Curriculum for Undergraduate Degree (B.Tech.) in Computer Science and Engineering (w.e.f. AY: 2020-21)

Part III: Detailed Curriculum

Eighth Semester

Course Name:	**Professional Ethics and Project Management**		
Course Code:	HM-HU 802	**Category:**	Management Science and Humanities Courses
Semester:	8th	**Credit:**	2
L-T-P:	2-0-0	**Pre-Requisites:**	Must have the knowledge on basic statistics and other decision-making tools
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1.	To understand the core values that shape the ethical behaviour of a professional.
2.	To understand the concepts of project planning and organization, budgeting and control, and project life cycles.
3.	To learn concepts related to organizational workflow including the staffing process, project planning elements, and the project plan contents and project communications.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1.	Morals, values and Ethics. Engineering Ethics & Professionalism. Code of Ethics. Profession and Professionalism- Models of professional roles- Theories about right action.	3
2.	Managing conflict. Whistle Blowing. Global Ethical Issues. Multinational Corporations- Environmental Ethics- Business Ethics- Computer Ethics - Role in Technological Development-Engineers as Managers- Consulting Engineers- Engineers as Expert witnesses and advisors-Moral leadership.	3
3.	Project Management : Definitions of Project and Project Management, Issues and Problems in Project Management, Project Life Cycle - Initiation / Conceptualization Phase, Planning Phase, Implementation / Execution Phase, Closure / Termination Phase [4L]	4
4.	Project Feasibility Studies – Pre-Feasibility and Feasibility Studies, Preparation of Detailed Project Report, Technical Appraisal, Economic/Commercial/Financial Appraisal including Capital Budgeting Process, Social Cost Benefit Analysis Project Planning – Importance of Project Planning, Steps of Project Planning, Project Scope, Work Breakdown Structure (WBS) and Organization Breakdown Structure (OBS), Phased Project Planning	4

5.	Project Scheduling and Costing – Gantt chart, CPM and PERT Analysis, Identification of the Critical Path and its Significance, Calculation of Floats and Slacks, Crashing, Time Cost Trade-off Analysis, Project Cost Reduction Methods.	6
6.	Project Monitoring and Control – Role of Project Manager, MIS in Project Monitoring, Project Audit. Case Studies with Hands-on Training on MS-Project.	4
Total		**24 L**

Course Outcomes:	
After completion of the course, students will be able to:	
1.	Apply the knowledge of human values and social values to contemporary ethical values and global issues.
2.	Make a framework for analyzing a project and apply their knowledge systematically to value a business
3.	Applying the principles and practices while maintaining high standards of practice, making ethical judgments and decisions in a respectful, and sustaining professional standing through a commitment to life-long learning.
4.	Implements the generally recognized framework and good practices of project management, organizational influences; operations; strategic planning; programs; project life cycles; and project management cycles

Learning Resources:	
1.	
2.	*Project Management - David I Cleland - Mcgraw Hill International Edition.*
3.	*Project Management – Gopalakrishnan – Mcmillan India Ltd*
4.	*Project Management – K Nagarajan*
5.	*Project Management- Erik Larson and Clifford Gray- SEI*

Course Name:	**Big Data Analytics**		
Course Code:	PE-CS 801A	**Category:**	Professional Elective Courses
Semester:	8th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	DBMS, JAVA, PYTHON
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To learn the concepts of Big Data and Hadoop
2	To understand and apply the concept of HDFS and MapReduce
3	To deal with Big Data using Hive, Pig, HBase, Impala, Sqoop

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	Introduction to big data: Variety of Big Data. Big Data and its Importance of 3 V's, 4 V's, 6 V's of Big Data, Characteristics' of Big Data. Introduction of Hadoop, Benefit of Hadoop, Core Components of Hadoop, Other Components of Hadoop, Hadoop Cluster, Hadoop Start-up Mode. Introduction to HDFS, Architecture of HDFS, Role and types of Name Node, HDFS Commands.	12
2	Introduction to MapReduce, Flow of Map Reduce, Word Count Problem by Using Map Reduce etc.	4
3	Introduction to Hive, Architecture of Hive, Data Types of Hive, Hive Query language, Handling Complex Data Types, Scripting in Hive, Different join operations on database tables. Introduction to PIG, Data Types in Pig, Pig Latin, Scripting in Pig.	10
4	Introduction to Sqoop, import data from HDFS To MySQL, Import data From Hive to MySQL. Exporting Data from Hive to Mysql.	4
5	Introduction to NoSQL, Types of NoSQL Databases. Introduction to HBase. Introduction to Impala. Introduction to Spark	6
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Describe the concept of Big Data, Hadoop and HDFS
2	Describe the concept of Map Reduce, Hive, HBase, Pig, Sqoop and Impala
3	Demonstrate the concept of data transfer between HDFS, MySQL and Hive.
4	Apply NoSQL for importing and exporting unstructured data

