NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL



OPEN ELECTIVE - II

VII Semester

for B.Tech. Program

(Effective from 2021-22)

Details of
Open Elective Courses

List of Open Elective - 2 Courses

Department	Course Code	Name of the Course
Civil	CE445	Building Technology
EEE	EE 445	Entrepreneurial Venture Creation
	EE446	Principles of Electrical Power Conversion
Mechanical	ME445	Alternative Sources of Energy
	ME446	New Venture Creation
	ME447	3D Printing
	ME448	Mechanisms & Machines Theory
ECE	EC446	Microprocessors and Microcontrollers
	EC447	IoT and Cyber Physical Systems
MME	MM445	Metallurgy of Non-Metallurgists
Chemical	CH445	Data Driven Modelling
	CH446	Fuel Cell Technology
	CH447	CO_2 Capture, Sequestration and Utilization
	CH448	Design of Experiments
CSE	CS445	Principles of Data Structures
	CS446	Pattern Recognition and Machine Learning
	CS447	Internet of Things
Biotechnology	BT445	Biosensors
Management	SM445	Human Resource Management
Maths	MA445	Optimization Techniques
Physics	PH445	Nanomaterials and Technology
	PH446	Multifunctional Materials and Devices
	PH447	Quantum Optics
Chemistry	CY445	Chemistry of Nano Materials
Humanities	HS445	Corporate Communication

Course Code: CE445	BUILDING TECHNOLOGY	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes:

At the end of the course, the student will be able to:

CO1	Apply basic principles to develop building plans
CO2	Identify general and special requirements for planning and design
CO3	Identify different prefabricated building components
CO4	Comprehend application of different construction equipment and technologies

Syllabus:

Building planning: Types of Buildings – components, definitions, economy and design, Principles and aspects of building planning, Definitions and importance of Grouping and circulation; Lighting and ventilation; Sustainability and Green Buildings.

General requirements: Requirements for safety against fire, termite, damping, earthquakes, Vertical transportation in building – planning of vertical transportation, Stairs, different forms of stairs, Other modes of vertical transportation.

Special Requirements: Air conditioning – process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation. Thermal insulation. Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation.

Prefabrication systems: Prefabricated walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication. Plumbing services – water supply system, maintenance of building pipe line, Sanitary fittings, Design of building drainage.

Construction Equipment: Introduction and Planning for construction Equipment, Earthmoving and Excavating equipment, Pile driving equipment, Lifting and Concreting Equipment.

Learning Resources:

Text Books:

1. Building Construction, Punmia B. C., Jain A.J., and Jain A.J., Laxmi Publication, 2016, Eleventh Edition.
2. The Text book for Building Construction, Arora S. P., and Bindra S. P., Dhanpat Rai Pubications, 2010.

Reference Books:

1. Building Construction, Varghese P.C., PHI Learning Pvt. Ltd., 2017, 2nd Edition.
2. Construction Planning, Equipment and Methods, Robert P., Clifford J. S., and Aviad S., McGrawHill Education, 2010

Online Resources:

1. https://nptel.ac.in/courses/105/103/105103206/
2. https://nptel.ac.in/courses/105/102/105102175/

EE 445	ENTREPRENEURIAL VENTURE CREATION	3-0-0: 3

Pre-Requisites: None (This course is not offered to Electrical Engineering Students)

Course Outcomes:

At the end of the course, the student will be able to

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Identify entrepreneurial opportunities, preparation of a business plan for launching a new venture
CO3	Explore the opportunities in the domain of respective engineering disciplines for launching a new venture
CO4	Understand the functional management issues of running a new venture

Syllabus:

ENTREPRENEUR AND ENTREPRENEURSHIP

Entrepreneurship and Small-Scale Enterprises (SSE); Role in Economic Development, Entrepreneurial Competencies; Institution Interface for SSE

ESTABLISHING THE SMALL-SCALE ENTERPRISE

Opportunity Scanning and Identification; Market Assessment for SSE; Choice of Technology and Selection of Site; Financing the New/Small Enterprises; Preparation of the Business Plan; Ownership Structures and Organizational Framework

OPERATING THE SMALL-SCALE ENTERPRISES

Financial Management Issues in SSE; Operational Management Issues in SSE; Marketing Management Issues in SSE; Organizational Relations in SSE

Learning Resources:

Text Books:

1. New Venture Management: The Entrepreneur's Roadmap, Kuratko, Pearson, 2008
2. Entrepreneurship: New Venture Creation, Holt, PHI(P) Ltd., 2001

Reference Books:

1. Management of New & Small Enterprises, Madhulika Kaushik, IGNOU course material, 1995
2. Entrepreneurship Development Training Material, B S Rathore, S Saini, TTTI, Chandigarh, 1988
3. A Hand Book for New Entrepreneurs, P C Jain, EDI-Faculty & External Experts, EDII, Ahmedabad, 1986
4. A Manual on How to Prepare a Project Report, J B Patel, D G Allampalli, EDII, Ahmedabad, 1991
5. A Manual on Business Opportunity Identification and Selection, J B Patel, EDII, Ahmedabad, 1995

Online Resources:

1. Champions Portal: www.champions.gov.in
2. Udyam Registration: https://udyamregistration.gov.in
3. MSME Databank: www.msmedatabank.in
4. National Small Industries Corporation: www.nsic.co.in
5. MSME Sambandh: sambandh.msme.gov.in
6. Government eMarket Place: www.gem.gov.in

EE 446	PRINCIPLES OF ELECTRIC POWER CONVERSION	3-0-0: 3

Pre-requisites: None

Course Outcomes:

At the end of the course, the student will be able to

CO1	Understands the basics in the electric power conversion using power switching devices.
CO2	Analyse the control of electrical machines.
CO3	Evaluate the conversion for range of renewable energy sources with the help of available electrical machines drives.
CO4	Analyze the different energy storage systems and Identify Industrial and domestic applications..

Syllabus:

POWER ELECTRONIC DEVICES AND CONVERTERS:

V-I Characteristics of SCR, MOSFET and IGBT. Phase controlled rectifiers, DC-DC converters and Inverters.

APPLICATIONS TO ELECTRIC DRIVES:
Speed control of DC motor, Induction motors, PMSM and BLDC drives

APPLICATIONS TO RENEWABLE ENERGY:
Introduction to solar cell, solar panels, MPPT, wind and other renewable energy sources, Integration of renewable energy sources to the grid.

ENERGY STORAGE SYSTEMS:
Study of automotive batteries, SMF, pumped storage systems, super-capacitors, fly wheels - applications, Li-ion batteries and applications to electric vehicles.

