FACULTY OF ENGINEERING

Scheme of Instruction & Examination
(CBCS Curriculum for the Academic Year 2019-2020)

and

Syllabi

B.E. VII and VIII Semester

of

Four Year Degree Programme

In

Information Technology
(With effect from the academic year 2019– 2020)
(As approved in the faculty meeting held on 25-06-2019)

Issued by
Dean, Faculty of Engineering
Osmania University, Hyderabad – 500 007
2019

SCHEME OF INSTRUCTION & EXAMINATION
B.E. VII - Semester
(INFORMATION TECHNOLOGY)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	**PC 701 IT**	VLSI Design	3	1	-	4	30	70	3	3
2	**PC 702 IT**	Big Data Analytics	3	1	-	4	30	70	3	3
3	**PC 703 IT**	Wireless Mobile Communication	3	1	-	4	30	70	3	3
4	**PC 704 IT**	Network Security and Cryptography	3	1	-	4	30	70	3	3
5		Open Elective – II	3	-	-	3	30	70	3	3
6		Open Elective – III	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
7	**PC 751 IT**	VLSI Design Lab	-	-	2	2	25	50	3	1
8	**PC 752 IT**	Big Data Analytics Lab	-	-	2	2	25	50	3	1
9	**PW 761 IT**	Project Work – I	-	-	4	4	50	-	-	2
10	**SI 762 IT**	Summer Internship	`	-	-	-	50	-	-	2
			18	04	08	30	330	520		24

Open Elective – II			Open Elective – III		
S. No.	Course Code	Course Title	S. No.	Course Code	Course Title
1	**OE 771 CE**	Green Building Technologies	1	**OE 781 CE**	Road Safety Engineering
2	**OE 772 CS***	Data Science Using R Programming	2	**OE 782 IT***	Software Engineering
3	**OE 773 EC**	Fundamentals of IoT	3	**OE 783 EC**	Principles of Electronic Communications
4	**OE 774 EE**	Non-Conventional Energy Sources	4	**OE 784 EE**	Illumination and Electric Traction systems
5	**OE 775 ME**	Entrepreneurship	5	**OE 785 ME**	Mechatronics

PC: Professional Course   PE: Professional Elective
L: Lectures   T: Tutorials   P: Practical   D: Drawing
CIE: Continuous Internal Evaluation   **SEE:** Semester End Examination (Univ. Exam)

Note: 1) Each contact hour is a Clock Hour
        2) The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.

Note-2: * The students have to undergo a Summer Internship of four weeks' duration after VI semester and credits will be awarded in VII semester after evaluation.
        ** Subject is not offered to the students of CSE and IT Departments.

Course Code	Course Title						Core / Elective
PC 701 IT	**VLSI Design**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	1	-	-	30	70	3

Course Objectives
- ➢ To provide a perspective on Digital Design in the Deep Sub-micron Technology.
- ➢ To focus on CMOS and Bi CMOS Short-channel Transistor Models.
- ➢ To Study CMOS Inverter elaborately.
- ➢ To explore static and dynamic implementations of combinational and sequential circuit designs and introduce Testability of VLSI circuits.

Course Outcomes

After completing this course, the student will be able to
1. Explain VLSI Design hierarchy and analyse logic gates using CMOS & transmission gate structures.
2. Identify the layers in the physical structure of ICs and draw the layouts of CMOS logic gates
3. Summarize the fabrication process of CMOS ICs and analyse the DC, switching characteristics of CMOS inverter.
4. Analyse dynamic CMOS & pseudo nMOS structures of logic gates, SRAM & DRAM cells
5. Develop Verilog code for logic gates, examine the effects of interconnect elements in logic cascades and Explain the floor-planning , routing techniques of VLSI circuits

UNIT-I

Moore's law, VLSI Design Hierarchy, MOSFET as switches, pass characteristics, Basic logic gates and complex logic gates using CMOS, Bubble pushing, XOR and XNOR gates, AOI and OAI logic gates, Transmission gates-TG based 2-to-1 MUX, XOR, XNOR circuits.

Electrical Characteristics of MOSFETs, Threshold voltage, nFET Current-Voltage equations, trans-conductance and drain characteristics of nFET, RC model of a FET, MOS capacitances, gate-source and gate- drain capacitances, Junction capacitances in a MOSFET, scaling concept of MOSFETs

UNIT-II

Integrated Circuit definition and layers, Top and side view of IC layers, CMOS Layers- MOSFET layers in an n-well process. Silicon patterning for series and parallel connected FETs. Layouts of NOT gate, transmission gate, non-inverting buffer, NAND2, NOR2, Complex logic gate, 4 input AOI gate. Stick diagram representation of NOT, NAND2 and NOR2.