Learning Resources:	
1	Michael Minelli, Michehe Chambers, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Business", 1st Edition, Ambiga Dhiraj, Wiely CIO Series, 2013.
2	DT Editorial Services, "Big Data, Black Book: Covers Hadoop 2, MapReduce, Hive, YARN, Pig, R and Data Visualization", Dreamtech Press India Pvt. Ltd., 2020
3	Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
4	Rajkumar Buyya, "Big Data Principles and Paradigms", MK
5	Tom White, "Hadoop: The Definitive Guide", 3rd Edition, O'reilly, 2012.
6	Lars George, "HBase: The Definitive Guide", O'Reilley, 2011
7	Alan Gates, "Programming Pig", O'Reilley, 2011.
8	Bart Baesens "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications (WILEY Big Data Series)", John Wiley & Sons,2014

Course Name:	**Cryptography & Network Security**		
Course Code:	PE-CS801B	**Category:**	Professional Elective
Semester:	8th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Discrete Mathematics
Full Marks:	100		
Examination Scheme:	Semester Examination: -70	Continuous Assessment: - 25	Attendance: -5

Course Objectives:	
1	To understand basics of Cryptography and Network Security
2	To be able to secure a message over insecure channel by various means.
3	To learn about how to maintain the Confidentiality, Integrity and Availability of a Data.
4.	To understand various protocols for network security to protect against the threats in the networks.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction to Cryptography Introduction to security attacks - services and mechanism - introduction to cryptography -Conventional Encryption: Conventional encryption model - classical encryption techniques -substitution ciphers and transposition ciphers – cryptanalysis – steganography - stream and block ciphers introduction only.	5
2	Confidentiality and Modular Arithmetic Confidentiality using conventional encryption - traffic confidentiality - key distribution – random number generation - Introduction to graph - ring and field - prime and relative prime numbers - modular arithmetic - Fermat's and Euler's theorem - primality testing - Euclid's Algorithm - Chinese Remainder theorem - discrete algorithms.	10
3	Public key cryptography and Authentication requirements Principles of public key crypto systems - RSA algorithm - security of RSA - key management – Diffle-Hellman key exchange algorithm - introductory idea of Elliptic curve cryptography – Elgamel encryption - Message Authentication and Hash Function: Authentication requirements -authentication functions - message authentication code - hash functions - birthday attacks –security of hash functions and MACS.	6
4	Integrity checks and Authentication algorithms MD5 message digest algorithm - Secure hash algorithm (SHA) Digital Signatures: Digital Signatures - authentication protocols - digital signature standards (DSS)	5
5.	Web and System Security Web Security: Secure socket layer and transport layer security - secure electronic transaction (SET) - System Security: Intruders - Viruses and related threads - firewall design principals –trusted systems.	5

6.	Introduction to Blockchain and Cryptocurrency, Concept of Consensus, Ethereum and application of Blockchain and Cryptocurrency in different domains considering the security aspects.	5
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1.	Explain the principle of cryptography
2.	Differentiate between symmetric and asymmetric key cryptography
3.	Explain the web security features and different security threats.
4.	Explain Blockchain and Cryptocurrency and its role in different domains.

Learning Resources:	
1.	William Stallings, "Crpyptography and Network security Principles and Practices", Pearson/PHI.
2.	Wade Trappe, Lawrence C Washington, "Introduction to Cryptography with coding theory", Pearson.
3.	Ferouzen "Cryptography & Network Security", TMH Publication.

Course Name:	**Web and Internet Technology**		
Course Code:	PE-CS801C	**Category:**	Professional Elective Courses
Semester:	8th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Computer Networks
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To develop an understanding of modern network concepts.
2	To introduce different technologies for web development
3	To provide basic concepts of network security

