 2012)
2. Bansi Dhar Malhotra and Chandra Mouli Pandey, Biosensors: Fundamentals and Applications (A Smithers Group Company, 2017)
3. Sadana and N. Sadana, Handbook of Biosensors and Biosensor Kinetics, Amsterdam; London: Elsevier Science, 2010.
4. U. E. Spichiger-Keller, Chemical Sensors and Biosensors for Medical and Biological Applications, Weinheim; New York: Wiley-VCH, 1998.
5. J.-M. Lehn; Supramolecular Chemistry-Concepts and Perspectives (Wiley-VCH, 1995)
6. P. D. Beer, P. A. Gale, D. K. Smith; Supramolecular Chemistry (Oxford University Press, 1999)
7. J. W. Steed and J. L. Atwood; Supramolecular Chemistry (Wiley, 2000)