DOMESTIC AND INDUSTRIAL APPLICATIONS:
Induction heating, melting, hardening, lighting applications and their control, UPS, battery chargers

Learning Resources:

Text Books:

1. Power Electronics-circuits, Devices and applications, M.H. Rashid, Prentice Hall India, NewDelhi, 2009.
2. Power Electronics, P.S. Bhimbra, Khanna publishers, New Delhi, 2012.

Reference Books:

1. Power electronics converters, applications and design, Ned Mohan, Undeland and Robbin, John Willey & Sons, Inc. New York, 2006.

Course Code: ME445	ALTERNATIVE SOURCES OF ENERGY	3-0-0: 3

Prerequisites: NIL

Course Outcomes:

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilization.
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Learning Resources:

Text Books:

1. Non conventional Energy Resources, B.H.Khan, Tata McGraw Hill, New Delhi, 2017, 3rd edition

2. Solar Energy-Principles of Thermal Collection and Storage, S.P.Sukhatme and J.K.Nayak, TMH, 2008, 3rd edition

Reference Books:

1. Solar Energy Thermal Processes, J.A.Duffie and W.A.Beckman, John Wiley, 2010, 2nd edition
2. Energy Technology: Non-Conventional, Renewable and Conventional, S.Rao and B.B.Parulekar, Khanna Publishers, 2010, 1st Edition.

Online Resources:

1. Non-conventional Energy Resources by Prof. Prathap Haridoss (IIT Madras), NPTEL Course (Link: https://nptel.ac.in/courses/121/106/121106014/)

Course Code: ME446	NEW VENTURE CREATION	3-0-0: 3

Prerequisites: NIL

Course Outcomes:

CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work
CO4	Develop a framework for technical, economic and financial feasibility for preparing a written business plan
CO5	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth

Syllabus:

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; EDP models, Institutional Interface for Small Scale Industry/Enterprises.

Business Idea generation: Opportunity Scanning and Identification; Creativity and product development process; The technology challenge – Innovation in a knowledge-based economy, sources of innovation pulses – Internal and external; Drucker's 7 sources of innovation impulses, General innovation tools, role of innovation during venture growth; Market survey and assessment; choice of technology and selection of site.

Planning a Start-up Enterprise: Forms of business organization/ ownership; Financing new enterprises – sources of capital for early-stage technology companies; Techno Economic Feasibility Assessment; Preparation of Business Plan for grants, loans and venture capital.

Operational Issues for new enterprises: Financial management issues; Operational/ project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.

Performance appraisal and growth strategies: Strategies to anticipate and avoid pitfalls associated with launching and leading a technology venture; Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Learning Resources:

Text Books:

1. Technology Ventures: From Ideas to Enterprise, Byers, Dorf, and Nelson, McGraw Hill. ISBN-13: 978-0073380186., 2010
2. Entrepreneurship: Successfully Launching New Ventures, Bruce R Barringer and R Duane Ireland, Pearson Edu., 2013 3rd ed.
3. Entrepreneurial Development, S.S. Khanka, S Chand & Company Ltd., 2012, 4th ed.

4. Entrepreneurship: A South-Asian Perspective, D.F. Kuratko and T.V. Rao, Cengage Learning, 2013.

Reference Books:

1. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
2. The practice of entrepreneurship, G.G. Meredith, R.E. Nelson & P.A. Neck, ILO, 1982
3. Management of Small-Scale Enterprises, Dr. Vasant Desai, Himalaya Publishing House, 2004

Course Code: ME447	3D PRINTING	3-0-0: 3

Prerequisites: NIL

Course Outcomes:

CO1	Understand the working principle and process parameters of 3D printing processes
CO2	Explore the applications of 3D Printing processes in various fields
CO3	Select suitable process and material for fabricating a given product
CO4	Develop a product using 3D Printing Process

Syllabus:

Introduction to 3D Printing: Introduction to 3D printing, evolution, Distinction between 3D Printing & CNC machining, Steps in 3D Printing, Classification of 3D Printing processes, Advantages of AM.

Liquid state-based 3D printing Process: Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, Micro-stereolithography, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working, principle, applications, advantages and disadvantages, case studies.

Solid state-based 3D printing Processes: Laminated object manufacturing (LOM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, Working principle, Applications, Advantages and disadvantages, Case studies, practical demonstration. Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

Powder Based 3D printing Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes. **Directed Energy Deposition Processes**: Process Description, Material Delivery, Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Electron Beam Based Metal Deposition, Processing-structure-properties, relationships, Benefits and drawbacks, Applications of Directed Energy Deposition Processes, case studies, Binder Jetting AM Process:process, applications

3D Printing Applications: Applications in prototyping, concept models, visualization aids, replacement parts, tooling, jigs & fixtures, moulds, casting, and end-use parts, Industrial applications in aerospace, automobile, medical, jewelry, sports, electronics, food, construction and architectural.

Learning Resources:

Text Books:

1. 3D Printing and Additive Manufacturing: Principles & Applications, Chua Chee Kai, Leong Kah Fai, World Scientific, 2015, 4th Edition
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Ian Gibson, David W Rosen, Brent Stucker, 2nd Edition, Springer, 2015

Reference Books:

1. Rapid Prototyping: Laser-based and Other Technologies, Patri K. Venuvinod and Weiyin Ma, Springer, 2004
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov, Springer, 2001.
3. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006.
4. Additive Manufacturing, Amit Bandyopadhyay Susmita Bose, CRC Press Taylor & Francis Group, 2020.
5. C.P Paul, A.N Junoop, “Additive Manufacturing: Principles, Technologies and Applications,Second Edition, McGrawHill, 2021.
6. Additive Manufacturing: A Tool for Industrial Revolution 4.0, M. Manjaiah, K. Raghavendra, N. Balashanmugam, J. Paulo Davim, Woodhead Publishing, Elsevier, 2021

Online resources:

1. https://www.nist.gov/additive-manufacturing
2. https://www.metal-am.com/
3. http://additivemanufacturing.com/basics/
4. https://www.3dprintingindustry.com/
5. https://www.thingiverse.com/
6. https://reprap.org/wiki/RepRap

Course Code: ME448	MECHANISMS & MACHINES THEORY	3-0-0: 3

Prerequisites: NIL Course

Outcomes:

CO1	Understand the basics of mechanisms
CO2	Understand the concepts of gears and gear trains
CO3	Apply the basic principles to find the performance parameters of Clutches, brakes and rotors
CO4	Design gears and governors for the given application

Syllabus:

Basics of Mechanisms

Definitions of Mechanism and Machine and distinguishing these two. Plane and space mechanisms with examples. Four bar mechanism and slider crank mechanism with practical examples; deriving the latter from the former. Kinematic pairs with examples. Kinematic chains with examples. Kinematic inversions of single and double slider crank mechanisms. Degrees of freedom of mechanisms. Grashof and non-Grashof mechanisms.