Fabrication of CMOS ICs, CMOS process flow, Design rules: minimum space width, minimum spacing, surround, extension.

UNIT-III

Layouts of Basic Structure: nwells, active area definition, design of n^+, p^+ regions, masks for the nFET, pFET, active contact cross section and mask set, metal1 line with active contact, poly contact: cross section and layout, Latchup and its prevention, Cell based Design

DC characteristics of the CMOS inverter, Expression for midpoint voltage of CMOS inverter, Symmetrical inverter, Inverter switching characteristics- RC switch model equivalent for the CMOS inverter, rise time and fall time expressions, fan-out, input capacitance and loading due to fan-out, propagation delay of CMOS inverter.

UNIT-IV

Pseudo nMOS logic gates, tri-state inverter circuit, Clocked CMOS circuit, charge leakage in C^2MOS circuit, Dynamic CMOS logic circuits: pre-charge and evaluation modes of operation, Domino logic, Dual rail logic

networks- Differential Cascade Voltage Switch Logic (DCVSL) AND/NAND, OR/NOR gates, Complementary Pass Transistor Logic (CPL) structures.

SRAM – General SRAM cell, 4T & 6T SRAM cell design parameters, Writing to SRAM, resistor model, SRAM arrays. Dynamic RAMs: 1T DRAM cell, charge leakage and refresh in a DRAM cell

UNIT-V

VLSI Design flow, structural gate level modelling, gate primitives, gate delays, switch level modelling, behavioural and RTL operators, timing controls, blocking and non-blocking assignments, conditional statements, Data flow modelling and RTL, Comparator and priority encoder, D latch and Master-Slave D flip-flop- Verilog code. Arithmetic circuits: half adder, full adder, ripple carry adder, carry look ahead adder-Verilog code.

Interconnect modelling; Interconnect resistance and capacitance, sheet resistance R_s, time delay, single and multiple rung ladder circuits, simple RC inter connect model, modelling inter connect lines with a series pass FET, Crosstalk, Floor planning and routing.

Suggested Readings:

1. John P. Uyemura, "Introduction to VLSI circuits and Systems", John Wiley & Sons, 2002
2. John P. Uyemura, "Chip design for submicron VLSI: CMOS layout and simulation" IE, Cengage learning, 2006.
3. Douglas A. Pucknell, Kamran Eshraghian, "Basic VLSI Design" 3rd Edition, PHI, 2000.
4. Jan M. Rabey and others "Digital Integrated Circuits A design perspective", Pearson Education

Course Code	Course Title						Core / Elective
PC 702 IT	**Big Data Analytics**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	1	-	-	30	70	3

Course Objectives
- ➢ Understand big data for business intelligence.
- ➢ Identify business case studies for big data analytics.
- ➢ Defend big data Without SQL.
- ➢ Discuss the process of data analytics using Hadoop and related tools.

Course Outcomes

By the end of this course, the students will be able to
1. Demonstrate big data and use cases from selected business domains.
2. Apply the knowledge of NoSQL big data management and experiment with Install, configure, and run Hadoop and HDFS.
3. Analyse map-reduce analytics using Hadoop.
4. Adapt Hadoop related tools such as HBase, Cassandra, Pig, and Hive for big data Analytics.

UNIT-I

Understanding Big Data: Characteristics of Data, Introduction to Big Data and its importance, Evolution of Big Data, Challenges posed by Big Data, Big data analytics and its classification, Big data applications: big data and healthcare – big data in medicine – advertising and big data, big data technologies.

UNIT-II

Hadoop Distributed File System: Hadoop Ecosystem, Hadoop Architecture, analysing data with Hadoop, HDFS Concepts, Blocks, Namenodes and Datanodes, Hadoop FileSystems, The Java Interface, Reading Data from a Hadoop URL, Reading Data Using the FileSystem API, Writing Data, Directories, Querying the FileSystem, Deleting Data, Anatomy of File Read and Write

UNIT-III

NOSQL Data Management: Introduction to NOSQL – aggregate data models, aggregates keyvalue and document data models, relationships – graph databases, schema less databases, materialized views, distribution models, sharding - version – map reduce – partitioning and combining – composing map-reduce calculations