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	Introduction (1L): Overview, Network of Networks, Intranet, Extranet and Internet. World Wide Web (1L): Domain and Sub domain, Address Resolution, DNS, Telnet, FTP, HTTP. Review of TCP/IP (1L): Features, Segment, Three-Way Handshaking, Flow Control, Error Control, Congestion control, IP Datagram, IPv4 and IPv6. IP Subnetting and addressing (1L): Classful and Classless Addressing, Subnetting. NAT, IP masquerading, IP tables. Internet Routing Protocol (1L): Routing -Intra and Inter Domain Routing, Unicast and Multicast Routing, Broadcast. Electronic Mail (1L): POP3, SMTP.	6
2	HTML (3l): Introduction, Editors, Elements, Attributes, Heading, Paragraph. Formatting, Link, Head, Table, List, Block, Layout, CSS. Form, Iframe, Colors, Color name, Color value. Image Maps (1L): map, area, attributes of image area. Extensible Markup Language (XML) (4L): Introduction, Tree, Syntax, Elements, Attributes, Validation, Viewing. XHTML in brief. CGI Scripts (1L): Introduction, Environment Variable, GET and POST Methods.	9
3	PERL (3L): Introduction, Variable, Condition, Loop, Array, Implementing data structure, Hash, String, Regular Expression, File handling, I/O handling. JavaScript (4L): Basics, Statements, comments, variable, comparison, condition, switch, loop, break. Object – string, array, Boolean, reg-ex. Function, Errors, Validation.	10

	Cookies (1L): Definition of cookies, Create and Store a cookie with example. Java Applets (2L): Container Class, Components, Applet Life Cycle, Update method; Parameter passing applet, Applications.	
4	Client-Server programming In Java (2L): Java Socket, Java RMI. Threats (1L): Malicious code-viruses, Trojan horses, worms; eavesdropping, spoofing, modification, denial of service attacks. Network security techniques (2L): Password and Authentication; VPN, IP Security, security in electronic transaction, Secure Socket Layer (SSL), Secure Shell (SSH). Firewall (1L): Introduction, Packet filtering, Stateful, Application layer, Proxy.	6
5	Internet Telephony (1L): Introduction, VoIP. Multimedia Applications (2L): Multimedia over IP: RSVP, RTP, RTCP and RTSP. Streaming media, Codec and Plugins, IPTV. Search Engine and Web Crawler (2L): Definition, Meta data, Web Crawler, Indexing, Page rank, overview of SEO.	5
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	recall the concepts of network and internet, technologies and protocols
2	apply different technologies such as HTML, CSS, JavaScript, Perl, applet and other Web technologies to develop static/ dynamic web pages for a given web application
3	apply JavaScript to implement cookie
4	design dynamic and interactive web pages by embedding JavaScript code in HTML to validate the user input
5	design security issues for devices like firewall

Learning Resources:	
1	Web Technology: A Developer's Perspective, N.P. Gopalan and J. Akilandeswari, PHI Learning, Delhi, 2013. (Chapters 1-5,7,8,9).
2	Internetworking Technologies, An Engineering Perspective, Rahul Banerjee, PHI Learning, Delhi, 2011. (Chapters 5,6,12)
3	Web Technologies, Uttam K. Roy, Oxford University Press

Open Elective -III

Subject Code	Subject Name	Offered by
OE-AUE801A	Electric Vehicle	AUE
OE-HU801G	Introduction to Philosophical Thoughts	MSH
OE-IT801B	E-Commerce	IT
OE-IT801C	Internet of Things	IT
OE-ME801A	3D Printing and Design	ME

Course Name:	**Electric Vehicle**		
Course Code:	OE-AUE801A	**Category:**	Open Elective Course
Semester:	8TH	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Electrical and Electronics and Automotive Engine and Chassis
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Understanding of basic principles, operation, performance of Electric vehicles

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Hybrid & Electric Vehicles:** History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Advantages & Disadvantages of hybrid and electric vehicles	4
2	**Vehicle Fundamentals:** Vehicle resistance, Types: Rolling Resistance, grading resistance, Aerodynamic drag vehicle performance, Calculating the Acceleration Force, maximum speed, Finding the Total Tractive Effort, Torque Required on the Drive Wheel, Transmission: Differential, clutch & gear box, Braking performance.	6
3	**Hybrid Electric Drive-trains:** Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	4
4	**Electric Drive-trains:** Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive- train topologies, fuel efficiency analysis.	4
5	**Electric Propulsion unit:** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of different motors drives like DC motor drives, Induction Motor drives etc.	4

6	**Energy Storage:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles; Electrochemical Batteries, Lead-Acid Batteries, Nickel Based Batteries, Lithium Based Batteries, Ultra Capacitors- Basic Principles and Performance, Ultrahigh-speed flywheels- Basic Principle and Power Capacity, Fly Wheel technologies. Energy recovery by regenerative braking. Operating principles of fuel cells.	6
7	**Sizing the drive system:** Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems	5
8	**Case Studies:** Design of a Battery Electric Vehicle (BEV).	3
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
2	Choose proper energy storage systems for vehicle applications.
3	Design and develop basic schemes of electric vehicles

