NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

OPEN ELECTIVE - I

VI Semester

for B.Tech. Program

(Effective from 2021-22)

Details of
Open Elective Courses

List of Open Elective-1 Courses

Department	Course Code	Name of the Course
Civil	CE395	Environmental Management
EEE	EE395	Linear Control Systems
	EE396	Swarm Intelligence Techniques
	EE397	Introduction to Internet of Things (IoT)
Mechanical	ME395	Automotive Mechanics
	ME396	Enterprise Resource Planning
	ME397	Composite Materials
	ME398	Industrial Management
ECE	EC395	Communication Systems
	EC396	Fundamentals of Computer Networks
MME	MM395	Fundamentals of Materials Processing Technology
Chemical	CH395	Nanotechnology and Applications
	CH396	Industrial Pollution Control
	CH397	Soft Computing Methods for Engineers
	CH398	Industrial Safety and Management
CSE	CS395	Fundamentals of Data Structures
	CS396	Object Oriented Programming Principles
	CS397	Data Analytics
Biotechnology	BT395	Green Technology
Management	SM395	Marketing Management
	SM396	Business for Non-Business Professionals
Maths	MA395	Numerical Solution of Differential Equations
Physics	PH395	Advanced Materials
	PH396	Renewable Energy Technologies
	PH397	Solar Photovoltaic Systems
Chemistry	CY395	Fundamental Methods of Chemical Analysis
Humanities	HS395	Soft Skills
	HS396	Foreign Language Course in French
	HS397	Foreign Language Course in German

Course Code: CE395	ENVIRONMENTAL MANAGEMENT	Credits 3-0-0: 3

Pre-requisites: None

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

CO1	Comprehend the need for Environmental Management
CO2	Identify the attributes of Environment Management system and standards
CO3	Apply different methodologies for impact assessment
CO4	Identify the techniques and control measures for Environment management

Syllabus:

Introduction to Environmental Management: Scope and nature of Environment Management. Its need and brief discussion on the ethical, legal and financial reasons for Environment Management, the framework and approach to develop Environment management system. Policies and legal aspect in India.

Environment management system (EMS) standard: Guideline to implement effective Environment management system, core element of EMS, EMS standard: ISO 14000, its evolution, principle and specification, benefit of EMS. Planning and its implementation, Comparison of other standards with ISO 14000.

Environmental Impact Assessment: EIA definition, its need and principle, scoping, screening and the baseline condition, different methodologies, Impact identification and decision making. EIA case studies in India.

Environment management plan: Planning and identification of baseline condition and impact, monitoring and evaluation of risk, mitigation plan, legislation and environmental audit, disaster management plan, Life cycle assessment and risk analysis.

Environmental management techniques and control measure: Environmental monitoring, modelling and risk assessment. Implementation of sustainable design, control measure for different environment pollution such as air pollution, water pollution, soil and noise pollution.

Learning Resources:

Text Books:
1. Environmental management: Science and Engineering for Industry, Iyyanki V. Muralikrishna and Valli Manickam, Butterworth-Heinemann, 2017.
2. Environmental Management Systems: An Implementation Guide for Small and Medium-Sized Organizations, Second Edition, NSF International, Ann Arbor, Michigan, January 2001
3. Environmental Impact Assessment by Harry W. Canter, McGraw Hill, 1996, 2nd edition.

Reference Books:
1. Environmental Impact Assessment, Rau, J.G. and Wooten, D.C., McGraw Hill Pub. Co., New York, 1996.
2. Environmental Impact Assessment Methodologies, Anjaneyulu.Y., and Manickam. V., B.S. Publications, Hyderabad, 2007.
3. Environmental Impact Assessment- Theory and Practice, Wathern.P., Routledge Publishers, London, 2004.ISO 19011: 2002, "Guidelines for quality and/or Environmental Management System auditing, Bureau of Indian Standards, New Delhi, 2002 Paul L Bishop 'Pollution Prevention: Fundamentals and Practice', McGraw- Hill international, Boston, 2000.

Online Resources:
1. [MEVE-001: Environmental Impact Assessment for Environmental Health - Course (swayam2.ac.in)](swayam2.ac.in)
2. [120108004.pdf (nptel.ac.in)](nptel.ac.in)
3. environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/ommodel2.html
4. environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/ommodel3.html

EE 395	LINEAR CONTROL SYSTEMS	3-0-0: 3

Pre-Requisites: None

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

CO1	Model and Analyze the dynamical Systems using Transfer Function method.
CO2	Determine Transient & Steady-State behaviours of dynamical systems.
CO3	Analyze the steady state errors, absolute/relative stability of dynamical systems in time domain & in frequency domain.
CO4	Model the dynamical systems using the state space approach

Syllabus:

Introduction: System, control system, representation of control system types of control systems, Open-loop and closed loop systems, Types of feedback, feedback and its effects, Laplace transform.

Modelling of Dynamical Systems: Mathematical modelling of Electrical and Electro-mechanical systems, Liquid level system, Automotive Systems, Hydraulic systems, Linearization concept.

Techniques to Develop Transfer Function of Systems: Block diagram reduction technique, signal flow graph and Mason's gain formula.

Time Domain Analysis: Test signals, time domain indices, steady state error constants, concept of BIBO stability, absolute stability. Routh- Hurwitz Criterion.

Root Locus Techniques: Introduction, Root loci theory, rules to plot the root locus, application to system stability analysis.

State-Space Representation of Dynamical Systems: Importance of States and its advantages, state space representation of dynamical systems.

Frequency Domain Analysis: Introduction, Bode plots, Frequency domain indices, application of Bode plots, Polar/Nyquist plots, Principle of PID controller.

Learning Resources:
Text Books:
1. Norman S. Nise, Control Systems Engineering, Willey Publications, 7th Edition, 2019.
2. I.J.Nagarath and M.Gopal: Control Systems Engineering, New Age Pub. Co, 6th Edition, 2017.
3. Katsuhiko Ogata, Modern Control Engineering, Pearson Education India, 5th Edition, 2015.
4. B.C.Kuo: Automatic Control Systems, Wiley, 9th Edition, 2014.

Reference Books:
1. Richard C. Dorf, Robert H. Bishop, Modern Control Systems, Prentice Hall, 13th Edition, 2015.
2. K.J. Astrom, R.M. Murray, Feedback Systems- An Introduction for Scientists and Engineers, 2nd Edition, 2011.

Online Resources:
1. https://www.controleng.com/

EE 396	**SWARM INTELLIGENCE TECHNIQUES**	**3-0-0: 3**

Pre-Requisites: None

Course Outcomes:

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

CO1	Understand the concepts of population-based optimization techniques.
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution.
CO3	Evaluate the importance of parameters in heuristic optimization techniques.
CO4	Apply for the solution of multi-objective optimization.

Syllabus:

FUNDAMENTALS OF SOFT COMPUTING TECHNIQUES: Definition - Classification of optimization problems, Unconstrained and Constrained optimization Optimality conditions, Introduction to intelligent systems Soft computing techniques, Conventional computing techniques versus Soft computing techniques – Classification of meta-heuristic techniques, Single solution based and population based algorithms, Exploitation and exploration in population based algorithms, Properties of Swarm intelligent Systems – Application domain, Discrete and continuous problems - Single objective and multi-objective problems.

GENETIC ALGORITHM AND PARTICLE SWARM OPTIMIZATION: Genetic algorithms - Genetic Algorithm versus Conventional Optimization Techniques, Genetic representations and selection mechanisms, Genetic operators- different types of crossover and mutation operators, Bird flocking and Fish Schooling, Anatomy of a particle - equations based on velocity and positions, PSO topologies - control parameters, Application to SINX maximization problem,

ANT COLONY OPTIMIZATION AND ARTIFICIAL BEE COLONY ALGORITHMS: Biological ant colony system, Artificial ants and assumptions – Stigmergic communications, Pheromone updating- local - global - Pheromone evaporation - ant colony system ACO models, Touring ant colony system - max min ant system - Concept of elistic ants, Task partitioning in honey bees - Balancing foragers and receivers – Artificial bee colony (ABC) algorithms - binary ABC algorithms, ACO and ABC algorithms for solving SINX maximization problem.