Quick return mechanisms and time ratio. Geneva and Steering Gear mechanisms, Cam and follower mechanism and applications.

Velocity Analysis

Concept of instantaneous center, Kennedy's theorem. Velocity analysis. Concept of relative velocity method. Examples are to be limited to mechanisms with not more than 4 links.

Spur Gears

Kinematics of gears, law of gearing, involute teeth, terminology such as addendum, dedendum, addendum circle, dedendum circle, pitch circle, base circle, pitch point, pressure line, pressure angle, clearance, rack and pinion, different types of pitches, path of contact.

Gear Trains

Kinematics of gear trains, simple gear trains and velocity ratio. Planetary gear trains and analysis; simple problems only.Differential gear of automobiles.

Mechanical Brakes and Clutches

Simple shoe brakes. Band brakes, Concept of self-locking in brakes, Construction of internal expanding shoe brakes. Disc brakes. Purpose and working principle of clutches. Single and multiple plate clutches. Simple problems.

Governors

Necessity of governor. Flywheels versus Governors. Different types of governors. Working principle of centrifugal governors. Gravity controlled and spring-controlled governors. Concept of control force. Control force diagram. Definition of stability of governor. Sensitivity of governor. Energy of governor.

Balancing of Rotors

Problem of balancing of rotors, principle of balancing, simple problems of single and two plane balancing.

Learning Resources:

Text Books:

1. Theory of Machines, Thomas Bevan, Pearson Publishers, 2011.
2. Theory of Machines and Mechanisms, Shigley, J.E. and Uicker, J.J. (Jr), McGraw Hill Publishing Company, New York, 1995.
3. Mechanisms and Dynamics of Machinery, Mabie, H.H. and Ocvirk, F.W., John Wiley and Sons, New York, 1978.

Course Code: EC445	MICROPROCESSOR AND MICROCONTROLLERS	Credits 3 - 0 - 0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Understand the architecture and instruction set of 8086 microprocessor and 8051 microcontroller
CO2	Design and develop various interfacing circuits with 8086 using 8255.
CO3	Understand the concepts of interrupt mechanism and serial communication.
CO4	Develop various applications by interfacing various modules to 8051.

Syllabus:

UNIT–I: Introduction to Microprocessor Architecture Introduction and evolution of Microprocessors– Architecture of 8086–Register Organization of 8086–Memory organization of 8086– General bus operation of 8086–Introduction to 80286–80386 and 80486 and Pentium.

UNIT–II: Minimum and Maximum Mode Operations Instruction set, addressing modes– Minimum and Maximum mode operations of 8086–8086 Control signal interfacing–Read and write cycle timing diagrams.

UNIT–III: I/O Interface 8255 PPI: Architecture of 8255–Modes of operation– Interfacing I/O devices to 8086 using 8255–Interfacing A to D converters– Interfacing D to A converters– Stepper motor interfacing– Static memory interfacing with 8086–DMA controller (8257)–Architecture–Interfacing 8257 DMA controller– Programmable Interrupt Controller (8259)–Command words and operating modes of 8259– Interfacing of 8259–Keyboard/display controller (8279)–Architecture–Modes of operation–Command words of 8279– Interfacing of 8279

UNIT–IV: Introduction to 8051 Micro Controller: Overview of 8051 Micro Controller–Architecture– Register set–I/O ports and Memory Organization– Interrupts–Timers and Counters–Serial Communication.

Unit- V: Interfacing and Applications of 8051: LEDs and push buttons Interfacing, Relays and Latch connections, Keyboard interfacing, seven segment display interfacing, A/D and D/A converter interfacing.

Learning Resources:

Text Books

1. D. V. Hall. Microprocessors and Interfacing, TMGH.2'1 edition 2006.
2. Kenneth. J. Ayala. The 8051 microcontroller 3rd Edition, Cengage learning, 2010.

Reference Books

1. Barry B. Brey, "The Intel Microprocessors", PHI, 7th Edition 2006
2. Muhammad Ali Majid, Janice Gillespie Majid and Rollin D McKinlay," The 8051 microcontroller and Embedded systems", Pearson, 2nd Edition.
3. Liu and GA Gibson," Microcomputer system 8086/8088 Family Architecture, Programming and Design", PHI 2nd Edition
4. Ajay. V. Deshmukh, "Microcontrollers and applications", TMGH 2005

Online Resources:

1. Microcomputers: Design and applications, IIT, Delhi, Prof. Anshul Kumar, No. of Lectures: 37
2. Microprocessors and applications, IIT, Madras, Prof. S. Srinivasan, No. of Lectures: 34.

Course Code: EC446	IoT AND CYBER PHYSICAL SYSTEMS	Credits 3 - 0 - 0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, student will be able to:

CO1	Realize and clearly identify the physical and logical control of today's modern networking architectures.
CO2	Understand System Architecture of the Cyber-Physical Systems (CPS), Edge connectivity, IoT and protocols.
CO3	Get the knowledge of the existing technologies for cognitive Internet of Things (IoT) systems, Agent-based systems and Cross layering issues and Traffic based schemes
CO4	Introduce state-of-the art research in the area of modern Internet Technologies regarding the Caching Techniques for Streaming Media

Syllabus:

1. Introduction to Cyber-Physical Systems: Standards, Topologies, Network Hardware, Network Standardization, Transmission Principles
2. Networked Systems and Internet structure: Introduction to the Internet and Cyber-Physical application interface, basic concepts of the Internet Services and Protocols, higher level protocols.
3. System Architecture of the Cyber-Physical Systems (CPS), Edge connectivity and protocols - Collaborative outsourcing in CPS, Sockets and Client/Server structures and wireless and wired P2P existing architectures
4. Hybrid and purely Mobile Peer-to-Peer Communication and principles, supported protocols and communication pros and cons
5. Wireless systems and CPS configuration and supported foundations and architectures
6. Cognitive CPS: efficiency, and resource manipulation
7. Wireless Sensor Network (WSN), life cycle, energy efficiency, lifetime of WSNs, energy conservation
8. Internet of Things (IoT) in the smart spaces Era
9. Enabling Multimedia applications in Cyber-Physical Systems
10. Resource Sharing schemes and protocols
11. Cloud Computing paradigm and the state-of-the-art methodologies
12. CPS and Edge Computing as a novel paradigm-Case studies

Learning Resources:

Text Books:

1. Content Networking: Architecture, Protocols, and Practice by M. Hofmann and L. Beaumont The Morgan Kaufmann (Series in Networking) 2013 ISBN 10:1-55860-834-6
2. Cyber-Physical Systems: Foundations, Principles and Applications (Intelligent Data-Centric Systems: Sensor Collected Intelligence) by H. Song, D. B Rawat, S.Jeschke and C. Brecher Academic Press 2016 ISBN-10: 0128038012 ISBN-13: 978- 0128038017
3. Beyond the Internet of Things: The Internet of Everything by J. Mongay Batalla et al. Springer International Publishing AG 2016 ISBN-10: 3319507567 ISBN-13: 978- 3319507569