UNIT-IV

Map Reduce and Yarn: Hadoop Map Reduce paradigm, Map and Reduce tasks, Job and Task trackers, writing a Unit Test with MR Unit, Mapper, Reducer, Map Reduce workflows – unit tests with MR Unit – test data and local tests – anatomy of Map Reduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – Map Reduce types – input formats – output formats

UNIT-V

Pig: Installing and Running Pig, an Example, Generating Examples, Comparison with Databases, Pig Latin, User-Defined Functions, Data Processing Operators, Pig in Practice. Hive: Installing Hive, The Hive Shell, An Example, Running Hive, Comparison with Traditional Databases, HiveQL, Tables, Querying Data, User-Defined Functions, writing a User Defined Functions, writing a User Defined Aggregate Function.

Suggested Readings:

1. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilly, 2012.
2. Eric Sammer, "Hadoop Operations", O'Reilly, 2012.
3. Vignesh Prajapati, Big data analytics with R and Hadoop, 2013.
4. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilly, 2012.

Course Code	Course Title						Core / Elective
PC 703 IT	**Wireless Mobile Communication**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	1	-	-	30	70	3

Course Objectives
> - To introduce the transition from 2D to 3D structural problems (linear and non-linear).
> - Analyse all kinds of loads and their respective effects.
> - To introduce a high-end computer oriented numerical analysis tool.

Course Outcomes

After completing this course, the student will be able to
1. Understand the fundamental concepts of wireless and cellular Networks.
2. Understand Spread spectrum modulation techniques and compare various Medium Access Control mechanisms
3. Describe WLAN and GSM
4. Analyse different variations of TCP for mobile communication systems.
5. Discuss protocols for MANETs and WAP

UNIT-I

Introduction to Wireless Communication Systems: Evolution of Mobile Radio Communications, Examples of Wireless Communication Systems. Modern Wireless Communication Systems: Second Generation (2G) Cellular Networks, Third Generation (3G) Wireless Networks, Wireless local Loop, **Wireless Local Area Networks. The Cellular Concept**: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and Systems Capacity, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems.

UNIT-II

Spread spectrum modulation techniques: Pseudo-noise sequence, direct sequence spread spectrum (DS-SS), frequency hopped spread spectrum(FHSS), performance of DS-SS, performance of FH-SS
Medium Access Control: Motivation for a specialized MAC: Hidden and Exposed terminals. Near and Far terminals; SDMA, FDMA, TDMA, and CDMA

UNIT-III

Wireless LAN: IEEE 802-11 Protocol, System Architecture, Protocol Architecture, Physical Layer & MAC Layer, Newer developments, Hiper LAN
GSM: Mobile services, System architecture, Localization, Call Handling, Handover, Security, New data services.

UNIT-IV

Mobile Network Layer: Mobile IP: Goals, assumptions and requirements, Entities and Terminology, IP packet delivery, Agent advertisement and discovery, Registration, Tunnelling and Encapsulation, Optimizations, Reverse tunnelling, Ipv6; Dynamic host configuration protocol.
Mobile Transport Layer: Traditional TCP: Congestion control, Slow start, Fast retransmit/fast recovery, Implications on mobility; Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission/timeout freezing, Selective retransmission, Transaction oriented TCP

UNIT-V

Mobile Ad hoc Networks (MANETs): Introduction, Applications & Challenges of a MANET, Routing, Classification of Routing Algorithms, Algorithms such as DSR, AODV, DSDV, etc., Mobile Agents, Service Discovery.

Protocols and Tools: Wireless Application Protocol-WAP. (Introduction, protocol architecture, and treatment of protocols of all layers), Bluetooth (User scenarios, physical layer, MAC layer, networking, security, link management) and J2ME.

Suggested Readings:

1. Theodore S. Rappaport, "Wireless Communications Principles and Practice", 2nd Edition, Pearson Education, 2003.
2. Jochen Schiller, "Mobile Communication", 2nd Edition, Pearson Education.

Course Code	Course Title						Core / Elective
PC 704 IT	**Network Security and Cryptography**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

➢ Familiarize students with basics of Network Security and cryptography.

➢ To understand the network security, services, attacks, mechanisms, types of attacks on TCP/IP protocol suite.

➢ To comprehend and apply network layer security protocols, Transport layer security protocols, Web security protocols.

➢ To comprehend and apply authentication services, authentication algorithms.

➢ Provide a solid understanding of main issues related to network security and the relevant cryptographic techniques.