SHUFFLED FROG-LEAPING ALGORITHM AND BAT OPTIMIZATION ALGORITHM: Bat Algorithm - Echolocation of bats - Behavior of microbats - Acoustics of Echolocation, Movement of Virtual Bats - Loudness and Pulse Emission, Shuffled frog algorithm - virtual population of frogs comparison of memes and genes, Memeplex formation - memeplex updation, BA and SFLA algorithms for solving SINX maximization problem, Application to multi-modal function optimization, Introduction to Multi-Objective optimization, Concept of Pareto optimality.

Learning Resources:
Text Books:
1. Recent Advances in Swarm Intelligence and Evolutionary Computation, Xin-She Yang, Springer International Publishing, Switzerland, 2015
2. Multi-Objective Optimization using Evolutionary Algorithms, Kalyanmoy Deb, John Wiley & Sons, 2001

Reference Books:

1. Artificial Intelligence and Intelligent Systems, N P Padhy, Oxford University Press, 2005

Online Resources:

1. https://nptel.ac.in/courses/103/103/103103164/
2. https://nptel.ac.in/courses/112/105/112105235/
3. https://nptel.ac.in/courses/106/105/106105173/

EE 397	Introduction to Internet of Things (IoT)	3-0-0: 3

Pre-Requisites: None

Course Outcomes: After completion of the course, students will be able to

CO1	Understand IOT and its design requirements
CO2	Select appropriate Sensors and Actuators for desired application
CO3	Compare various technologies and protocols
CO4	Design and experiment various use cases with IoT

Syllabus:

Introduction to IoT: Characteristics of Internet of Things- Need of IoT, IoT architecture, Area of Applications, IoT applications in Smart Cities, Agriculture, Security, Transport and Medical & Health. **IoT Sensing and Actuation**: Introduction, Sensors, Sensor Characteristics, Sensorial Deviations, Sensing Types, Scalar sensing, Multimedia sensing, Hybrid sensing, Virtual sensing, Sensing Considerations. Actuators, Actuator Types, Hydraulic actuators, Pneumatic actuators, Electric actuators, Thermal or magnetic actuators, Mechanical actuators, Soft actuators, Actuator Characteristics.

IoT Connectivity Technologies (Fundamentals): Introduction, IEEE 802.15.4, Zigbee, RFID, DASH7, Z-Wave, LoRa, NB-IoT, Wi-Fi, Bluetooth. **Communication Technologies (Fundamentals)**: Introduction, Constrained nodes, Constrained Networks, Infrastructure Protocols, Discovery Protocols, Data Protocols, Identification Protocols, Device Management, Semantic Protocols

Introduction to Arduino: Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi. **IOT Case Studies**: Agricultural IoT, Components of an agricultural IoT, Advantages of IoT in agriculture, Case Studies, Smart irrigation management system. Vehicular IoT, Components of vehicular IoT, Advantages of vehicular IoT, Crime assistance in a smart IoT transportation system. Healthcare IoT, Components of healthcare IoT, Advantages and risk of healthcare IoT, Case Studies. IoT Case Studies in Electrical Engineering: IoT application to Smart Grid, Smart Cities and Smart Homes, EV Connected Vehicles.

IOT Projects Demonstration: Beginning IoT Hardware Projects, Arduino installation and setup, Setting up Arduino IDE for NodeMCU, Writing an Arduino Sketch, Demo Experiments with Arduino, Printing on the serial console, LED interface with Arduino, DHT Sensor interface with NodeMCU, MQ-2 Gas sensor interface with NodeMCU, Ultrasonic sensor interface with NodeMCU, Obstacle detection using NodeMCU, Servo motor interface with NodeMCU, Relay interface with NodeMCU, Data transmission between NodeMCU and remote server, Pulse sensor interface with NodeMCU.

IoT Analytics(Basics): Introduction, Machine learning, Advantages of ML, Challenges in ML, Types of ML, Selected Algorithms in ML, k-nearest neighbor (KNN), Decision tree, Random forest, k-means clustering, Agglomerative clustering, Density-based spatial clustering of applications with noise(DBSCAN), clustering, Performance Metrics for Evaluating ML Algorithms.

Paradigms, Challenges, and the Future: Introduction, Evolution of New IoT Paradigms (Discussion Only), Internet of battlefield things (IoBT), Internet of vehicles (IoV), Internet of underwater things (IoUT), Internet of drones (IoD), Internet of space (IoSpace), Internet of

services (IoS), Internet of people (IoP), Internet of nano things (IoNT), Internet of everything (IoE). Challenges Associated with IoT, Mobility, Addressing -Power Heterogeneous connectivity, Communication range, Security, Device size.

Learning Resources:
Text Books:

1. Sudip Misra, Anandarup Mukherjee and Arijit Roy "Introduction to IoT" by, Cambridge University Press, 2021

2. Dimitrios Serpanos, Marilyn Wolf, "Internet-of-Things (IoT) Systems - Architectures, Algorithms, Methodologies" Springer Publications, 2018

3. Mansaf Alam • Kashish Ara Shakil, Samiya Khan, "Internet of Things (IoT)-Concepts and Applications" Springer Publications, 2020

Reference Books:

1. Anandarup Mukherjee, Chandana Roy, Sudip Misra - Introduction to Industrial Internet of Things and Industry 4. 0-CRC Press (2020)

2. Peter Hoddie, Lizzie Prader - IoT Development for ESP32 and ESP8266 with JavaScript_ A Practical Guide to XS and the Moddable SDK-Apress (2020)

3. Mansaf Alam, Kashish Ara Shakil, Samiya Kha - Internet of Things (IoT)_ Concepts and Applications (S.M.A.R.T. Environments)-Springer (2020).

4. Anuradha, J., Tripathy, B. K - Internet of things (IoT) _ technologies, applications, challenges and solutions-CRC Press_Taylor & Francis (2018)

Online Resources:

1. National Programme on Technology Enhanced Learning (NPTEL) Online courses, Course-Introduction to Internet of Things
https://nptel.ac.in/courses/106/105/106105166/

Course Code: ME395	AUTOMOTIVE MECHANICS	Credits 3-0-0:3

Pre-requisites: NIL

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

CO1	Understand the basic lay-out of an automobile.
CO2	Understand the operation of engine cooling, lubrication, ignition, electrical and air conditioning systems.
CO3	Understand the principles of transmission, suspension, steering and braking systems.
CO4	Understand automotive electronics.
CO5	Explore latest developments in automobiles.

Syllabus:

Introduction: Overview of the course, Examination and Evaluation patterns, History of Automobiles, Classification of Automobiles.

Power Plant: Classification, Engine Terminology, Types of Cycles, working principle of an IC engine, advanced classification of Engines- Multi cylinder engines, Engine balance, firing order.

Fuel System and Ignition System and Electrical system: spark Ignition engines- Fuel tank, fuel filter, fuel pump, air cleaner/filter, carburettor, direct injection of petrol engines. Compression Ignition engines, Fuel Injection System- air & solid injection system, Pressure charging of engines, super charging and turbo charging, Components of Ignition systems, battery ignition system, magneto ignition system, electronic ignition and ignition timing. Main electrical circuits, generating & stating circuit, lighting system, indicating devices, warning lights, speedometer.

Lubricating system and cooling systems: Functions & properties of lubricants, methods of lubrication-splash type, pressure type, dry sump, and wet sump & mist lubrication. Oil filters, oil pumps, oil coolers. Characteristics of an effective cooling system, types of cooling system, radiator, thermostat, air cooling & water cooling.

Chassis: Systems in an automobile, body, chassis frame, parts of the automobile body, terminology, automobile frames, functions, constructions, sub frames, materials and defects in frames.

Transmission, axles, clutches, propeller shafts and differential: Types of gear boxes, automatic transmission, electronic transmission control, functions and types of front and rear axles, types and functions of the clutches, design considerations of Hotchkiss drive torque tube drive, function and parts of differential and traction control.

Steering System: functions of steering mechanism, steering gear box types, wheel geometry.

Braking and suspension system: functions and types of brakes, operation and principle of brakes, constructional and operational classification and parking brake. Types of springs shock observers, objectives and types of suspension system, rear axles   suspension,

electronic control and proactive suspension system.