Reference Books:

1. Internet of Things and Smart Environments by S. Shahrestani Springer International Publishing AG 2017 ISBN-10: 3319601636 ISBN-13: 978- 3319601632.
2. Ambient Assisted Living and Enhanced Living Environments: Principles, Technologies and Control by C. Dobre et al. Elsevier, Publisher 2017 eBook ISBN: 9780128052822 Paperback ISBN: 9780128051955
3. Internet of Things (IoT) in 5G Mobile Technologies (Modeling and Optimization in Science and Technologies) by C. X. Mavromoustakis, G. Mastorakis and J. Mongay Batalla Springer International Publishing AG 2016 ISBN-10: 3319309110 ISBN-13: 978- 3319309118

Course Code: MM445	METALLURGY FOR NON-METALLURGISTS	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

At the end of the course, the student will be able to

CO1	Discuss the characteristics and applications of metals and alloys.
CO2	Explain different fabrication techniques.
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select metal/alloy for engineering applications.

Syllabus:

Introduction to Metallurgy: Metals and Alloys classification, engineering applications of Metals/alloys.

Structure of Metals and Alloys: Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals.

Mechanical Properties: Plastic Deformation Mechanisms, Tensile, Creep, Fatigue, Fracture.

Strengthening Mechanisms: Strain Hardening, Grain Size Refinement, Solid Solution Strengthening, Precipitation Hardening.

Fabrication and Finishing of metal products: Metal Working and Machining.

Testing of Metals: Destructive and Non-Destructive Testing, Inspection and Quality Control of Metals.

Engineering Alloys: Steel Products and Properties, Cast Irons, Tool Steels and High Speed Steels, Stainless Steels, selective non-ferrous metals and alloys.

Heat Treatment: Annealing, Normalizing, Hardening and Tempering.

Material selection processes: Case studies.

Text Books:

1. M. F. Ashby, Engineering Metals, 4th Edition, Elsevier, 2005.
2. R. Balasubramaniam (Adapted): Calister's Materials Science and Engineering, 7th Edition, Wiley India (P) Ltd, 2007.
3. R. Abbaschian, L. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, East-West Press, 2009.
4. V Raghavan, Elements of Materials Science and Engineering- A First Course, 5th Edition, PHI Publications, 2011.

Course Code: CH445	DATA DRIVEN MODELLING	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Identify disturbance models
CO2	Estimate parametric and non-parametric models
CO3	Determine the model structure
CO4	Validate the developed models

Syllabus:

System Identification - Motivation and Overview. Models of Discrete-Time LTI Systems – Convolution equation. Difference equations, Transfer functions, State-space models, Discretization, Sampling and Hold operations, Sampling theorem.

Non-parametric models - impulse response, step response and frequency response models.

Disturbance models - random processes, representation of stationary processes, white-noise process, auto-covariance function (ACF), cross-covariance function (CCF), ARMA and ARIMA models. Parametric model structures - ARX, ARMAX, OE, BJ models.

Regression techniques, statistical properties.

Estimation of non-parametric models - impulse / step response coefficients, frequency response models. Estimation of parametric models - notions of prediction and simulation, predictors for parametric models, prediction-error methods, Instrumental Variable method.

Model Structure Selection and Diagnostics - estimation of delay and order, residual checks, properties of parameter estimates, model comparison and selection, model validation.

Learning Resources:

Text Books:

1. Principles of System Identification: Theory and Practice, Arun K. Tangirala, CRC Press, 2015.
2. Nonlinear System Identification, Oliver Nelles, Springer, 2020, 2nd Edition.

Reference Books

1. System Identification – An Introduction, Karel J. Keesman, Springer, 2015, 2nd Edition.
2. System Identification: Theory for the User, Lennart Ljung, Pearson education, 1997, 2nd Edition.
3. Identification of Dynamic Systems: An Introduction with Applications, Rolf Isermann and Marco Munchhof, Springer, 2011.

Online Resources:

1. NPTEL course link: https://nptel.ac.in/courses/103/106/103106149/
2. MATLAB SysID tool webinar by Prof. Ljung: https://in.mathworks.com/videos/introduction- to-system-identification-81796.html

Course Code: CH446	FUEL CELL TECHNOLOGY	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes:

At the end of the course, the student will be able to

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Identify the intricacies in the operation of fuel cell stack and fuel cell system.
CO4	Apply fuel processing techniques for fuel cells

Syllabus:

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others. Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.

Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity. Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modelling.

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal, Using renewable fuels for SOFCs.

Learning Resources:

Text Books:

1. Hoogers G, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, 2006.
3. F. Barbir, PEM Fuel Cells: Theory and Practice, Elsevier/Academic Press, 2 nd Edition, 2013

Reference Books:

1. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications
2. Laminie J, Dicks A, Fuel Cell Systems Explained, 2nd Edition, John Wiley, New York, 2003.

Online Resources:

1. https://nptel.ac.in/courses/103/102/103102015/

Course Code: CH447	CO_2 CAPTURE, SEQUESTRATION & UTILIZATION	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Identify the necessity of CO_2 capture, storage and utilization
CO2	Distinguish the CO_2 capture techniques
CO3	Evaluate CO_2 Storage and sequestration methods
CO4	Assess Environmental impact of CO_2 capture and utilization

Syllabus:

Introduction: Global status of CO2 emission trends, Policy and Regulatory interventions in abatement of carbon footprint, carbon capture, storage and utilization (CCS&U)

CO2 capture technologies from power plants: Post-combustion capture, Pre-combustion capture, Oxy-fuel combustion, chemical looping combustion, calcium looping combustion

CO2 capture agents and processes: Capture processes, CO2 capture agents, adsorption, ionic liquids, metal organic frameworks

CO2 storage and sequestration: Geological sequestration methods, Biomimetic carbon sequestration

CO2 Utilization: CO2 derived fuels for energy storage, polymers from CO2, CO2 based solvents, CO2 to oxygenated organics, Conversion into higher carbon fuels, High temperature catalysis

Environmental assessment of CO2 capture and utilization: Need for assessment, Green chemistry and environmental assessment tools, Life cycle assessment (LCA), ISO standardization of LCA, Method of conducting an LCA for CO2 capture and Utilization.

Learning Resources:

Text Books:

1. Carbon dioxide utilization: Closing the Carbon Cycle, Peter Styring, Elsje Alessandra Quadrelli, Katy Armstrong, Elsevier, 2015, 1st Edition.
2. Carbon Capture, Storage and, Utilization: A Possible Climate Change Solution for Energy Industry, Goel M, Sudhakar M, Shahi RV, TERI, Energy and Resources Institute, 2015, 1st Edition.
3. Carbon Capture and Storage, CO_2 Management Technologies, Amitava Bandyopadhyay, CRC Press, 2014, 1st Edition.