Course Outcomes

After completing this course, the student will be able to

1. Understand the most common type of information and network threat sources.
2. Be able to determine appropriate mechanisms for protecting the network.
3. Design a security solution for a given application system with respect to security of the system.
4. Understand the information and network security issues and apply the related concepts for protection and communication privacy.
5. Comprehend various network security threats and cryptographic algorithms.

UNIT – I

Security Concepts: Introduction, The need for security, Security approaches, Principles of security, Types of Security attacks, Security services, Security Mechanisms, A model for Network Security Cryptography Concepts and Techniques: Introduction, plain text and cipher text, substitution techniques, transposition techniques, encryption and decryption, symmetric and asymmetric key cryptography, steganography, key range and key size, possible types of attacks.

UNIT – II

Symmetric key Ciphers: Block Cipher principles, DES, AES, Blowfish, RC5, IDEA, Block cipher operation, Stream ciphers, RC4.

Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Diffie-Hellman Key Exchange.

UNIT – III

Cryptographic Hash Functions: Message Authentication, Secure Hash Algorithm (SHA-512), Message authentication codes: Authentication requirements, HMAC, CMAC, Digital signatures. Key Management and Distribution: Symmetric Key Distribution Using Symmetric & Asymmetric Encryption, Distribution of Public Keys, Kerberos, X.509 Authentication Service.

UNIT – IV

Transport-level Security: Web security considerations, Secure Socket Layer and Transport Layer Security, HTTPS, Secure Shell (SSH) Wireless Network Security: Wireless Security, Mobile Device Security, IEEE 802.11 Wireless LAN, IEEE 802.11i Wireless LAN Security

UNIT – V
E-Mail Security: Pretty Good Privacy, S/MIME IP Security: IP Security overview, IP Security architecture, Authentication Header, encapsulating security payload, Combining security associations.

Suggested Readings:

1. Cryptography and Network Security – Principles and Practice: William Stallings, Pearson Education, 6th Edition
2. Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition

Course Code	Course Title						Core / Elective
OE 771 CE	**Green Building Technologies**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
> ➢ To impart knowledge of the principles behind the green building technologies.
> ➢ To know the importance of sustainable use of natural resources and energy.
> ➢ To understand the principles of effective energy and resources management in buildings.
> ➢ To bring awareness of the basic criteria in the green building rating systems.
> ➢ To understand the methodologies to reduce, recycle and reuse towards sustainability.

Course Outcomes
After completing this course, the student will be able to
1. Define a green building, along with its features, benefits and rating systems.
2. Describe the criteria used for site selection and water efficiency methods.
3. Explain the energy efficiency terms and methods used in green building practices.
4. Select materials for sustainable built environment & adopt waste management methods.
5. Describe the methods used to maintain indoor environmental quality.

UNIT-I
Introduction to Green Buildings: Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

UNIT- II
Site selection and planning: Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting, ventilation, etc.

Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

UNIT-III
Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

UNIT-IV
Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, (c) use of materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials
Waste Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

UNIT-V

Indoor Environmental Quality for Occupant Comfort and Wellbeing: Daylighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

Suggested Readings:
1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.
3. *Alternative building materials and technologies* by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. *Non-Conventional Energy Resources* by G. D. Rai, Khanna Publishers.
5. *Sustainable Building Design Manual*, Vol.1 and 2, TERI, New Delhi 2004.
6. Mike Montoya, *Green Building Fundamentals*, Pearson, USA, 2010.
7. Charles J. Kibert*, Sustainable Construction - Green Building Design and Delivery*, John Wiley & Sons, New York, 2008.
8. Regina Leffers*, Sustainable Construction and Design*, Pearson / Prentice Hall, USA, 2009.

Course Code	Course Title						Core / Elective
OE 772 CS	**Data Science Using R Programming**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- ➢ To learn basics of R Programming environment: R language, R- studio and R packages
- ➢ To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting
- ➢ To learn Decision tree induction, association rule mining and text mining

Course Outcomes

At the end of the course, the students will be able to
1. Use various data structures and packages in R for data visualization and summarization
2. Use linear, non-linear regression models, and classification techniques for data analysis
3. Use clustering methods including K-means and CURE algorithm

UNIT – I

Data Science: Introduction to data science, Linear Algebra for data science, Linear equations, Distance, Hyper planes, Half spaces, Eigen values, Eigenvectors.

UNIT II

Statistical Modelling, Random variables, Probability mass/density functions, sample statistics, hypothesis testing.