Learning Resources:	
1	Husain I., Electric and Hybrid Vehicles: Design Fundamentals, CRC Press.
2	Ehsani M., Gao Y., Gay S.E. and Emadi A., Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press.
3	Larminie J. and Lowry J., Electric Vehicle Technology Explained, Wiley.
4	John M. Miller, Propulsion Systems for Hybrid Vehicles, The Institution of Engineering and Technology
5	Chris Mi, M.Abul Masrur and David Wenzhong Gao, 1st Edition, Hybrid Electric Vehicles, John Wiley & Sons, Ltd, 2011

Course Name:	**Introduction to Philosophical Thoughts**		
Course Code:	OE-HU801G	**Category:**	Open Elective Courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Human Values
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1.	To understand the Philosophical values and learn the various school of Philosophical thoughts.
2.	To apply concise explanations and arguments about basic philosophical problems

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1.	Nature of Indian Philosophy: Plurality as well as common concerns. Basic concepts of the Vedic and Upanisadic: Atman, Jagrata, Svapna, Susupti, Turiya, Brahman, Karma, Rta, Rna	16
2.	Carvaka school: its epistemology, metaphysics and ethics. Mukti Jainism: Concepts of sat, dravya, guna, paryaya, jiva, ajiva, anekantavada, syadvada, and nayavada ; pramanas, ahimsa, bondage and liberation.	10
3.	Buddhism: theory of pramanas, theory of dependent origination, the four noble truths; doctrine of momentaryness; theory of no soul. The interpretation of these theories in schools of Buddhism: Vaibhasika, Sautrantrika, Yogacara, Madhyamika.	5
4.	Nyaya: theory of Pramanas; the individual self and its liberation ; the idea of God and proofs for His existence.	5
Total		**36 L**

Course Outcomes:	
After completion of the course, students will be able to:	
1.	Describe and distinguish key philosophical concepts in the main subfields of philosophy, including concepts such as free will, mind, knowledge, belief, reality, faith, reason, good, etc.
2.	Discuss core philosophical problems, such as whether there is a god, what does it mean to be conscious, are we free to make choices, what is justice, etc.
3.	Explain and defend a position on basic philosophical problems.
4.	Read and comprehend philosophical texts, both classical and contemporary and concise explanations and arguments about basic philosophical problems

Learning Resources:	
1.	M. Hiriyanna : Outlines of Indian Philosophy.
2.	C.D.Sharma : A Critical Survey of Indian Philosophy.
3.	S.N.Das Gupta : A History of Indian Philosophy Vol – I to V.
4.	S.Radhakrishnan : Indian Philosophy Vol – I & II.
5.	T.R.V.Murti : Central Philosophy of Buddhism.

Course Name:	**E-Commerce**		
Course Code:	OE-IT801B	**Category:**	Open Elective Courses
Semester:	8th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	DBMS, Computer Networks
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance:5

Course Objectives:	
1	To facilitate the students about the concept of E-commerce.
2	To develop the ability to distinguish different business models.
3	To impart the knowledge of electronic payment system.
4	To provide knowledge of different legal and security issues related with E-Commerce.

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to E-Commerce :** Definition, Scope of E-Commerce, E-Commerce and Trade Cycle, Electronic Markets, Mobile Commerce, Electronic Data Interchange (EDI): Technology, Standards (UN/EDIFACT), Communications, EDI and Business, Relationship Between E – Commerce & Networking, Different Types of Networking: Internet, Intranet & Extranet, Wireless Application Protocol: Definition, Hand Held Devices, Infrastructure Requirement for E – Commerce, Rules & Regulations for Controlling E – Commerce	8
2	**Business Model of E-Commerce:** Model Based on Transaction Type, Model Based on Transaction Party Business-to-Consumer (B2C) – Business-to-Business (B2B) – Consumer-to Consumer (C2C) – Consumer-to-Business (C2B). Brokerage Model – Value Chain Model – Advertising Model.	4
3	**Supply Chain Management:** E – logistics, Supply Chain Portal, Supply Chain Planning Tools (SCP Tools), Supply Chain Execution (SCE), SCE - Framework, Internet's effect on Supply Chain Power.	4
4	**Legal Issues** Legal issues**:** Risks, Paper Document vs. Electronic document, Authentication of Electronic document, Laws, Legal issues for Internet Commerce: Trademarks and Domain names, Copyright, Jurisdiction issues, Service provider liability, Enforceable online contract.	4
5	**Security Issues:** Security Issues and solutions: Risk of E – Commerce: Overview, Security for E – Commerce, Security Standards, Firewall, Cryptography, Symmetric and Asymmetric Cryptosystems, Digital certificates, RSA, DES, and Digital Signature, Protocols for secure messaging, Internet Security, Cyber Laws.	8