Reference Books:

1. Calcium and Chemical Looping Technology for Power Generation and Carbon Dioxide (CO2) Capture, Fennell P, Anthony B, Woodhead Publishing Series in Energy: No. 82, 2015, 1st Edition.
2. Developments in Innovation in Carbon Dioxide Capture and Storage Technology: Carbon Dioxide Storage and Utilization, Mercedes Maroto-Valer M, Vol 2, Woodhead Publishing Series in Energy, 2014, 1st Edition.
3. Fundamentals of Enhanced Oil and Gas Recovery from Conventional and Unconventional Reservoirs, Alireza Bahadori, Elsevier Inc., 2018, 1st Edition.

Course Code: CH448	DESIGN OF EXPERIMENTS	Credits 3-0-0: 3

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Design experiments for a critical comparison of outputs
CO2	Propose hypothesis from experimental data
CO3	Implement factorial and randomized sampling from experiments
CO4	Estimate parameters by multi-dimensional optimization

Syllabus:

Introduction: Strategy of experimentation, basic principles, guidelines for designing experiments. Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means: Hypothesis testing, Choice of samples size, Confidence intervals, Randomized and paired comparison design.

Experiments with Single Factor: An example, The analysis of variance, Analysis of the fixed effect model, Model adequacy checking, Practical interpretation of results, Sample computer output, Determining sample size, Discovering dispersion effect, The regression approach to the analysis of variance, Non-parametric methods in the analysis of variance, Problems.

Design of Experiments: Introduction, Basic principles: Randomization, Replication, Blocking, Degrees of freedom, Confounding, Design resolution, Metrology considerations for industrial designed experiments, Selection of quality characteristics for industrial experiments. Parameter Estimation.

Response Surface Methods: Introduction, methods of steepest ascent, Analysis of a second- order response surface, Experimental designs for fitting response surfaces: Designs for fitting the first-order model, designs for fitting the second-order model, Blocking in response surface designs, Computer-generated (Optimal) designs, Mixture experiments, Evolutionary operation, Robust design, Problems.

Design and Analysis: Introduction, Preliminary examination of subject of research, Screening experiments: Preliminary ranking of the factors, active screening experiment- method of random balance, active screening experiment Plackett-Burman designs, Completely randomized block design, Latin squares, Graeco-Latin Square, Youdens Squares, Basic experiment-mathematical modelling, Statistical Analysis, Experimental optimization of research subject: Problem of optimization, Gradient optimization methods, Nongradient methods of optimization, Simplex sum rotatable design, Canonical analysis of the response surface, Examples of complex optimizations.

Learning Resources:

Text Books:

1. Lazic Z. R., Design of Experiments in Chemical Engineering, A Practical Guide, Wiley, 2005.
2. Antony J., Design of Experiments for Engineers and Scientists, Butterworth Heinemann, 2004.
3. Montgomery D. C., Design and Analysis of Experiments, Wiley, 5th Edition, 2010.
4. Doebelin E. O., Engineering Experimentation: Planning, Execution, Reporting, McGraw-Hill, 1995.

Course Code: CS445	PRINCIPLES OF DATA STRUCTURES	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the concept of ADT, identify data structures suitable to solve problems
CO2	Develop and analyze algorithms for stacks, queues
CO3	Develop algorithms for binary trees and graphs
CO4	Implement sorting and searching algorithms
CO5	Implement symbol table using hashing techniques

Syllabus:

Introduction to Iterative and Recursive Algorithms

Abstract Data Types (ADTs), Implementation and Applications of Stacks, Operations and Applications of Queues, Array Implementation of Circular Queues, Implementation of Stacks using Queues, Implementation Queues using Stacks, Linked Lists, Search and Update Operations on Varieties of Linked Lists, Linked List Implementation of Stacks and Queues

Introduction to Trees, Implementation of Trees, Binary Trees, Tree Traversals with an Application, Binary Search Trees (BSTs), Query and Update Operations on BSTs, AVL Trees, Rotations, Search and Update Operations on Balanced BSTs, Splay Trees, B-trees, Trie, C-Trie

Hashing: Implementation of Dictionaries, Hash Function, Collisions in Hashing, Separate Chaining, Open Addressing, Analysis of Search Operations

Priority Queues: Priority Queue ADT, Binary Heap Implementation and Applications of Priority Queues, Disjoint Sets.

Sorting Algorithms: Stability and In Place Properties, Insertion Sort, Merge Sort, Quick Sort, Heap Sort, Lower Bound for Comparison Based Sorting Algorithms, Linear Sorting Algorithms: Counting Sort, Radix Sort, Bucket Sort

Graph Algorithms: Graphs and their Representations, Graph Traversal Techniques: Breadth First Search (BFS) and Depth First Search (DFS), Applications of BFS and DFS, Minimum Spanning Trees (MST), Prim's and Kruskal's algorithms for MST, Connected Components, Dijkstra's Algorithm for Single Source Shortest Paths, Biconnected Components.

Text Books / Reference Books / Online Resources:

5. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Second Edition, PHI, 2009.
6. Mark Allen Weiss, "Data Structures and Algorithm Analysis in C++", Third Edition, Pearson Education, 2006
7. Ellis Horowitz, Sartaj Sahni and Sanguthevar Rajasekaran, "Fundamentals of Computer Algorithms", Second Edition, Universities Press, 2011.
8. Michael T.Goodrich and Roberto Tamassia, "Algorithm Design: Foundations, Analysis and Internet Examples", Second Edition, Wiley-India, 2006.

Course Code: CS446	PATTERN RECOGNITION AND MACHINE LEARNING	Credits 3-0-0: 3

Pre-requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand and Design Unsupervised Learning Methods
CO2	Design Regression model to solve the classification and prediction problems
CO3	Design Neural network to solve classification and function approximation problems
CO4	Build optimal classifiers using genetic algorithms and Support vector machines

Syllabus:

Well defined learning problems, Designing a Learning System, Dimensionality Reduction, PCA, LDA; Introduction to Statistical Decision Theory - Regression, Linear Regression, Multivariate Regression and Logistic Regression; Unsupervised Learning Methods: Clustering, Partitional, Hierarchical and Density based clustering Methods; DECISION TREE LEARNING - Decision tree learning algorithm-Inductive bias- Issues in Decision tree learning; Bootstrapping & Cross Validation, Class Evaluation Measures, ROC curve, MDL, Ensemble Methods - Bagging, Committee Machines and Stacking, Boosting; Bayesian Learning – Bayes theorem, Concept learning, Bayes Optimal Classifier, Naïve Bayes classifier, Bayesian belief networks, EM algorithm; ARTIFICIAL NEURAL NETWORKS – Perceptron, Gradient descent and the Delta rule, Adaline, Multilayer networks, Derivation of back-propagation rule-Back-propagation Algorithm, Convergence, Generalization; Support vector Machines; Instance-Based Learning – k-Nearest Neighbor Learning, Locally Weighted Regression.