UNIT III

Predictive Modelling: Linear Regression, Simple Linear Regression model building, Multiple Linear Regression, Logistic regression

UNIT IV

Introduction to R Programming, getting started with R: Installation of R software and using the interface, Variables and data types, R Objects, Vectors and lists, Operations: Arithmetic, Logical and Matrix operations, Data frames, functions, Control structures, Debugging and Simulation in R.

UNIT V

Classification: performance measures, Logistic regression implementation in R, K-Nearest neighbours (KNN), K-Nearest neighbours implementation in R, Clustering: K-Means Algorithm, K-Means implementation in R.

Suggested Readings:
1. Nina Zumel, Practical Data Science with R, Manning Publications, 2014.
2. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017.
3. Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly, 2017.
4. Roger D Peng, R Programming for Data science, Lean Publishing, 2016.
5. Rafael A Irizarry, Introduction to Data Science, Lean Publishing,2016.

Course Code	Course Title						Core / Elective
OE 773 EC	**Fundamentals of IoT**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- ➢ Discuss fundamentals of IoT and its applications and requisite infrastructure
- ➢ Describe Internet principles and communication technologies relevant to IoT
- ➢ Discuss hardware and software aspects of designing an IoT system
- ➢ Describe concepts of cloud computing and Data Analytics
- ➢ Discuss business models and manufacturing strategies of IoT products

Course Outcomes
At the end of the course, the students will be able to
1. Understand the various applications of IoT and other enabling technologies.
2. Comprehend various protocols and communication technologies used in IoT
3. Design simple IoT systems with requisite hardware and C programming software
4. Understand the relevance of cloud computing and data analytics to IoT
5. Comprehend the business model of IoT from developing a prototype to launching a product.

UNIT - I
Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics (Ref 1)
IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

UNIT – II
Internet Principles and communication technology: Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source. Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling (Ref 2)

UNIT – III
API Development and Embedded programming: Getting started with API, writing a new API, Real time Reactions, Other Protocols, Techniques for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. (Ref 2)
Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather monitoring (Ref 1)

UNIT – IV
IoT Systems - Logical Design using Python: Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations., Classes, Python packages for IoT (Ref 1 and Ref 3) IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT – V

Cloud computing and Data analytics and IoT Product Manufacturing: Introduction to Cloud storage models and Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation. (Ref 1) Business model for IoT product manufacturing, IoT Start-ups, Mass manufacturing, Ethical issues in IoT. (Ref 2)

Suggested Readings:

1. Internet of Things (A Hands-On-Approach), Vijay Madisetti, Arshdeep Bahga, VPT Publisher, 1st Edition, 2014.
2. Designing the Internet of Things, Adrian McEwen (Author), Hakim Cassimally. Wiley India Publishers.
3. Fundamentals of Python, Kenneth A Lambert and B.L. Juneja, Cengage Learning
4. *Internet of Things* - Converging Technologies for smart environments and Integrated ecosystems, River Publishers.
5. *Internet of things* -A hands on Approach, Arshdeep Bahga, Universities press.

Course Code	Course Title						Core / Elective
OE 774 EE	**Non-Conventional Energy Sources**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

To impart the knowledge of basics of different non-conventional types of power generation & power plants in detail so that it helps them in understanding the need and role of Non-Conventional Energy sources particularly when the conventional sources are scarce in nature

Course Outcomes

On completion of course the student will be able to:

1. Understand the different nonconventional sources and the power generation techniques to generate electrical power.
2. Understand the Solar energy power development and different applications.
3. Understand different wind energy power generation techniques and applications.
4. Design a prescribed engineering sub-system
5. Recognize the need and ability to engage in lifelong learning for further developments in this field.

UNIT-I

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells-Polarization - Conversion efficiency and Applications of Fuel Cells.

UNIT-II

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

UNIT-III

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations -Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

UNIT- IV

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-Thermal Energy - Types of Geo-Thermal Energy Systems - Applications of Geo-Thermal Energy.

UNIT-V

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass -Biomass gasifiers.

Suggested Readings:

1. Rai G.D, *Non-Conventional Sources of Energy,* Khandala Publishers, New Delhi, 1999.
2. M.M. El-Wakil, Power *Plant Technology.* McGraw Hill, 1984.