6	**Electronic Payment System:** Types of electronic payment systems; Digital token based electronic payment system: E-cash, properties of e-cash, electronic cash in action, business issues and electronic cash, operational risk and electronic cash, electronic cheques; smart cards and electronic payment system; credit card based electronic payment system; Risk and electronic payment system; designing electronic payment system.	4
7	**E-business and E-Marketing:** Internet bookshops, Electronic Newspapers, Virtual Auctions, Online Share Dealing, Gambling on the net, Home –shopping, E-Marketing, Tele-marketing, E-Diversity, Case studies through internet.	4
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the concept of E-Commerce and Business models.
2	Describe how procurement and supply chains relate to B2B E-commerce.
3	Discuss legal issues surrounding e-commerce.
4	Identify the key security threats and its solution in the E-commerce environment.

Learning Resources:	
1	E-Commerce-Strategy, Technologies & Applications by David Whitley, TMH
2	E-Commerce- The cutting edge of business by Kamlesh K. Bajaj, TMH
3	E-Commerce through ASP by W Clarke- BPB
4	Bhaskar Bharat : Electronic Commerce - Technologies & Applications.TMH
5	Krishnamurthy, E-Commerce Mgmt, Vikas
6	Beginning E-Commerce, Reynolds, SPD
7	E – Commerce : Strategy Technologies & Applications, Tata McGraw Hill.
8	Global E-Commerce, J. Christopher & T.H.K. Clerk, University Press
9	Murthy : E – Commerce , Himalaya Publishing.

Course Name:	**Internet of Things**		
Course Code:	OE-IT801C	**Category:**	Open Elective Courses
Semester:	8th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Fundamentals of computer network, Network Security
Full Marks:	100		
Examination Scheme:	Semester Examination:70	Continuous Assessment:25	Attendance:05

Course Objectives:	
1	In this course, students will explore various components of Internet of things such as Sensors, internetworking, and cyber space.
2	In the end they will also be able to design and implement IoT circuits and solutions.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Introduction to IoT:** Sensing, Actuation, Networking basics, Communication Protocols, Sensor Networks, Machine-to-Machine Communications, IoT Definition, Characteristics. IoT Functional Blocks, Physical design of IoT, Logical design of IoT, Communication models & APIs. Environmental Parameters Measurement and Monitoring: Why measurement and monitoring are important, effects of adverse parameters for the living being for IOT	8
2	**Sensors:** Working Principles: Different types; Selection of Sensors for Practical Applications Introduction of Different Types of Sensors such as Capacitive, Resistive, Surface Acoustic Wave for Temperature, Pressure, Humidity, Toxic Gas etc	4
3	**M2M to IoT:** Introduction, From M2M to IoT, M2M towards IoT-the global context, A use case example, Differing Characteristics. Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT,	4
4	**IoT Reference Architecture**- Getting Familiar with IoT Architecture, Various architectural views of IoT such as Functional, Information, Operational and Deployment. Constraints affecting design in IoT world-Introduction, Technical design Constraints.	6
5	**Domain specific applications of IoT:** Home automation, Industry applications, Surveillance applications, Other IoT application.	4
6	**Developing IoT solutions:** Introduction to Python, Introduction to different IoT tools, Introduction to Arduino and Raspberry Pi Implementation of IoT with Arduino and Raspberry, Cloud Computing, Fog Computing, Connected Vehicles, Data Aggregation for the IoT in Smart Cities, Privacy and Security Issues in IoT. Recent trends in smart sensor for day to day life, evolving sensors and their architecture.	8
Total		**34L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Understand general concepts of Internet of Things (IoT).
2	Recognize various devices, sensors and applications.
3	Understand M2M and IoT architectures.
4	Understand the application of IoT solutions.
5	Apply IoT solutions in various domain using sensors, actuators and Devices.
Learning Resources:	
1	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
2	Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", 1st Edition, VPT, 2014
3	Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
4	Cuno Pfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493- 9357-1

Course Name:	**3D Printing and Design**		
Course Code:	OE-ME801A	**Category:**	Open elective courses
Semester:	Eighth	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Manufacturing Processes
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques.
2	To familiarize students with different processes in rapid prototyping systems.
3	To teach students about mechanical properties and geometric issues relating to specific rapid prototyping applications.