Text Books / Reference Books / Online Resources:

1. Tom.M.Mitchell, "Machine Learning", McGraw Hill International Edition, 1997.
2. C Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

Course Code: CS447	INTERNET OF THINGS	Credits 3-0-0: 3

Pre-requisites:

Course Outcomes: At the end of the course, the student will be able to

CO1	Analyse the protocol Stack for Internet of Things to address the heterogeneity in devices and networks
CO2	To familiarise the IoT Hardware, Software and various Platforms of IoT
CO3	Understanding the smart IoT Applications using smart sensor devices, fog and cloud systems
CO4	Usage of smart mobile apps for societal applications

Syllabus:

Internet of Things-Concepts, Characteristics, Challenges, Industrial IoT, IoT Hardware, IoT Operating system, IoT Platforms IoT Architectures- Reference Model, Protocol Architecture, Perception Layer- Sensors, RFID, Network Layer-802.15.4, ZigBee, BLE and 6LoWPAN Application Layer- MQTT, CoAP, Introduction to Edge Computing and Fog Computing, Cloud Computing in IoT, Web APIs, Mobile app developments for IoT, Introduction to Arduino Programming: Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi, IoT Smart Applications-Smart City, Health-Care, Smart Homes, Connected Vehicles, Smart Grid,

Text Books / Reference Books / Online Resources:

1. Olivier Hersent, “The Internet of Things Key Applications and Protocols”, Wiley, 2012
2. Sudip Misra, “Introduction to IoT”, Cambridge University Press; First edition , 2021
3. David Hanes, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press; 1st edition 2017
4. Arshdeeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2015
5. Raj Kamal, "Internet of Things: Architecture and Design Principles", McGraw Hill Education private limited, 2017
6. Kai Hwang, Min Chen, "Big Data Analytics for Cloud, IoT and Cognitive Computing", Wiley, 2018

Course Code: BT445	BIOSENSORS	Credits 3-0-0:3

Pre-Requisites: None

Course Outcomes: At the end of the course, the student will be able to

CO1	Explain mechanism of biological and transducing elements
CO2	Associate cellular pathways with energy transduction, sensing and detection
CO3	Understand the performance limitations of various biosensors
CO4	Design and develop bioanalytical devices / biosensor
CO5	Describe applications of biosensors in food, health and environmental domains

Syllabus:

General Overview of Biosensors: History of biosensor development, applications, requirements of biosensors and classification, definitions and concepts terminology; main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

Physico-Chemical Transducers: Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; piezoelectric transducers.

Biorecognition Systems: Enzymes; oligonucleotides and nucleic acids; lipids (Langmuir Blodgett bilayers, phospholipids, liposomes); membrane receptors and transporters; tissue and organelles (animal and plant tissue); cell culture, limitations and problems, immobilization of biomolecules.

Design and Fabrication of Biosensors: Self-assembled mono layers screen printing, photolithography, micro-contact printing, MEMS, miniaturization-application of nano-materials, nanoparticles, carbon nanotubes (CNTs) and others.

Application of Biosensors: Application of modern sensor technologies: clinical chemistry; test-strips for glucose monitoring; urea determination; environmental monitoring; technological process control; food quality control; forensic science benefits; problems and limitations.

Learning Resources:

Text Books:

1. Chemical Sensors and Biosensors, Brian R. Eggins, John Wiley& Sons, 2003, 1st Edition
2. Biosensors: Theory and Applications, Donald G. Buerk, CRC Press, 2009, 1st Edition
3. Biosensors: Fundamentals and Applications, Chandra Mouli Pandey and Bansi Dhar Malhotra, De Gruyter 2019,1st Edition

Reference Books:

1. Chemical Sensors and Biosensors: Fundamentals and Applications, Florinel-Gabriel Banica, Wiley, 2012, 1st Edition
2. Introduction to Bioanalytical Sensors, Alice Cunningham, John Wiley& Sons, 1998, 1st Edition.

Online Resources:

1. https://www.edx.org/course/principles-of-electronic-biosensors

Course Code: SM440	HUMAN RESOURCE MANAGEMENT	Credits 3-0-0:3

Course Outcomes:

At the end of the course, the student will be able to

CO1	Define the concepts and factors contributing to human resource management
CO2	Outline the functions of human resource management in decision making
CO3	Analyse the contributions of people practices at industrial and strategic level of human resource management.
CO4	Apply the digital solutions of human resource management in decision making
CO5	Adapt the principles of human resource management in solving problems in organisations.

Syllabus:

Human Resource Management- Concept, nature, scope, and Objectives; Human resource planning - determining the demand for workforce, predicting the future supply; Job analysis and Job design;

Functions of HRM - Recruitment and selection, Training and Development- Methods and Evaluation of Training; Career Development and planning; Performance Appraisal- Methods, Performance Management, Compensation.

Industrial Relations- Nature, Importance, Trade Unions. Collective bargaining, workers participation movement, HRM- Diversity Management, Employee Engagement, HR analytics, Digital HRM, Green HRM

Learning Resources:

Text Books:

1. Human Resource Management, Dessler, G., & Varkkey, India: Pearson Education, 2018
2. Organization Theory and Design, Richard D. Daft, Cengage Learning, 2016

Reference Books:

1. Human Resource Management, Bohlander George W, Snell Scott A, Veena Vohra, Cengage Learning, 2015
2. Human Resource Management, David A. Decenzo and Stephens P. Robins, John Wiley & Sons, 2018
3. Organizational Behavior, Robbins, Stephen, & Sanghi, S., Pearson Education.
4. Organizational Behaviour, Luthans, F, , McGraw Hill, 2018

Online Resources:

1. www.shrm.com
2. www.hrkatha.com
3. www.nationalhrd.com
4. www.nipm.com
5. www.istdindia.org

Course Code: MA445	OPTIMIZATION TECHNIQUES	Credits 3-0-0: 3

Pre-Requisites: NIL

Course Outcomes: At the end of the course, the student will be able to:

CO1	Formulate and solve linear Programming Problems
CO2	Determine the optimum solution to constrained and unconstrained
CO3	Apply dynamic programming principle to Linear programming problems
CO4	Determine the integer solutions to Linear Programming Problems

Syllabus:

Linear Programming: Introduction and formulation of models, Convexity, Simplex method, Big-M method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem

Nonlinear Programming: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method