Course Code	Course Title						Core / Elective
OE 775 ME	**Entrepreneurship**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
  ➢ To motivate students to take up entrepreneurship in future
  ➢ To learn nuances of starting an enterprise & project management
  ➢ To understand the design principles of solar energy systems, their utilization and performance evaluation
  ➢ To understand the behavioural aspects of entrepreneurs and time management

Course Outcomes
At the end of the course, the students will be able to
  1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
  2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
  3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
  4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques
  5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches of time management, their strengths and weakness. The urgency addiction and time management matrix.

UNIT-I

Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

UNIT-II

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.

UNIT-III

Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.

UNIT-IV

Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.

UNIT-V

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

Suggested Readings:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House, 1997
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",* 1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5^{lh} Ed., 2005.

Course Code	Course Title					Core / Elective
OE 781 CE	**Road Safety Engineering**					**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	0	0	0	30	70	3

Course Objectives
> ➢ Introduction to various factors considered for road safety and management
> ➢ Explain the road safety appurtenances and design elements
> ➢ Discuss the various traffic management techniques

Course Outcomes
At the end of the course, the students will be able to
1. Prepare accident investigation reports and database
2. Apply design principles for roadway geometrics improvement with various types of traffic safety appurtenances/tools
3. Manage traffic including incident management

UNIT – I
Road Accidents: Causes, scientific investigations and data collection, Analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of Road accident statistics, Safety performance function: The empirical Bayes method Identification of Hazards road location. Application of computer analysis of accident data.

UNIT – II
Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & Driver characteristics influencing road safety.

UNIT – III
Road Signs and Traffic Signals: Classification, Location of Signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols. Road Marking: Role of Road markings, Classification, visibility. Traffic Signals: Need, Signal face. Illumination and location of Signals, Factors affecting signal design, pedestrians' safety, fixed and vehicle actuated signals. Design of signa1s, Area Traffic control. Delineators, Traffic Impact Attenuators, Road side rest areas, Safety Barriers, Traffic Aid Posts.

UNIT – IV
Traffic Management Techniques: Integrated safety improvement and Traffic Calming Schemes, Speed and load limit, Traffic lights, Safety cameras, Tests on driver and vehicles, pedestrian safety issues, Parking, Parking enforcement and its influence on Accidents. Travel Demand Management; Methods of Traffic management measures: Restriction of Turning Movements, One-way streets, Tidal Flow Operation Methods, Exclusive Bus Lanes and Closing Side-streets; Latest tools and techniques used for Road safety and traffic management. Road safety issues and various measures for road safety; Legislation, Enforcement, Education and Propaganda, Air quality, Noise and Energy Impacts; Cost of Road Accidents.

UNIT – V
Incident Management: Introduction, Characteristics of Traffic Incidents, Types of Incidents, Impacts, Incident management process, Incident traffic management; Applications of ITS: Motorist information, Equipment used; Planning effective Incident management program, Best practice in Incident management

programs. National importance of survival of Transportation systems during and after all natural disasters especially cyclones, earthquakes, floods etc. and manmade disasters like sabotage, terrorism etc.

Suggested Readings:
1. Guidelines on Design and Installation of Road Traffic Signals, IRC:93.
2. Specification for Road Traffic Signals, IS: 7537-1974.
3. Principles and Practice of Highway Engineering by L.R. Kadiyali and N.B. Lal.
4. Hand Book of T.E. Myer Kutz, Editor McGraw Hill, 2004.

Course Code	Course Title						Core / Elective
OE 782 CS	**Software Engineering**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- ➢ To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
- ➢ To impart knowledge on various phases, methodologies and practices of software development
- ➢ To understand importance of software modelling using UML
- ➢ To understand the importance of testing in software development and study various testing strategies and software quality metrics.

Course Outcomes
At the end of the course students will be able to:
1. Acquire knowledge about different software development processes and their usability in different problem domains.
2. Understand the process of requirements collection, analysing, and modelling requirements for effective understanding and communication with stakeholders.
3. Design and develop the architecture of real world problems towards developing a blueprint for implementation.
4. Use the UML language to design various models during software development life cycle.
5. Understand the concepts of software quality, testing and maintenance.

UNIT-I
The software Problem: Cost, Schedule and Quality, Scale and change, Software Processes: - Process and project, Component Software Processes, Software Development Process Models, Project management Process.

UNIT-II
Software Requirements Analysis and Specification: Value of a good SRS, Requirements Process, Requirements Specification, Functional Specification with Use Cases, Other approaches for analysis. Software Architecture: Role of Software Architecture Views, Component and connector view, Architectural styles for C & C view, Documenting Architecture Design, Evaluating Architectures.