Course Contents:

Module No.	**Description of Topic/ Experiment**	**Contact Hrs.**
1	**Module 1:** Definition , Generic Additive Manufacturing (AM) Process, Terms related to AM, Benefits of AM, Distinction between AM and CNC machining, Additive manufacturing process chain: Variation between different AM machines, Metal systems, Maintenance of Equipment, Material Handling Issues.	8L
2	**Module 2:** Introduction to rapid prototyping (RP), Need of RP in context of batch production, Basic principles of RP, Steps in RP, Process chain in RP in integrated CAD- CAM environment, Advantages of RP, Medical applications.	6L
3	**Module 3:** Classification of different RP techniques – based on raw materials, layering technique (2-D or 3-D) and energy sources: Process technology, Stereo-lithography (SL), photo polymerization, liquid thermal polymerization, Solid foil polymerization.	8L
4	**Module 4:** Selective laser sintering, Selective powder binding, ballistic particle manufacturing – both 2D and 3-D, Fused deposition modeling, Shape melting, Laminated object manufacturing, Solid ground curing, 3-D printing.	8L
5	**Module 5:** Introduction to Reverse Engineering: Meaning, Use, RE-The generic process, Phase of RE–scanning, Contact Scanners, Noncontact Scanners, Point Processing, Application Geometric Model, Development.	6L
Total		**36L**

Course Outcomes:
After completion of the course, students will be able to: 1. Demonstrate the knowledge of Additive Manufacturing and Rapid Prototyping technologies. 2. Describe different RP techniques. 3. know fundamentals of Reverse Engineering.

Learning Resources:	
1	Ian Gibson, David W. Rosen, Brent Stucker , "Additive Manufacturing Technologies" , Springer, 2009.
2	Chua C. K., Leong K. F., and Lim C. S., "Rapid Prototyping: Principles and Applications", Second Edition, World Scientific Publishers (2003).
3	Patri K. Venuvinod, Weiyin Ma "Rapid Prototyping: Laser-Based and Other Technologies" Springer , 2004

Open Elective -IV

Subject Code	Subject Name	Offered by
OE-EC801A	Information and Coding Theory	ECE
OE-EC801B	Micro-Electronics and VLSI Design	ECE
OE-EE801A	Renewable Energy	EE
OE-HU801A	Business Analytics and Entrepreneurship	MSH

Course Name:	**Information and Coding theory**		
Course Code:	OE-EC 801A	**Category:**	Open Elective
Semester:	8th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Communication Engineering
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	Students will be capable to explain Information, Entropy of various types of channel
2	Students can discuss various Source coding mechanism in order to enhance average bit rate
3	Students will acquire knowledge about numerous channel coding techniques to accomplish error free transmission

Course Contents:		
Module No.	**Description of Topic**	**Contact Hrs.**
1	**Information and Entropy:** Basic concept of Information, Uncertainty, average information, Mutual information, Entropy, Concept of Discrete memory less Source and Discrete memory less channel, Loss less channel, Deterministic channel, Binary symmetrical channel, Maximum Entropy, Channel matrix, Information measure	7
2	**Discrete Channel Capacity:** Shanon – Hertley channel capacity theorem, Information rate, Error probability, Gaussian channel noise, Bandwidth SNR trade off, Information Capacity Theorem, Shanon Limit	4
3	**Source Coding:** Basic source coding mechanism, Shanon Fano coding, Hauffman Coding hypothesis, Source Coding theorem,	4
4	**Channel Coding:** Hamming code and hamming distance, Linear block code, Generator matrix, Parity check matrix, Syndrom calculation, error matrix, cyclic properties of coding, Division algorithm for polynomial, Systematic cyclic coding, Generator and parity check polynomial, Cyclic redundancy check	6

5	**Galois algorithm and BCH Codes:** Galois field and minimal polynomial, GF(8) and GF(16) field elements primitive polynomial, Irreducible polynomial, BCH generator polynomial construction for single dual and triple error detection and correction, BCH decoding, Reed soloman codes. RS encoders and Decoders	8
6	**Convolution Code Viterbi algorithm**: Introduction of convolution codes, Sequential coding and Decoding using shift Registers, Code Tree, Code Trellis, State diagram for encoder, Rate ½ Convolution Encoder, Generating Function and Modified state diagram, Viterbi Decoding algorithm of convolution code, Turbo codes	7
Total		**36**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Define Information, Uncertainty, Entropy and channel capacity of AWGN channel
2	Student will able to introduce various source coding scheme
3	Students can evaluate error control coding techniques to detect and correct the channel error