Automotive air conditioning: ventilation, heating, air condition, refrigerant, compressor and evaporator.

Wheels and tyres: Wheel quality, assembly, types of wheels, wheel rims. Construction of tyres and tyre specifications.

Textbooks:
1. Automobile Engineering, K.M. Gupta.l, Vol.I & II, Umesh Pub, 2010.
2. Automotive Mechanics, W.H. Crouse and D.L. Anglin, Tata McGraw Hill, New Delhi,2005.
3. Automotive Mechanics, J. Heitner, Affiliated South West Press, New Delhi,2000.

Reference Books:
1. Automobile Engineering, G.B. Narang, Khanna Publishers, New Delhi, 2001.
2. Automobile Engineering, Kamaraju Ramakrishna, PHI Learning pvt. Ltd., New delhi-2012.
3. Encyclopedia of Automotive Engineering, Parts 1-6, D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), Wiley, 2015.
4. Automotive Engineering Fundamentals, R. Stone and J. K. Ball, SAE International, 2004.

Online resources:
1. Fundamentals of Automotive Systems - Course (nptel.ac.in)

Course Code: ME396	ENTERPRISE RESOURCE PLANNING	Credits 3-0-0: 3

Pre-requisites: NIL

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

CO1	Understand the concepts of ERP and managing risks.
CO2	Choose the appropriate technologies for ERP implementation.
CO3	Develop the implementation process.
CO4	Analyze the role of Consultants, Vendors and Employees.
CO5	Evaluate the role of PLM, SCM and CRM in ERP.

Syllabus:

Introduction to ERP: Enterprise – an overview, brief history of ERP, common ERP myths, Role of CIO, Basic concepts of ERP, Risk factors of ERP implementation, Operation and Maintenance issues, Managing risk on ERP projects.

ERP and Related Technologies: BPR, Data Warehousing, Data Mining, OLAP, PLM, SCM, CRM, GIS, Intranets, Extranets, Middleware, Computer Security, Functional Modules of ERP Software, Integration of ERP, SCM and CRM applications.

ERP Implementation: Why ERP, ERP Implementation Life Cycle, ERP Package Selection, ERP Transition Strategies, ERP Implementation Process, ERP Project Teams.

ERP Operation and Maintenance: Role of Consultants, Vendors and Employees, Successes and Failure factors of ERP implementation, Maximizing the ERP system, ERP and e-Business, Future Directions and Trends.

Text Books:

1. Enterprise Resource Planning, Alexis Leon, Tata McGraw Hill, Fourth Edition, 2019.
2. ERP in Practice, Jagan Nathan Vaman, Tata McGraw Hill, 2007.
3. ERP: Tools, Techniques, and Applications for Integrating the Supply Chain, Carol A Ptak, CRC Press, 2003, 2nd Edition.

Reference Books:

1. Enterprise Resource Planning – Text and Cases, Rajesh Ray, Tata McGraw Hill, 2011

Online Resources:

1. Swayam/NPTEL courses.

Course Code: ME397	COMPOSITE MATERIALS	Credits 3-0-0: 3

Pre-requisites: NIL

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

CO1	Understand composite material and their reinforcements
CO2	Select constituent materials for preparing appropriate composites
CO3	Analyze interfaces of composites for predicting their mechanical properties.
CO4	Develop metal matrix, ceramic matrix and polymer matrix composites with given proportions of constituents

Syllabus:

Introduction: Overview of the course, history and basic concept of composites, Types and constituents, reinforcement and matrices, interface and mechanism of strengthening.

Fundamental concepts: Definition and Classification of Composites, particulate and dispersion hardened composites, continuous and discontinuous fibre reinforced composites MMC, PMC, CMC.

Metal Matrix Composites Processing: Liquid state processes, solid state processes and in situ processes.

Polymer Matrix Composites Processing: Hand lay-up and spray technique, filament winding, pultrusion, resin transfer moulding, bag and injection moulding, sheet moulding compound. Matrix resins-thermoplastics and thermosetting matrix resins. Reinforcing fibres-Natural fibres (cellulose, jute, coir etc), carbon fiber, glass fiber, Kevlar fiber, etc. Particulate fillers-importance of particle shape and size. Coupling agents-surface treatment of fillers and fibres, significance of interface in composites. short and continuous fibre reinforced composites, critical fibre length, and anisotropic behaviour.

Ceramic Matrix Composites Processing: Cold pressing & sintering, hot pressing reaction bonding processes, infiltration, in-situ chemical reaction, Sol-Gel and polymer pyrolysis, self-propagating high temperature synthesis. Carbon- carbon composites, Interfaces.

Rule of mixtures. Stress, strain transformations.

Text books
1. Chawla, Composite Materials Science and Engineering, Springer
2. Hull, An introduction to composite materials, Cambridge
3. Steven L. Donaldson, ASM Handbook Composites Volume 21, 2001.
4. Krishan K. Chawla, Composite Materials, Science and Engineering, Springer, 2001.
5. Suresh G. Advani, E. Murat Sozer, Process Modelling in Composites Manufacturing, 2nd Ed. CRC Press.

Course Code: ME398	INDUSTRIAL MANAGEMENT	Credits 3-0-0: 3

Pre-requisites: NIL

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

CO1	Understand the evolutionary development of management thought and general principles of management
CO2	Apply marketing concepts and tools for successful launch of a product
CO3	Understand the role of productivity in streamlining a production system
CO4	Apply the inventory management tools in managing inventory
CO5	Apply quality engineering tools to the design of the products and process controls
CO6	Apply project management tools to manage projects

Syllabus:

General Management: Evolution of industry and professional management; functions of management; design of an organization structure, Hawthorn experiments, primary groups and informal organizational structures, leadership styles and characteristics of effective leadership, Mc Gregor's Theory X and Theory Y, Maslow's and Hertzberg's motivational theories, Japanese Management.

Marketing Management: Marketing management process and the four Ps of marketing mix; market segmentation, targeting and positioning; product life cycle and marketing strategies in different stages of product life cycle.

Productivity and Work Study: Productivity definition, its role in the economy, techniques for improving productivity, method study procedure, flow process chart and flow diagram, two handed process chart, principles of motion economy, work sampling, stop watch time study.

Quality Management: control charts - and R, p & c charts, Sampling plan –design of single sampling plan using OC curve, rectifying inspection and AOQL; Taguchi's method of total quality control, Quality function deployment, Introduction to TQM

Inventory Management: Purposes of inventories, inventory costs, ABC classification, EOQ,P and Q systems of inventory control.

Project Management: Network diagrams, critical path method, total slack and free slack, crashing of activities and resource levelling, PERT.

Text books
1. Donald J clough. "Concepts in Management science", Prentice Hall of India.
2. Philip Kotler, "Marketing Management", Prentice Hall of India, New Delhi, 2020.
3. Koontz, H. et. al., "Essentials of Management" - Mc Graw Hill Book Co., New York, 2019.
4. Chase and Aquilano - Operations Management -Mc Graw Hill Pub. Books Co. New York, 2019.

Course Code: EC395	COMMUNICATION SYSTEMS	Credits 3 - 0 - 0: 3

Pre-requisites: None

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

CO1	Understand different modulation and demodulation schemes for analog communication
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design trade-offs and performance of communications systems.

Syllabus:

Signal Analysis: Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.

Noise Analysis: External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise in phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation: Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.

Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM,FM,PCM and DM.

Information Theory: Uncertainty, Information, Entropy, Source Coding Theorem, Data Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capacity Theorem, Bandwidth - Power Tradeoff, Huffman Coding.

Text Books:
1. S. Haykin, Communication Systems, Fourth Edition, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rd Edn, Oxford University Press, Chennai, 1998.
3. Leon W.Couch II., Digital and Analog Communication Systems, Sixth Edition, Pearson Education inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, Fourth Edition, MGH, New York, 2002.

Course Code: EC396	FUNDAMENTALS OF COMPUTER NETWORKS	Credits 3 - 0 - 0: 3

Pre-requisites:

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

CO1	Identify and explain the fundamental concepts of network architecture, protocols and internetworking principles.
CO2	Understand the concepts of LANs, WANs, switching, routing, congestion
CO3	Understand Internet and Transport Protocols and gain knowledge on Internetwork operations.
CO4	Understand the important aspects of internet applications such as network security, Email and network management, DNS, web servers and multimedia.