Dynamic Programming: Principle of optimality, recursive relations, solution of LPP

Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem

Learning Resources:

Text Books:

1. Operations Research, **Kanti Swarup, P. K. Gupta and Man Mohan**, S. Chand & Co., 2014, 16th Revised Edition
2. Introduction to Optimization: Operations Research, **J. C. Pant**, Jain Brothers, 2015, Seventh Edition

Reference Books:

1. Mathematical Programming Techniques, **N. S. Kambo**, East West Publishers, 2008

Course Code: PH445	NANOMATERIALS AND TECHNOLOGY	Credits 3-0-0: 3

Pre-Requisites: none

Course Outcomes: At the end of the course, the student will be able to:

CO1	Identify and categorize various forms of Nanostructured material in association with interdisciplinary aspect of modern Nanoscience.
CO2	Solve the Schrödinger equations for 2D, 1D and 0D quantum confinement nanostructures.
CO3	Understand unique size dependent properties of Nanomaterials and comprehend size-tunable properties of nanomaterials.
CO4	Understand structure, properties and applications of Fullerenes and Carbon Nanotubes.
CO5	Comprehend different synthesis techniques, characterization tools, and evaluate application of Nanomaterials in the light of societal impact.

Syllabus:

Introduction to Low Dimensional Materials
Fundamentals of Nanostructured materials (various shapes and sizes) their technological significance, Classification of Low dimensional Systems-2D, 1D, and 0D systems, Surface effect and Quantum Confinement effect, Solve the Schrödinger equations for 2D, 1D and 0D quantum confinement nanostructures, Density of States in bulk and low dimensional Systems-derivation and explanation.

Properties of Nanomaterials
Size dependent Properties of Nanomaterials-Physical, Chemical, Optical, Electronic, Mechanical and Magnetic Properties.

Fullerene and Carbon Nanotubes
Introduction to Fullerene and Carbon Nanotubes, Structure and their Properties; Synthesis Techniques of Single walled and Multi Walled Carbon Nanotubes and Growth Kinetics; Applications of Fullerene and Carbon Nanotubes

Synthesis of Nanomaterials
Physical and Chemical Techniques, Nucleation and Growth Mechanism of thin film and nanostructure formation; Thermal Evaporation and Electron beam Evaporation, Arc-discharge, Laser Ablation, Chemical Vapor Deposition, Colloidal synthesis, Self-Assembled Monolayer, Spin coating, Dip coating, Spray pyrolysis; Nanofabrication-photolithography and Electron-beam Lithography.

Characterization and Current Applications:
Characterization Techniques: X-Ray Diffraction, Electron microscope (SEM, TEM), and Scanning probe microscopes (STM, AFM); Applications of Nanomaterials in Modern Nanodevices- Biological, Optoelectronic and Sensing devices.

Learning Resources:

Text Books:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R. Fahrner, Nanotechnology and Nanoelectronics; Springer,2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Wiley, 2006.
4. B.S. Murty, P Shankar, Baldev Raj, B B Rath and James Murday, Textbook of Nanoscience and Nanotechnology, Universities Press, 2012

Reference Books:

1. Charles P. Poole, Frank J. Owens, Introduction to Nanotechnology, Wiley 2012
2. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology, Narosa,2011.
3. Raul J. Martin-Palma, Akhlesh Lakhtakia, Nanotechnology, SPIE Press, USA, 2010.
4. Robert Kelsall, Ian Hamley and Mark Geoghegan, Nanoscale Science and Technology, Wiley, 2005.

Online Resources:

1. https://www.edx.org/course/fundamentals-of-nanomaterials-and-nanotechnology.
2. https://nptel.ac.in/courses/118/104/118104008/.
3. https://nanohub.org/resources/101.
4. https://www.coursera.org/lecture/nanotechnology/.

Course Code: PH446	MULTI-FUNCTIONAL MATERIALS AND DEVICES	Credits 3-0-0: 3

Pre-Requisites: none

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand the significance and pre-requisites of multi-functional materials.
CO2	Understand the necessity for new and novel materials in our day to day scenario.
CO3	Understand the need for the development of self-healing technologies and biomaterials for healthcare.
CO4	Understand about the smart gels and textiles for many exotic applications.
CO5	Understand the urge for self-expanding implants and basics of personalized multi-functional devices

Syllabus:

New Materials

Need for new materials, Piezoelectric materials, Electrostrictive materials, Magnetostrictive materials, Rheological materials, Thermoresponsive materials, Electrochromic materials, Fullerenes, Biomimetric materials, Quantum tunneling composite etc., Requirements in Industry, Engineering, Medicine, Sports, Cosmetics, Food, Agriculture, Textiles, Energy conservation and Construction.

Pre-requisites of Multi-Functional Materials

Multi-functional materials, properties and requirement for multi-functional system, General classification of multi-functional materials, Production of multi-functional materials, Merits and demerits of multi-functional materials, Exotic applications of multi-functional materials.

Multi-Functional Materials for Self-Healing Technologies

Introduction, Self-healing process, Materials for self-healing, Biomaterials, Need for biomaterials, Examples of uses of biomaterials, Material attributes for biomedical applications, Biocompatibility, Biomaterials science, Classes of Biomaterials.

Smart Gels and Textiles for Exotic Applications

Smart gels, Aerogels, Superhydrophobicity, Measurement of hydrophobicity, Self-cleaning technologies, Smart textiles, Applications in sports, Healthcare, Fire-fighting, Military/Security, etc.

Shape Memory Alloys, Self-Expanding Implants and Devices

Shape Memory Alloys (SMA), One-way and two-way memory effect, Pseudoelasticity, Preparation and properties of SMA, Practical limitations, Magnetic putty, Applications of SMA as Self-Expanding Implants, Components of a multi-functional device, Characteristics, Examples of novel multi-functional devices, Personalization of implants and devices.

Learning Resources:

Text Books:

1. Materials that Move: Smart Materials, Intelligent Design, Bengisu, Murat; Ferrara, Marinella, Springer International Publishing, 2018.
2. Encyclopedia of Smart Materials, Schwartz, Mel, Ed., John Wiley and Sons, 2002.
3. Smart Materials, Schwartz, Mel, CRC Press, 2009.

Reference Books:

1. Intelligent Materials, Shahinpoor, Mohsen; Schneider, Hans-Jorg, Eds., RSC Publishing, 2007.
2. Smart Structures: Physical Behaviour, Mathematical Modelling and Applications, Gaudenzi, Paolo, John Wiley & Sons, 2009
3. A Review of Shape Memory Alloy Research, Applications and Opportunities, Mohd Jani, Jaronie; Leary, Martin; Subic, Aleksandar; Gibson, Mark A, Materials & Design. 56: 1078–1113 (2014)
4. Adaptronics and Smart Structures: Basics, Materials, Design, and Applications, Janocha, Hartmut, Springer, 2007.