Learning Resources:	
1	Ranjan Bose, Information Theory coding and cryptography, 2/e, TMH
2	Salvatore Gravano, Error control Codes, Oxford University press
3	Shu Lin & Danial J castalo, Error control Coding, 2/e, Pearson

Course Name:	**Microelectronics and VLSI Design**		
Course Code:	OE-EC801B	**Category:**	Open Elective Courses
Semester:	Seventh	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Knowledge of CMOS
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To learn about VLSI design methodologies.
2	To learn about VLSI fabrication process and layout design rules
3	To learn about CMOS analog circuits.
4	To learn about digital CMOS logic circuits.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**MOSFET:** Electrical characteristics of MOSFET, Threshold voltage, Current expression, Body effect, Channel length modulation, MOSFET scaling, Short-channel effects.	6
2	**VLSI Methodologies:** Introduction to VLSI design, Moore's Law, VLSI Design flow, Design hierarchy, VLSI Design style: Full custom, Gate array, standard-cell, and Macro cell based design, Field programmable devices.	4
3	**Micro-electronic Processes for VLSI Fabrication:** Wafer preparation, Oxidation, Diffusion, Ion implantation, Epitaxy, Metallization, Etching and Lithography. NMOS fabrication: n-well and p well process, Twin tub process. **Layout:** Stick diagram, Layout and Layout design rules.	10
4	**Analog VLSI Circuits:** Introduction to Analog IC Design, MOS switch, Active load / resistors, CMOS Current source & sink, CMOS Voltage reference circuits/voltage dividers, Current Mirror, Differential amplifier, Operational Amplifier, Switched capacitor filter.	10
5	**CMOS for Digital VLSI Circuits:** CMOS Inverter, CMOS logic Circuits: NAND, NOR and other complex CMOS logic circuits, CMOS Full Adder, CMOS Transmission Gate, Sequential CMOS logic circuits: SR Latch, D-latch, clocked JK Latch/ Master-Slave JK, Edge triggered flip-flop, CMOS Power: static and dynamic power dissipation, latch up.	10
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	State VLSI design methodologies.
2	Describe different steps of VLSI fabrication process and layout design rules.
3	Explain the operation of different CMOS analog circuits.
4	Explain the operation of various digital CMOS logic circuits.

Learning Resources:	
1	CMOS Digital Integrated Circuits, S. Mo. Kang and Yusuf Leblebici, 3rd Ed, TMH.
2	Design of Analog CMOS Integrated Circuits, Behzad, Razavi, MGH.
3	CMOS Analog Integrated Circuit Design, Allen Holberg, Oxford University Press.
4	VLSI Design, Debaprasad Das, 2nd Edition, Oxford University Press.
5	Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey, Prentice-Hall Publication, 2nd Edition.
6	Basic VLSI Design, D. Pucknell & Eshraghian, PHI, 3rd Edition.
7	Fundamental of Semiconductor Fabrication, Garry S. May, Simon M SZE, WILEY.
8	CMOS Circuit Design, R. Jacob Baker, Harry W. Li, David E. Boyce, PHI.

Course Name:	**Renewable Energy**		
Course Code:	OE-EE801A	**Category:**	Open Elective Course
Semester:	8th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Basic Electrical & Electronics Engineering
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance: 05

Course Objectives:	
1	To understand the difference between Renewable and non-renewable energy sources
2	To understand methods of conversion of solar energy and wind energy to other form of energy
3	To understand methods harnessing energy from Biomass, Geothermal and ocean
4	To understand the principle of operation of Magneto Hydrodynamic power generation
5	To understand the principle and operation of fuel cell.
6	To solve numerical problems of Renewable and non-renewable energy sources

Course Contents:

Module No.	**Description of Topic**	**Contact Hrs.**
1	**Introduction to Energy sources:** Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy for meeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	4L
2	**Solar Energy:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic – solar cells, different types of PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PV systems & its applications. PV hybrid systems	10L
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations	6L
4	**Energy from Biomass:** Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting,	5L

	maintaining biogas production, Fuel properties of bio gas, utilization of biogas.	
5	**Geothermal Energy:** Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.	5L
6	**Energy from Ocean:** Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.	5L
7	**Hydrogen Energy:** Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles	3L
8	**Fuel cell:** Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells	2L
Total		**40L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the principle of conversion of solar energy, wind energy , biomass, Geothermal Energy, Ocean energy and Hydrogen energy to other form of energy.
2	Suggest location to set up wind mill and biogas generation plant
3	Use Solar energy, Wind energy, Biomass, Geothermal energy, Ocean energy, Hydrogen energy and fuel cell for different applications.
4	Explain the principle of operation of magneto hydrodynamic power generation
5	Estimate conversion efficiency of fuel cell.