Syllabus:

INTRODUCTION: Data Communication, Networks, Protocols and Standards, Topology, Categories of Networks, OSI & TCP/IP Protocol suites

PHYSICAL LAYER: Transmission modes, DTE-DCE Interface, Modems, Guided media, Unguided media, Performance, Multiplexing, Switching, DSL, FTTC.

DATA LINK LAYER: Data Link Control - Line discipline, Flow control, Error control; Data Link protocols – Asynchronous Protocols, Synchronous protocols, Character oriented protocols, Bit oriented protocols, Link Access Procedures, Repeaters, Bridges, Hubs, Switches,

LANS and MANS: Project 802, Ethernet, Fast Ethernet, Gigabit Ethernet, PPP.

NETWORK LAYER: Routers, Gateways, Routing algorithms - Shortest path routing, Distance vector routing, Congestion control - Leaky bucket algorithm, TCP/IP Protocol Suite- IP protocol, IP addresses, Subnetting, ARP, RARP; ICMP

TRANSPORT LAYER: Duties of Transport layer, Transport connection, OSI Transport protocol, TCP, UDP

APPLICATION LAYER: BOOTP and DHCP, DNS, TELNET, FTP, SMTP, HTTP, WWW, Aspects of Network security, Digital Signatures

Text Books:
1. Data Communications and Networking, BEHROUZ A. FOROUZAN, 2nd Ed (Update), Tata McGraw-Hill, New Delhi, 2003

Reference Books:
1. Computer Networks, ANDREW S. TANENBAUM, 4rd Ed., Prentice-Hall of India, New Delhi, 2000
2. Data and Computer Communications, WILLIUM STALLINGS, 6th Ed., Prentice Hall of India, New Delhi
3. Computer Networks and Internet, DOUGLAS E COMER, Pearson Education, Asia, 2000.

Course Code: MM395	FUNDAMENTALS OF MATERIALS PROCESSING TECHNOLOGY	Credits 3-0-0: 3

Pre-Requisites: None

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

CO1	Classify engineering materials.
CO2	Discuss material processing techniques.
CO3	Select a suitable processing technique for a given material and application.
CO4	Explain surface engineering techniques and their engineering significance.

Syllabus:

Introduction to engineering materials: Metals and alloys - phase diagrams, ferrous metals, nonferrous metals, super alloys, guide to processing of metals; ceramics - structure and properties of ceramics, traditional ceramics, new ceramics, glass, some important elements related to ceramics; polymers - fundamentals of polymer science and technology, thermoplastic and thermosetting polymers, elastomers; composite materials - classification of composite materials, metal matrix, polymer matrix and ceramic matrix composites.

Fundamental properties of materials: Mechanical properties-stress-strain relationships, hardness, tensile properties, effect of temperature on properties, visco-elastic behaviour of polymers, thermal properties and electrical properties of metals, polymers, ceramics and composites.

Metal casting fundamentals and metal casting processes: Overview of casting technology, melting and pouring, solidification and casting, sand casting, other expendable-mold casting processes, permanent-mold casting processes, casting quality, metals for casting.

Particulate processing of metals and ceramics: Powder metallurgy-characterization of engineering powders, production of metallic powders, conventional processing and sintering, alternative processing and sintering techniques, materials and products for powder metallurgy, design considerations in powder metallurgy, processing of traditional ceramics, processing of new ceramics, cermet's and their processing.

Fundamentals of metal forming and shaping processes: Rolling, forging, extrusion, drawing, sheet metal forming: Overview of metal forming, friction and lubrication in metal forming; bulk deformation processes in metal forming-rolling, other deformation processes related to rolling, forging, other deformation processes related to forging, extrusion, wire and bar drawing; cutting and bending operations, sheet-metal drawing, other sheet metal forming operations, dies and presses for sheet-metal processes, sheet-metal operations not performed in presses.

Fundamentals of welding: Overview of welding technology, the weld joint, physics of welding, features of a fusion-welded joint; Welding processes-arc welding, resistance welding, oxy-fuel gas welding, other fusion welding processes, solid-state welding, weld quality, weldability; brazing, soldering and adhesive bonding.

Surface engineering: Importance of surface engineering, classification of surface engineering processes, introduction to thermal, mechanical, thermo-chemical and electro-chemical surface engineering processes with their advantages, limitations and applications.

Text Books:

1. Manufacturing Engineering and Technology, Kalpakjian and Schmid, Prentice Hall, New Jersey, 2013.
2. Fundamentals of Modern Manufacturing, Mikell P. Groover, John Wiley & Sons, Inc, New Jersey, 2010.
3. Materials and Processes in Manufacturing, DeGarmo, Black, and Kohser, John Wiley & Sons, Inc, New York, 2011.
4. Welding processes and Technology, R. S. Parmar, Khanna Publishers, 2010
5. Manufacturing Technology-I, H.S.Bawa, Tata Mc Graw Hill Publishers New Delhi, 2007.
6. Manufacturing processes for Engineering Materials, Serope Kalpakjian, Addison Wesley, 2001.

Course Code: CH395	NANOTECHNOLOGY AND APPLICATIONS	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 properties of nanomaterials
CO2	Synthesize nanoparticles
CO3	Evaluate safety and health related issues of nanoparticles
CO4	Characterize nanoparticles
CO5	Identify the applications of nanotechnology in Industries

Syllabus:

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nanosizes and properties comparison with the bulk materials, different shapes and sizes and morphology.

Fabrication of Nanomaterials: Top Down Approach, Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods: Chemical Vapour Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface Charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon buckyballs, List of stable carbon allotropes extended fullerenes, metallofullerenes solid C60, bucky onions nanotubes, nanocones Difference between Chemical Engineering processes and nanosynthesis processes.

Quantum mechanics: Quantum mechanics Quantum dots and its Importance, Pauli exclusion principle Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots, Semiconductor quantum dots, Introduction - Nanoclay Synthesis method, Applications of nanoclay.

Nanomaterials characterization: Instrumentation Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy

Applications in Chemical Engineering: Self-assembly and molecular manufacturing: Surfactant based system Colloidal system applications, ZnO, TiO2, Silver Nanoparticles Functional materials Applications, Production Techniques of Nanotubes, Carbon arc, bulk synthesis, commercial processes of synthesis of nanomaterials, Nanoclay, Commercial case study of nano synthesis - applications in chemical engineering, Nanoinorganic materials - CaCO3 synthesis, Hybrid wastewater treatment systems, Electronic Nanodevices, sensor applications.

Nanobiology: biological methods of synthesis. Applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nanomaterials, Environmental Impacts,

Case Study for Environmental and Societal Impacts

Learning Resources:

Text Books
1. Kulkarni Sulabha K., Nanotechnology: Principles and Practices, Capital Publishing Company, 2015, 3rd edition.
2. Gabor L. Hornyak., Harry F. Tibbals, Joydeep Dutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009, 1st edition.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005, 1st edition.

Reference Books
1. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009, 1st edition.
2. Davies, J.H. The Physics of Low Dimensional Semiconductors: An Introduction, Cambridge University Press, 1998, 1st edition.
3. B. Viswanathan, Nano Materials, Alpha Science, 2009, 1st edition.
4. T.Pradeep, Nano - The essentials understanding nanoscience and nanotechnology, The McGraw Hill,2007, 1st edition.

Online Resources:
1. https://nptel.ac.in/courses/118/104/118104008/

Course Code: CH396	INDUSTRIAL POLLUTION CONTROL	Credits 3-0-0: 3

Pre-Requisites: None

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

CO1	Analyze the effects of pollutants on the environment
CO2	Distinguish air pollution control methods
CO3	Assess treatment technologies for wastewater
CO4	Identify treatment technologies for solid waste
CO5	Select treatment methodologies for hazardous and E-waste

Syllabus:

Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil.

Air pollution sources & effects: Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, Ambient air sampling, Stack sampling, Analysis of air pollutants.

Air pollution control methods & equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment.

Control of specific gaseous pollutants: Control of sulphur dioxide emissions, Control of nitrogen oxides, Carbon monoxide control, Control of hydrocarbons and mobile sources.