UNIT-III
Planning a Software Project: Effort Estimation, Project Schedule and staffing, Quality Planning, Risk Management Planning, Project Monitoring Plan, Detailed Scheduling. Design: Design concepts, Function oriented Design, Object Oriented Design, Detailed Design, Verification, Metrics.

UNIT-IV
Coding and Unit Testing: Programming Principles and Guidelines, incrementally developing code, managing evolving code, unit testing, code inspection, Metrics. Testing: Testing Concepts, Testing Process, Black Box testing, White box testing, Metrics.

UNIT-V
Maintenance and Re-engineering: Software Maintenance, supportability, Reengineering, Business process Reengineering, Software reengineering, Reverse engineering; Restructuring, Forward engineering, Economics of Reengineering. Software Process Improvement: Introduction, SPI process, CMMI, PCMM, Other SPI Frameworks, SPI return on investment, SPI Trends.
Suggested Readings:

1. Pankaj Jalote, "Software Engineering- A Precise Approach", Wiley India, 2010.
2. Roger. S. Pressman, "Software Engineering - A Practitioner's Approach", 7th Edition, McGraw Hill Higher Education, 2010.
3. Deepak Jain, "Software Engineering", Oxford University Press, 2008.
4. Rajib Mall, "Fundamentals of Software Engineering", 4th Edition, PHI Learning, 2014.
5. Ian Sommerville, "Software Engineering", 10th Edition, Addison Wesley, 2015.

Course Code	Course Title						Core / Elective
OE 783 EC	**Principles of Electronic Communications**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
 ➢ Provide an introduction to fundamental concepts in the understanding of communications systems.
 ➢ Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transport layer.
 ➢ Provide an introduction to the evolution of wireless systems and current wireless technologies.

Course Outcomes
 1. Understand the working of analog and digital communication systems
 2. Understand the OSI network model and the working of data transmission
 3. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems.

UNIT – I
Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels.
 Signal Transmission Concepts: Baseband transmission and Broadband transmission,
Communication Parameters: Transmitted power, Channel bandwidth and Noise, Need for modulation
Signal Radiation and Propagation: Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

UNIT – II
Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

UNIT – III
Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

UNIT – IV
Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony.
Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

UNIT – V
Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

Suggested Readings:
 1. *Principles of Electronic Communication Systems*, Louis E. Frenzel, 3e, McGraw Hill, 2008.
 2. *Data Communications and Networking,* Behrouz A. Forouzan, 5e TMH, 2012.
 3. Kennady, Davis, *Electronic Communications systems*, 4e, McGraw Hill, 1999.

Course Code	Course Title						Core / Elective
OE 784 EE	**Illumination and Electric Traction Systems**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- ➤ To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc.,
- ➤ To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- ➤ To understand the concept of electrification of traction system

Course Outcomes
On successful completion of course, students will be able to:
1. Design the resistive and inductive heating and calculate the requirements of heating power for an industrial need
2. Analyse the type of motor control required and select the type and rating of motor.
3. Understand and Design illumination for different application
4. Understand the traction and use of DC machines
5. Analyse the traction mechanics to arrive at a rating of drive.

UNIT-I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens — Design of elements. Core type, Coreless type furnaces, High frequency eddy current heating, Dielectric heating. Arc furnace. Electric welding, Resistance welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

UNIT-II

Schematic Utilization and Connection Diagrams for Motor Control: Two supply sources for 3 phase Induction motors. Direct reversing, remote control operation, and jogging operating of Induction motor. Contactor control circuit. Push button control stations. Over load relays, limit switches, float switches. Interlocking methods for reversing control.

UNIT-III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, lighting calculations — Determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps — Fluorescent lamp, Starting and power factor corrections, Stroboscopic effects — Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT-IV

Electric Traction: System of Electric Traction — Transmission of drive — Systems of track electrification — Traction mechanics — Speed time curves — Tractive effort — Power of Traction motor — Specific energy consumption — Mechanics of train movement— Coefficient of adhesion.
Traction Motors: Desirable characteristics, DC series motors, AC series motors 3-phase induction motors, DC motor series & parallel control, Energy saving.

UNIT-V

Train Lighting: Systems of train lighting — Special requirements of train lighting — Methods of obtaining unidirectional polarity — Methods of obtaining constant output — Single battery system — Double battery parallel block system — Principal equipment of double battery system — Coach wiring — Dynamo.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

Suggested Readings:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4. B.L. Theraja, A Text Book of Electrical Technology, S. Chand & Company Ltd, Vol —I.