Learning Resources:	
Recommended Text Books	
1	Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill
2	Non-conventional Energy sources, G.D. Rai, Khanna Publishers.
3	Non-conventional Energy Resources, B. H. Khan, , Tata Mc Graw Hill
Alternative Text Books	
4	Renewable energy resources and emerging technologies, D.P. Kothari, PHI
Reference Books	
5	Non-conventional Energy, Ashok V. Desai, New Age International Publishers Ltd.

Course Name:	**Business Analytics and Entrepreneurship**		
Course Code:	OE-HU 801A	**Category:**	Open Elective Courses
Semester:	8th	**Credit:**	3
L-T-P:	3-0-0	**Pre-Requisites:**	Machine Learning
Full Marks:	100		
Examination Scheme:	Semester Examination: 70	Continuous Assessment: 25	Attendance:5

Course Objectives:	
1	To gain an understanding of how to use business analytics to formulate and solve business problems and to support managerial decision making.
2	To learn how to use and apply Excel and analytical Modeling to solve business problems.
3	To inculcate the entrepreneurial skills to potential entrepreneurs.
4	To make the potential entrepreneurs. understand the legal procedures and norms involved establishing a new venture.

Course Contents:

Module No.	Description of Topic	Contact Hrs.
1	**Foundations of Business Analytics and Gap Analysis:** Introduction to Business Analytics, Analytics on Spreadsheets, Gap Analysis, Carrying Out Gap Analysis, Steps in Gap Analysis, Conducting a representative Survey for Gap Analysis, Case study on Predicting Consumer Behavior and Gap Analysis in Smartphone Market.	8
2	**Analytical Modeling:** Factor Analysis Concepts, Application of Factor Analysis, Concepts of Cluster Analysis, Similarity Measures, Application of Cluster Analysis, Linear Discriminant Analysis Model, Predictive Modelling and its Application, Theoretical Formulation and Mathematical Interpretation of Logistics Regression, Indicator for Model Fit, Applying Logistics Regression, Application of Logistics Regression in Predicting Risk in Portfolio Management	10
3	**Segmentation of target market:** Introduction to RFM Analysis, Enhancing Response Rates with RFM Analysis, Introduction to Chi-square Automatic Interaction Detection (CHAID), Predictive Modelling by CHAID.	6
4	**Entrepreneurship:** Entrepreneurship: Introduction and importance, Factors influencing entrepreneurship, psychological factors, Social factors, Economic factors, Environmental factors, Characteristics and Skills of an entrepreneur Types of entrepreneurs: according to type of business, Technology, Motivation, Growth, Stages, New generations of entrepreneurship viz. social entrepreneurship, Ideapreneurship, Health entrepreneurship, Tourism entrepreneurship, Women entrepreneurship etc. & Barriers to entrepreneurship	6

5	**Entrepreneurial Motivation & Creativity, Rules, and Legislation** Motivation: Maslow's theory, Herzberg's theory, McClelland's Need – achievement theory, Values / Ethics, Risk taking behavior Creativity: Creativity and entrepreneurship, Steps in Creativity, Innovation and inventions, using left brain skills to harvest right brain ideas. Legal Protection of innovation, Industries Development (Regulations) Act, 1951, Factories Act, 1948, The Industrial Employment (Standing Orders) Act, 1946, Environment (Protection) Act, 1986, Industrial Dispute Act 1947 etc.	6
Total		**36L**

Course Outcomes:	
After completion of the course, students will be able to:	
1	Explain the concept and methods of business analytics.
2	Apply appropriate analytical methods to find solutions to business problems.
3	Explain the importance of different factors and skills for entrepreneurship.
4	Describe the rules and regulations to establish a new venture.

Learning Resources:	
1	"Business Analytics: An Application Focus", Purba Halady Rao, Prentice Hall.
2	"Business Analytics" James R. Evans, Pearson.
3	"Modeling Techniques in Predictive Analytics", Thomas W. Miller, Pearson
4	"Enterprise Analytics: Optimize Performance, Process, and Decisions Through Big Data", Thomas H. Davenport, Pearson.
5	"Fundamentals of Business Analytics", Seema Acharya, Wiley India.
6	"Business Intelligence: A Managerial Perspective on Analytics", Ramesh Sharda, Dursun Delen, Efraim Turban, David King, Prentice Hall