Water pollution: Water resources, Origin of wastewater, types of water pollutants and their effects.

Waste water sampling, analysis and treatment: Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, Advanced wastewater treatment, Recovery of materials from process effluents, Zero liquid discharge, Membrane based treatment, industrial case studies.

Solid waste management: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal.

Hazardous waste management: Definition and sources, Hazardous waste classification, Treatment methods, Disposal methods. E-waste: Sources, environmental and social issues, management practices

Learning Resources:

Text Books:

1. Environmental Pollution Control Engineering, Rao C.S., New Age International Publishers, India, 2018, 3rd Edition.
2. Air Pollution and Control Engineering, Noel de Nevers, Waveland Press, Inc., 2016, 3rd Edition
3. Environmental Science and Engineering, Glynn Henry J., Gary W. Heinke, Prentice Hall of India, 2004, 2nd Edition.
4. Air Pollution, Rao M.N, Rao H.V.N, Tata McGraw Hill Education, 2017, 1st Edition.

Reference Books:
1. Environmental Chemistry, De A.K, New Age International Publishers, 2007, 7th Edition.
2. Waste water engineering: treatment and reuse, George Tchobanoglous, Franklin Louis Burton, H. David Stensel, Metcalf & Eddy, Inc., McGraw Hill Education, 2003, 4th Edition.
3. E-waste recycling, NPCS Board of consultants and Engineers, Asia Pacific Business Press Inc. 2015.
4. Handbook of Pollution Prevention Practices, Nicholas P. Cheremisinoff, CRC press, 2001, 1st Edition.

Online Resources:
1. https://nptel.ac.in/courses/105/102/105102089/
2. https://nptel.ac.in/courses/103/107/103107084/
3. https://cpcb.nic.in/
4. http://moef.gov.in/en/
5. https://mnre.gov.in/
6. https://tspcb.cgg.gov.in/default.aspx

Course Code: CH397	SOFT COMPUTING METHODS FOR ENGINEERS	Credits 3-0-0: 3

Pre-Requisites: None

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

CO1	Use neural networks to model the process plants
CO2	Develop fuzzy logic-based controllers for different processes
CO3	Combine fuzzy logic with neural networks for hybrid systems
CO4	Design controllers using fuzzy logic
CO5	Apply genetic algorithms for optimization

Syllabus:

Introduction: Soft Computing, Neural Networks, Fuzzy Logic, Genetic Algorithms.

Artificial Neural Network: Fundamental Concept, Evolution of Neural Networks, Basic Models of Artificial Neural Network, Important Terminologies of ANNs

Supervised Learning Network: Perceptron Networks, Adaptive Linear Neuron (Adaline), Multiple Adaptive Linear Neurons, Back-Propagation Network, Radial Basis Function Network, Time Delay Neural Network, Functional Link Networks, Tree Neural Networks

Unsupervised Learning Networks: Fixed Weight Competitive Nets, Kohonen Self- Organizing Feature Maps, Learning Vector Quantization, Counter propagation Networks, Adaptive Resonance Theory Network

Stability Analysis of a Class of Artificial Neural Network Systems: Stability Conditions of a Class of Non-Linear Systems, Formation of Main Matrices and Sub-Matrices for an ANN System, Methodology Developed for Stability Analysis of ANN.

Introduction to Fuzzy Logic: Classical Sets and Fuzzy Sets, Fuzzy Relations, Tolerance and Equivalence Relations, Noninteractive Fuzzy Sets, Membership Functions, Fuzzification - Methods of Membership Value Assignments, Defuzzification - Lambda- Cuts for Fuzzy Sets (Alpha-Cuts), Defuzzification Methods, Fuzzy Arithmetic and Fuzzy Measures.

Fuzzy Rule Base and Approximate Reasoning: Truth Values and Tables in Fuzzy Logic, Fuzzy Propositions, Formation of Rules, Decomposition of Rules, Aggregation of Fuzzy Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Fuzzy Expert System, Fuzzy Decision Making

Fuzzy Logic Control Systems: Control System Design, Architecture and Operation of FLC System, FLC System Models, Application of FLC Systems

Stability Analysis of Certain Classes of Fuzzy Systems: Stability Analysis of Fuzzy Systems given by System Matrices, Numerical Illustrations for Fuzzy System Stability

Genetic Algorithm: Biological Background, Traditional Optimization and Search Techniques, Genetic Algorithm and Search Space, Basic Terminologies in Genetic Algorithm, Operators in Genetic Algorithm, Constraints in Genetic Algorithm, The Schema Theorem, Classification of Genetic Algorithm, Holland Classifier Systems, Genetic Programming.

Differential Evolution Algorithm: Differential Evolution – Process Flow and Operators, Selection of DE Control Parameters, Schemes of Differential Evolution

Hybrid Soft Computing Techniques: Neuro-Fuzzy Hybrid Systems, Genetic Neuro- Hybrid Systems, Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid Systems

Applications of Soft Computing to different engineering systems.

Learning Resources:

Text Books:
1. Principles of Soft Computing, S. N. Sivanandam and S. N. Deepa, John Wiley & Sons, 2018, 3rd Edition.
2. Artificial Neural Networks, Bose and Liang, Tata McGraw Hill, 1996.

Reference Books:

1. Fuzzy Modeling and Fuzzy Control, Huaguang Zhang, Derong Liu, Birkhauser Publishers, 2006.
2. Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence, Kosco B, Prentice Hall of India, 1992.
3. Fusion of Neural Networks, Fuzzy Systems and Genetic Algorithms: Industrial Applications, Lakshmi C. Jain, N. M. Martin, CRC Press, 1998.

Course Code: CH398	INDUSTRIAL SAFETY AND MANAGEMENT	Credits 3-0-0: 3

Pre-Requisites: None

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

CO1	Analyze the effects of release of toxic substances
CO2	Select the methods for prevention of fires and explosions
CO3	Identify the hazards and preventive measures
CO4	Assess the risks using fault tree diagram.

Syllabus:

Introduction and Industrial hygiene: Safety programs, Engineering ethics, Accident and loss Statistics, Acceptable risk, Public perceptions, Nature of the accident process, Inherent safety, Anticipation and identification, Hygiene evaluation and control.

Fires and Explosions and concepts to prevent fires and explosions: Fire triangle, Distinction between fires and explosions, Flammability characteristics of liquids and vapors, limiting oxygen concentration and inerting, Flammability diagram, inerting, Controlling static electricity, Explosion-proof equipment and instruments, Ventilation, Sprinkler systems.

Introduction to reliefs: Relief concepts, location of reliefs, relief types, relief scenarios, Data for sizing reliefs, relief systems.

Hazards Identification: Process hazards checklists, Hazards surveys, Hazards and Operability studies, safety reviews.

Safety procedures and designs: Process safety Hierarchy, managing safety, Best practices, procedures- operating, Procedures-permits, Procedures- safety reviews and accident investigations, Designs for process safety

Learning Resources:

Text Books:
1. Chemical process safety (Fundamentals with Applications) DA Crowl and JF Louvar, Prentice Hall, 2013, 3rd Edition.

Reference Books:
1. Chemical Engineering, Volume 6, John Metcalf Coulson, John Francis Richardson, R.K.Sinnott Butterwoth-Heinemann 1999.
2. Safety in the process Industries, Rulph King, Butterworth-Heinemann, 1990.

Course Code: CS395	FUNDAMENTALS 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:

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

Course Code: CS396	OBJECT ORIENTED PROGRAMMING PRINCIPLES	Credits 3-0-0: 3

Pre-requisites: None

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

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO5	Create GUI based applications.

Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, Object-oriented design, Structure of java program. Types and modifiers, Classes, declaring objects in classes, Methods, constructors, garbage collection, Method overloading, passing objects as parameters, Inheritance, various forms and types of inheritance, Multilevel hierarchy, use of super, method overriding, Applications of method overriding, abstract classes, Packages with examples

Interfaces and implementation, Exception handling, types, throwing, creating own exceptions, Multithreading and concepts, its usage and examples, Input/output streams, String operations and examples, Collection classes-array, stack collection, bitset collection, Utility classes-string

tokenizer, bitset, date, Applets- methods, creation, designing and examples, Event handling-event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-layout manager, user interface components, Graphics programming

Text Books / Reference Books / Online Resources:

1. Timothy Budd, "*Understanding Object-Oriented Programming with Java*", Pearson, 2000.
2. Herbert Schildt, "*The Complete Reference Java 2*", TMH, 2017.