Online Resources:

1. http://pubs.rsc.org/bookshop/collections/series?issn=2046-0066
2. www.ted.com/talks/anna_ploszajski_smart_materials/
3. http:// www.smart-material.com/
4. https://thehammersmithgroup.com
5. https://www.smartdevicessupport.com

Course Code: PH447	QUANTUM OPTICS	Credits 3-0-0: 3

Pre-Requisites: none

Course Outcomes: At the end of the course, the student will be able to

CO1	Understand quantum optics and its applications
CO2	Classify the properties of light based on photon statistics
CO3	Distinguish the physical phenomena behind the weak and strong filed atom-photon interactions
CO4	Apply the principles of quantum optics to quantum cryptography
CO5	Adopt the concept of quantum bits to quantum computing

Syllabus:

Photon counting statistics, Classification of light by photon statistics, Thermal light, Chaotic light, Theory of Photodetection, Shot noise in quantum aspects

Resonant light atom interaction, Weak field and strong fields interaction, Baloch sphere, Atom in cavities, cold atoms, laser cooling, Bose Einstein condensation

Quantum cryptography, Basic principles, Quantum key distribution, Single photon source and detectors.

Quantum computing, Quantum bits, Quantum logic gates and circuits, decoherence and error correction, Application of quantum computers, Entangle states, Generation of Entangled photon pairs, Teleportation

Learning Resources:

Text Books:

1. “Quantum Optics”, Mark Fox, Oxford University Press, 2005.
2. “The Quantum theory of Light”, R. Loudon, Oxford University Press, 2000.

Reference Books:

1. “Introductory Quantum Optics”, C. C. Gerry and P. L. Knight, Cambridge University Press, 2004.
2. “Quantum Optics”, M.O. Scully, Cambridge University Press, 2004.

Online Resources:

1. https://www.coursera.org/learn/quantum-optics-single-photon
2. https://www.coursera.org/learn/quantum-optics-two-photons

Course Code: CY445	CHEMISTRY OF NANOMATERIALS	Credits 3-0-0: 3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Review of the state of the art of materials structured at the nanometric level.
CO2	Enable the students to know the characterization of nanostructure materials
CO3	Demonstrate the discrete materials produced for nanotechnology such as carbon

Syllabus:

Chapter 1 Introduction: Scope of nanoscience and nanotecnology, nanoscience in nature, Classification of nanostructured materials, Importance of nanomaterials.

Chapter 2 Synthetic Methods Chemical Routes (Bottom-Up approach); Sol-gel synthesis, Microemulsions or reverse micelles, Solvothermal synthesis, Microwave heating synthesis and sonochemical synthesis: Physical methods (Top-Down approach); Inert gas condensation, plasma arc technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition method

Chapter 3 Techniques for characterization; Powder X-ray diffraction for particle size analysis, Operational principle and applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectrophotometers and its application for band gap measurement, Scanning electron microscopy (SEM) and EDAX analysis, Transmission electron microscopy (TEM), Scanning probe microscopy (SPM), BET method for surface area determination, Dynamic light scattering technique for particle size analysis.

Chapter 4 Studies of nano-structured Materials; Synthesis, properties and applications of the following nanomaterials: Fullerenes and carbon nanotubes, Core-shell nanoparticles, nanoshells, self- assembled monolayers, Monolayer protected metal nanoparticles, Nanocrystalline materials. Thin films.

Learning Resources:

Text Books:

1. NANO: The Essentials: T Pradeep, MaGraw-Hill, 2007.
2. Textbook of Nanoscience and nanotechnology: B S Murty, P Shankar, Baldev Rai, BB Rath and James Murday, Univ. Press, 2012.

Reference Books:

1. Nanostructures & Nanomaterials; Synthesis, Properties & Applications: Guozhong Cao, Imperial College Press, 2007.
2. Nanotechnology: Fundamentals and Applications: Manasi Karkare, IK International, 2008.
3. Nanomaterials Chemistry, C. N. R. Rao, Achim Muller, K.Cheetham, Wiley-VCH, 2007.

Course Code: HS445	CORPORATE COMMUNICATION	Credits 3-0-0:3

Course Outcomes: At the end of the course, the student will be able to:

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Use fluent and appropriate speech in formal business situations
CO4	Develop good listening skills and leadership qualities
CO5	Acquire appropriate corporate email, mobile and telephone etiquette
CO6	Demonstrate corporate social responsibility and ethics

Syllabus:

Importance of Communication in the Corporate World:
What is corporate? - Corporate culture & communication - Process of communication – Networks & channels of communication – Barriers to communication – Strategies to overcome them - Use of technology in successful communication – Role of psychology in communication- Internal & External Communication.

Oral Communication

A. Oral Fluency and Communication Techniques: Speech mechanics – Mental process of speaking – Extempore speech practice –Body Language – Group discussion practice – Group dynamics – interview strategies – kinds and structure of interviews – selection, stress and appraisal interviews.

B. Seminar skills and Presentation skills: Strategies-preparation and techniques –telephone and email etiquette - Use of Power point -Techniques.

Listening and Writing for Career Purposes Skills: Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening.

Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.

Leadership Communication Styles - Business leadership: Aspects of leadership-qualities of a leader- training for leadership-delegation of powers and ways to do it-humour-commitment. Identity Crisis in the Corporate **–** Need for Values, professional and corporate ethics and Social concern – Corporate Social Responsibility –Communication in a crisis -- Knowledge Management – Communication to the public & the mass – Role of Communication in enhancing organization's health & wealth.

Corporate responsibility: Circulating to employees' vision and mission statements - ethical practices - Human rights - Labour Rights – Environment – governance - Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders.

Corporate Ethics and Business Etiquette: Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body

language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.

Text Books/Reference Books/Online Resources:

1. Corporate Communication. Paul Argenti.2012.
2. Essentials of Corporate Communication: Implementing Practices for Effective Reputation Management. Cees B.M. Van Riel and Charles J Frombrun. Routledge.2007.
3. Corporate Communications: Theory and Practice. Joep Cornelissen. SAGE. 2004.
4. Fundamentals of Corporate Communications. Richard Dolphin and David Reed.Routledge.2009
5. Lesikar's Basic Business Communication - 7th Edition Authors: Raymond V. Lesikar, John D. Pettit, Marie E. Flatley Publisher: Irwin. 1996.
6. Developing Communication Skills - *Author(s)*Krishna Mohan, Meera Banerji Publisher: Macmillan Publishers India, 2nd edition 2009.
7. Business Correspondence and Report Writing – Author: R.C. Sharma & Krishna Mohan – 3rd Edition. Publisher: Tata McGraw-Hil**l. –** 2008