Course Code: CS397	DATA ANALYTICS	Credits 3-0-0: 3

Pre-requisites: None

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

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Syllabus:

Organization and Information Systems, Foundation Concepts, Information Systems in Business, the Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for Strategic Advantage. Changing Environment and its impact on Business, Kinds of Information Systems. Computer Fundamentals, Computer Hardware, and Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data Resource Management, Technical Foundations of Database Management, Managing Data Resources Telecommunication and Networks, Telecommunications and Networks, the Networked Enterprise, Telecommunications Network Alternatives System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT, Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology.

Text Books / Reference Books / Online Resources:

1. Kenneth J Laudon, Jane P. Laudon, "Management Information Systems", 10th Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, "Management Information Systems", 3rd Edition, TMH, 2004.

Course Code: BT395	GREEN 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 historical, global, environmental and economic impacts of green technology systems
CO2	Address smart energy and green infrastructure
CO3	Address biomass energy and non-renewable energy challenges
CO4	Understand green buildings concept
CO5	Build models that simulate sustainable and renewable green technology systems

Syllabus:

Biomass Energy: Basic concepts, sources of biomass energy, uses of biomass energy, science and engineering aspects of biomass energy, production of biomass electricity, transmission of biomass electricity, storage of biomass electricity, estimation of air required for complete combustion, estimation of minimum amount of air required for a fuel of known composition, estimation of dry flue gases for known fuel composition, calculation of the composition of fuel & excess air supplied, from exhaust gas analysis, dew point of products, flue gas analysis (O_2, CO_2, CO, NOx, SOx).

Energy Transformation: Energy transformation from source to services, energy sources, Sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources; fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.

Environmental Effects: Environmental effects of energy extraction, conversion and use; sources of pollution from energy technologies, criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends-process/product innovation-, technological/ environmental leap-frogging; eco/green technologies for addressing the problems of water, energy, health, agriculture and biodiversity.

New Green Energy Concepts: Green buildings, green roof design characteristics, conceptual water and energy balance in a green roof, evapotranspiration, green entrepreneurship and business models.

Economics of Energy: Market barriers of biomass fuels, biomass fuel standardization, biomass fuel life cycle, sustainability of biomass fuels, economics of biomass fuels, fuel stoichiometry and analysis: fuel stoichiometry relations, biomass as a major source of energy in India: fuel-wood use in rural households. consequences for ecosystems, future energy scenario in rural areas, utilization of biomass in industrial and semi-industrial settings, future utilization of biomass in India.

Learning Resources:

Text Books:

1. Biomass to Renewable Energy Processes, Jay Cheng, CRC press, 2009, 1st Edition
2. Biofuels: Securing the Planet's Future Energy Needs, AyhanDemirbas, Springer, 2009, 1st Edition.

3. Renewable Energy, S.C. Bhatia and R. K. Gupta, Woodhead Publishing India (WPI), 2018, 1st Edition.

Reference Books:

1. Green Technology: An A to Z guide, Dustin R. Mulvaney, SAGE publications, 2011, 1st Edition.

Online Resources:

1. https://nptel.ac.in/courses/103/107/103107157/

Course Code: SM395	MARKETING MANAGEMENT	Credits 3-0-0:3

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

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environment
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Syllabus:

Introduction: Importance of Marketing, Scope of Marketing, Core Marketing concepts company orientation towards market place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement at Corporate level and at Business unit level. Assigning resources to Strategic Business units through B.C.G Matrix and G.E Model.

Analysing Macro environment: Demographic environment. Economic Environment, Technical Environment, Social-Cultural Environment and political – Legal Environment.

Components of Marketing information systems: Internal Records, Marketing intelligence, Marketing research and Marketing Decision support system.

Consumer Behaviour: Buying Decision process and the factors influencing consumer Behavior- Psychological factors, social factors, cultural factors and personal factors.

Importance of Market segmentation, Target market selection and positioning. Importance of new product development process and the various stages involved.

Product Life Cycle and Brand Equity: The concept of product lifecycle and the various strategies used by the marketer in each stage. Product characteristics and classification, Product mix and product line decisions Branding Decisions, Building Brand Equity.

Pricing: Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost based and demand-based methods.

Role of Marketing channels: Channel functions and channel levels channel Design and channel Management Decisions, Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.

Marketing Communication: Importance of integrated Marketing communication. Advantages and Disadvantages of Various promotional tools- Advertising, Sales promotion, personal selling, publicity and public Relations and Direct marketing.

Learning Resources:

Text Books:

1. Marketing Management, A South Asian Perspective by Philip Kotler, Kevin Lane Keller, 15th Edition.
2. Marketing Management: Indian Context Global Perspective, Ramaswami and Namakumari, 2018.

3. Marketing Management, Michael Etzer, Bruce J Walker, William Stanton, Ajay Pandit, 2017.

Reference Books:

1. Marketing Management, Philip Kotler, PHI, 14th Edition, 2014.
2. Marketing Management, William Stonton & Etzel, TMH, 13thEdition, 2013.
3. Marketing Management, Rajan Saxena, TMH, 2017.

Course Code: SM396	BUSINESS FOR NON-BUSINESS PROFESSIONALS	Credits 3-0-0:3

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

CO1	Identify business problems and opportunities.
CO2	Understand how different aspects of business fits together
CO3	Plan a business.
CO4	Identify Business segments of interest
CO5	Prepare business plans.

Syllabus:

Business Planning: Introduction; Products & Services; Strategy (business models); IPR

Review of Accounting: Triad of Balance Sheet, Income Statement, Cashflow

Marketing & Sales: Differentiation, Customer Value, Selling Skills, Key Account management, Service Strategy, Customer Service

Introduction to Finance, Company structure: Stock market, Company, Limited Liability Partnerships, NGO

Quality: Various Quality Models (ISO, CMM, Service)

Human Resources & Personal Effectiveness: People, Motivation, Compensation & Benefits, Performance Management

Learning Resources:

Text Books:
1. Total Quality Management, Besterfield, Dale H. et al., Pearson India; 5th ed., 2018.
2. Getting to Yes: Negotiating Agreement without Giving In, Fisher, Roger, Penguin Books; updated rev. ed., 2011.
3. Leading Change, Kotter, John P, Harvard Business Review Press; rev. ed., 2012.
4. The Art of Software Testing, Myers, Glenford J., Badgett, Tom and Sandler, Corey, Wiley; 3rd ed., 2015.
5. Essential Deming: Leadership Principles from the Father of Quality, Orsini, Joyce Nilsson, McGraw-Hill Education; 2013.
6. Lean Thinking: Banish Waste and Create Wealth In Your Corporation, Womack, James P. and Jones, Daniel T., Simon and Schuster; rev. ed., 2013.

Course Code: MA395	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	Credits 3-0-0: 3

Pre-Requisites: Nil

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

CO1	Solve nonlinear differential equations by numerical methods
CO2	Determine the convergence region for a finite difference method
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Syllabus:

Ordinary Differential Equations: Multistep (explicit and implicit) methods for initial value problems, Stability and Convergence analysis, Linear and nonlinear boundary value problems, Quasi-linearization, Shooting methods

Finite difference methods: Finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, error analysis, stability analysis, convergence analysis

Partial Differential Equations: Classification of partial differential equations, finite difference approximations for partial derivatives

Parabolic Equations: Finite difference schemes for Parabolic equations, Schmidt's two level, multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis

Hyperbolic Equations: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods

Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods

Learning Resources:

Text Books:

1. Numerical Solution of Differential Equations, M. K. Jain, New Age International, 2018, Fourth Edition
2. Numerical Solution of Partial Differential Equations, G. D. Smith, Oxford University Press, 2004

Reference Books:

1. Computational Methods for Partial Differential Equations, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age International, 2016, Second Edition

Course Code: PH395	ADVANCED MATERIALS	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 synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Identify and categorize various composite materials for engineering applications
CO4	Differentiate superconducting materials
CO5	Comprehend the characteristics and uses of functional materials

Syllabus:

Nano Materials: Origin of nanotechnology, Classification of nanomaterials, Physical, chemical, electrical, mechanical properties of nanomaterials. Preparation of nanomaterials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon-nano tubes(CNT).Synthesis, preparation of nanotubes, nanosensors, Quantum dots, nanomedicines.

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopedicimplants, dental materials.

Composites: General characteristics of composites, composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces.

Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, laser materials.

Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.

Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, polycrystalline, amorphous, liquid crystalline materials.

Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, resonators, pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets.

Learning Resources:

Text Books:

1. T. Pradeep, Nano: The Essentials; TATA McGraw-Hill, 2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press, 2012.

Reference Books:

1. Krishan K Chawla, Composite Materials; 2ndEdition, Springer 2006
2. Raul J. Martin-Palma, Akhlesh Lakhtakia, Nanotechnology, SPIE Press, USA, 2010.
3. Robert Kelsall, Ian Hamley and Mark Geoghegan, Nanoscale Science and Technology, Wiley, 2005.

Online Resources:

https://nptel.ac.in/courses/113/104/113104009/
https://nptel.ac.in/courses/113/105/113105057/
https://nptel.ac.in/courses/112/104/112104251/

Course Code: PH396	RENEWABLE ENERGY TECHNOLOGIES	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 basics of different energy harvesting technologies
CO2	Design, develop and test the solar energy harvesting
CO3	Design, develop and test the wind energy harvesting
CO4	Design and develop and test the hybrid energy harvesting systems.

Syllabus

Classification of energy sources, energy picture of India, electricity production by non-renewable energy sources, need for energy harvesting, renewable energy sources, Photovoltaic Systems Connected to the Grid, Advantages and disadvantages of renewable energy sources.

Photovoltaic Electricity Production, Photovoltaic conversion, I-V characteristics of a cell and conversion output, different types of solar cells, materials for solar cells, Advantages and disadvantages of solar energy technology. Wind energy technology, principle and operation of wind turbine, different types of wind generators, Integration of Wind Turbine Generators into the Grid, Advantages and disadvantages of solar energy technology.

Marine Energy Resources Conversion System, . Electricity productivity from marine resources, Ocean wave generator systems, Tidal energy converters, Advantages and disadvantages of ocean energy technology. Hydropower energy, Geothermal energy.

Hybrid energy harvesting technologies, piezoelectric energy technology, triboelectric energy harvesting technology, Advantages and disadvantages of piezo and triboelectric energy harvesting technolgies.

Learning Resources:

Text Books:
1. Renewable Energies, Jean-Claude Sabonnadière, Wiley Education, 2009.
2. Renewable Energy Resources– John Twidell and Tony Weir, 3rd edition, Taylor and Francis, 2015.
3. Triboelectric Nanogenerators, Z L Wang, Springer, 2016.

Reference Books:
1. Renewable Energy Technology– Indu Shekhar Jha, 1st edition New Age International Publishers, 2018.
2. Renewable Energy Sources and Emerging Technologies, D P Kothari, PHI, 2011.

Online Resources:
1. https://nptel.ac.in/courses/121/106/121106014/

CourseCode: PH397	SOLAR PHOTOVOLTAIC SYSTEMS	Credits 3-0-0:3

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Pre-Requisites: none

Course Outcomes: After studying this course, the student will be able to:

CO1	Outline the technologies to harness the power of solar energy.
CO2	Understand solar energy conversion and utilization processes currently used.
CO3	Comprehend solar photovoltaic systems for residential and industrial purposes.
CO4	Understand different Photovoltaic technologies, materials & their applications.
CO5	Understand solar energy manufacturing, environmental challenges, economic aspects, and future developments.

Syllabus:

Introduction to Solar Energy Conversion
Fundamentals of Solar Energy-Spectral Irradiance, Terrestrial Solar Radiation, Atmospheric effects, Air Mass, The Sun's Position, Solar Radiation on a Tilted Surface, Solar Insolation, Measurement and Analysis of Solar Irradiance.

Solar Photovoltaics
Solar Cell and its operation, Silicon solar structure and parameters, efficiency of solar and spectral response; Solar cell design principles-light trapping, optical losses, anti-reflection coatings, Top contact design, Metal Grid Pattern. Environmental and safety issues, Cell passivation.

Different Solar Cell Technologies
First Generation Silicon Solar Cells, Second Generation Thin Film Solar Cells-CIGS, and CdTe, Third Generation Solar Cells- Dye Sensitized Solar Cells, Organic Solar Cells, Perovskite Solar Cells.

Solar PV Modules and PV Systems
PV Module Circuit Design-Module Structure, Packing Density, Interconnections, Mismatch and temperature effects, Electrical and Mechanical Insulation, Lifetime of PV Modules, Degradation and Failure, PV Module Parameters, Efficiency of PV Module; Solar PV systems-Design of Off Grid Solar Power Plant. Installation and Maintenance.

Storage in PV Systems
Battery Operation, Types of Batteries, Battery parameters, Application and selection of Batteries for Solar PV System, Battery Maintenance and Measurements, Battery Installation for PV system.

Learning Resources:

Text Books:
1. Martin A. Green, Solar Cells: Operating Principles, Technology and system Applications, published by the University of New South Wales, 1998.
2. D. Yogi Goswami, Principles of Solar Engineering, Taylor and Francis, 2000.
3. Stuart Wenham, Martin Green, and Muriel Watt, Applied Photovoltaics, Earthscan, 2007.

Reference Books:
1. F. Lasnier and T. G. Ang, Photovoltaic Engineering Handbook, IOP Publishing UK (Adam Hilger USA) 1990.
2. S. M. Sze, and Ming-Kwei Lee, Semiconductor Devices: Physics, and Technology, third edition , New York, NY: Wiley, 2012.

Online Resources:

1. https://energyeducation.ca/encyclopedia/Photovoltaic_system
2. https://www.open.edu/openlearn/nature-environment/environmental-studies/energy-resources-solar-energy/content-section-1
3. https://www.pveducation.org/
4. http://energy.asu.edu.jo/index.php/r-d/solar-thermal-systems

Course Code: CY395	FUNDAMENTAL METHODS OF CHEMICAL ANALYSIS	Credits 3-0-0: 3

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

CO1	Describe the basic principles related to the characterization of compound
CO2	Describe a range of thermal analysis techniques, the instruments used and the types of results expected
CO3	Describe the different types of spectroscopic techniques including FTIR, UV-vis, NMR and Mass
CO4	Demonstrate a systematic knowledge of the range and breadth of the analysis of all classes of compounds
CO5	Review critically the potential impact of the characterization of compounds

Syllabus:

Spectroscopic Techniques: Review of UV-Visible, Fluorescence Spectrometry, Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy

Atomic Absorption Spectroscopy: AES, AAS Chapter 3, X-ray Spectroscopy. X-ray fluorescence (XRF).

Thermal Analysis: Basics of TGA, DTG, DTA, DSC and DMTA with suitable examples.

Separation Techniques: Fundamental of Chromatography Techniques TLC, Column, HPLC

Basic principles of NMR and Mass Spectrometry

Learning Resources:

Text Books:
1. Principles of Instrumental Analysis, Skoog, Holler, Crouch, 6th Edition, Cengage Learning, 2010.
2. Instrumental Methods of Analysis, Willard, Merritt, Dean, Settle, 7th Edition, CBS / Wadsworth Publ. Co., 1988.

Reference Books:
1. Surface enhanced Raman scattering: Physics and applications, Katrin Kneipp, Martin Moskovits, Harald Kneipp (Eds), Springer, 2010.

Course Code: HS395	SOFT SKILLS	Credits 3-0-0-3

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

CO1	Understand the importance of soft skills
CO2	Apply the principles of assertive behavior
CO3	Demonstrate the capacity for Emotional Intelligence
CO4	Prioritize team work and team playing skills
CO5	Learn the importance of body language in communication

Syllabus:

- Introduction to soft skills
- Introduction: Relevance of soft skills
- Behavior types
- Passive, aggressive and assertive
- Assertiveness: definition and ways to assert oneself

- Emotional intelligence: definition, importance, EQ vs IQ, theoretical framework of Daniel Goleman; definitions of Mayer and Salovey
- Examples and types of EQ; measuring EQ
- YouTube clippings on EQ
- Emotionally intelligent behavior vs emotionally destructive behavior
- Team building: Tuckman's team building model
- Case studies
- Johari window: importance and significance as a self-assessment tool
- Revision

- Body language: non-verbal communication and its importance
- Types of non-verbal communication: postures and gestures
- Types of non-verbal communication: postures and gestures
- Space and time as non-verbal communication
- Proxemics, kinesics, haptics, and the significance of non-verbal communication
- YouTube clippings illustrating body language and culture as a mediator in body language
- Time management and its importance
- Case studies
- Revision

- Communication skills: making a presentation
- Dos and Don'ts of Group Discussion and debating
- Grooming: from campus to corporate
- Dos and Don'ts of grooming
- Video clippings on grooming

- Becoming an entrepreneur
- Case studies
- Revision
- Summarizing

Text Books/Reference Books/Online Resources:
1. Developing Soft Skills by Robert M. Sherfield, Montgomery and Moody 4th Edition. 2009,

Pearson Publishers

2. Soft Skills: Know Yourself & Know The World by K. Alex, S. Chand publishers, 2009
3. Coping with Difficult People Robert Bramson Publisher Dell 2009.
4. Managing Soft Skills for Personality Development (1st Edition). 2012. B. N. Ghosh. Tata McGraw Hill.
5. The ACE of Soft Skills: Attitude, Communication and Etiquette for Success by Ramesh Gopalaswamy, Pearson Education, 2011.
6. Cornerstone: Developing Soft Skills. Sherfield.Pearson.2008.
7. Soft Skills: Enhancing employability, I. K. International publishing house limited. 2011.
8. Soft skills at work: Technology for career success. 2009. Beverly Amer.
9. Enhancing employability @soft skills. Shalini Verma. Pearson education. 2009.

Course Code: HS396	FOREIGN LANGUAGE COURSE IN FRENCH	Credits 3-0-0-3

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

CO1	Introducing oneself and someone else
CO2	Talking about one's surroundings
CO3	Buying objects from a shop, Giving simple explanations
CO4	Asking and giving directions
CO5	Writing a short message

Syllabus:
- Introducing oneself and someone else
- French Alphabet
- Numbers
- Colour names
- Use of Tu and Vous (familiar and formal You in English)
- French sounds and rhythm of spoken French

- Greeting someone and taking leave of someone
- Days of the week
- Months of the year
- Verbs ETRE and AVOIR
- Number and Gender of Nouns
- An overview of: Nasal and oral vowels
- Consonants
- Semi-consonants

- Counting
- Spelling out names
- Talking about one's surroundings
- Definite and indefinite and contracted articles
- Country names
- Francophonie (the French speaking world)
- Codes of politeness
- *La syllable*
- *Tonique*

- Asking and giving simple information
- Buying objects from a shop
- Giving simple explanations
- Conjugation of some regular and irregular verbs
- Possessive adjectives
- Demonstrative adjectives
- Geographical situation and administrative distribution of France And the Parisian region
- *Liaison*
- *Elision*

- Asking and giving directions
- Writing a short message (Example: post card)
- Agreement of adjectives with nouns
- Prepositions
- Iconic figures and other famous features from the French speaking world
- *Enchainement*
- *Le groupe de souffle*

Text Books:

Alter ego 1, Saison 1, Objectif express 1

Online Resources:

You learn french, blogspot.com, Learn French with Alexa (YouTube)

Course Code: HS397	FOREIGN LANGUAGE COURSE IN GERMAN	Credits 3-0-0-3

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

CO1	Understand the basics of German Language, its pronunciation, its basic grammatical rules etc.
CO2	Identify the features pertaining to the syntax and its usage.
CO3	Analyse the sentences heard or read in its basic features without much delay or translation.
CO4	Apply the rules of grammar and syntax while speaking, writing, reading or listening.
CO5	Demonstrate their linguistic ability in the four faculties mentioned in CO4.

- Alphabet (Alphabet)
- Buchstabieren (Spelling)
- Begrüssen / Grüssen Und Sich Verabschieden (Greetings and Saying 'Bye')
- Sich Selbst Und Andere Vorsellen (Introducing Oneself and others)

GRAMMAR:
- Personal pronomen: Ich, Du, Er, Sie, Es, Wir, Ihr, Sie, Sie)
- (Personal pronouns: I, You, He, She, It, We, You All, They, You)
- Verb Und Konjugation: Präsens (Verb And Conjugation: Present Tense))
- Verben ‚Haben' Und ‚Sein' (Verbs: To Have And To Be)

- Zahlen (Null – Eine Milliarde (Numbers Zero – One Billion)
- Rechnen Auf Deutsch: +, - X, ÷ (Calculating In German)
- Telefonnummer Angeben (Giving The Phone Number)
- Deutsche Namen (German Names)
- Ja/Nein Fragen (Yes/No Questions)

GRAMMAR:
- Satzstruktur (Sentence Structure)
- Nominativ (Nominative – Subject Case)
- W- Fragen: Was, Wer, Wann, Woher, Wo, Wie Viele (W-Questions:
- What, Who, When, Where From, Where, How Many)
- Bestimmter Artikel: Der, Die, Das (Definite Articles; Der, Die, Das)
- Namen Der Deutschen Städte (Names of German Cities)
- Namen Der Länder (Names of Countries)
- Familienmitglieder (Members of The Family)
- Wer/Was Ist Das? / Wer/Was Sind Das? (Who Is This/What Is This? Who are They/What are They?)

GRAMMAR:
- Unbestimmter Artikel: Ein, Eine (Indefenite Articles; A, An)
- Plural Der Substantive (Plural Forms Of Nouns)
- Internationale Wörter (International Words)
- Aussagesatz (Statement)
- Fragesatz (Interrogative Sentence –Questions)
- Negation: Nicht, Kein/Keine (Negation: Not, No/None)
- Wochentage (Days of The Week)
- Monate (Months)
- Jahreszeiten (Seasons)

- ✓ Berufe (Professions)
- ✓ Uhrzeit (Telling The Time)
- ✓ Wichtige Feste (Important Festivals)

GRAMMAR:
- ✓ Ja/Nein/Doch (Yes/No/Of Course)
- ✓ Demonstrativpronomen: Dieser, Diese, Dieses, Diesen
- ✓ (Demonstrativpronomen: This, That)
- ✓ Imperativformen: Du/Ihr/Sie (Imperative
- ✓ Forms: You, You All)
- ✓ Possessivpronomen (Possessive Pronoun)
- ✓ Man (One)
- ✓ Essen/Getränke (Fo0d/Drinks))
- ✓ Farben (Colors)
- ✓ Kleidungsstücke (Dresses)
- ✓ Körperteile (Parts of The Body)
- ✓ Schulsachen (Things for The School)
- ✓ Fächer (Subjects)

GRAMMAR:
- ✓ Akkusativ (Akkusative – The Object Case)
- ✓ Akkusativverben (Verbs in Accusative)
- ✓ Die Ordnungszahlen (Ordinal Numbers)
- ✓ Dativ (Dative -The Object Case)
- ✓ Genitiv (Genetive Case)
- ✓ Tageszeiten (Times of the Day)
- ✓ Sportarten (Different Kinds of Sports)
- ✓ Freizeitbeschäftigung (Hobbys)
- ✓ Lesetexte (Texts for Reading Comprehension)
- ✓ German Songs - Let Us Sing in German!

GRAMMAR:
- ✓ Modalverben: Können, Müssen, Wollen, Möchten, Sollen, Dürfen
- ✓ (Modal Verbs: Can, Must, Want, Like, Should, May)
- ✓ Perfekt (The Present Perfect Tense)
- ✓ Präteritum (Simple Past Tense)
- ✓ Futur I (Future Tense)

Text Books/Reference Books/Online Resources:
1. Get Started in German Absolute Beginner Course (English, Mixed media product, McNab Rosi)
2. Beginning with German (English, Paperback, Hamby Maria) Strategies to Maximize your Understanding in German. A2 Level.
3. Introductory German Lessons (English, Paperback, Otto Emil)
4. Easy German (English, Paperback, Denne Ben)