Course Code	Course Title						Core / Elective
OE 785 ME	**Mechatronics**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives:

Student has to understand the

- ➢ How to identify, formulate, and solve engineering problems
- ➢ The design a system, component, or process to meet desired needs within realistic constraints
- ➢ The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
- ➢ The use of drive mechanisms and fluid power systems
- ➢ The use of industrial electronic devices
- ➢ The demonstrate the design of modern CNC machines, and Mechatronics elements

Course Outcomes:

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

1. Model and analyse electrical and mechanical systems and their interconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems
3. Do the complete design, building, interfacing and actuation of a Mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various Mechatronics applications
5. Demonstrate the use of industrial electronic devices
6. Demonstrate the design of modern CNC machines, and Mechatronics elements

UNIT-I

Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development

UNIT-II

Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems
Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors

UNIT-III

Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro pneumatic circuits

UNIT-IV

Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to microprocessor & micro controller, Temperature measurement interface and LVDT interface, Systems response

UNIT-V

Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLC programming

Suggested Readings:

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education
2. HMT Ltd, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998
3. Michaels Histand & David G, Alciatore, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill International Edition
4. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning
5. S.R. Majumdar, Oil Hydraulic Systems – Principles & Maintenance, McGraw-Hill Publishing Company Limited, New Delhi
6. Godfrey Onwubolu, Mechatronics: Principles and Applications, Butterworth-Heinemann

Course Code	Course Title						Core / Elective
PC 751 IT	**VLSI Design Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	2	25	50	1

Course Objectives

➢ To introduce the students to understand basics in Hardware design using CAD tools
➢ Understand and Experience Verilog Design Flow
➢ Learn Transistor-Level CMOS Logic Design using both Verilog and VHDL
➢ Understand VLSI Fabrication and experience CMOS Physical Design using backend tools

Course Outcomes

After completing this course, the student will be able to

1. Demonstrate Xilinx ISE suite to write Verilog code for logic gates, combinational circuits and sequential circuits.
2. Write Verilog code for basic logic gates, complex logic gates, combinational circuits, and sequential circuits using switch level, gate level, data flow and behavioural modelling.
3. Develop test bench code using Verilog and verify the simulation results.
4. Demonstrate the FPGA implementation of digital circuits and generate the synthesis report.
5. Draw the layouts of basic logic gates using Microwind

List of Experiments to be performed

1. Switch level modelling using Verilog
   a) Logic gates   b) AOl and OAI gates
   c) Transmission gate   d) Complex logic gates using CMOS
2. Gate-level Modelling—Digital circuits using gate primitives—using Verilog.
   a) Half adder and full adders   b) AOl gate with and without delay
   c) OAl gate with and without delay   c) 2:1 MUX using tri-state buffers
   d) S-R latch
3. RTL Modelling of general VLSI system components.
   a) 4:1 MUX   b) 2 to 4 Decoder   c) 8:3 Priority encoder   d) Flip-flops
4. Mixed gate-level and Switch-level modelling using Verilog
   a) Constructing a 4-input AND gate using CMOS 2-input NAND and NOR gates.
   b) Constructing a 2 to 4 decoder using CMOS 2-input AND gates and NOT gates etc.
5. Synthesis of Digital Circuits
   a) Ripple carry adder and carry look-ahead adder
6. Verilog code for finite state machine
7. Simple layouts of Inverter, NAND2 and NOR2 gates
8. Stick diagram representations of Inverter, NAND2 and NOR2 gates

Course Code	Course Title						Core / Elective
PC 752 IT	**Big Data Analytics Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	2	25	50	1

Course Objectives
- ➢ To provide the knowledge to setup a Hadoop Cluster
- ➢ To impart knowledge to develop programs using MapReduce Technique
- ➢ To learn file handling in HDFS
- ➢ To introduce Pig, PigLatin and HiveQL to process big data
- ➢ To learn machine learning operations using Mahout Hadoop
- ➢ To introduce NoSQL databases

Course Outcomes
After completing this course, the student will be able to
1. Understand Hadoop working environment
2. Work with big data applications in multi node clusters
3. Write scripts using Pig to solve real world problems
4. Write queries using Hive to analyse the datasets
5. Model and build a recommendation system using Mahout Hadoop
6. Apply big data and echo system techniques for real world

List of Experiments to be performed

1. Understanding and using basic HDFS commands
2. Word count application using Mapper Reducer on single node cluster
3. Analysis of Weather Dataset on Multi node Cluster
4. Working with files in Hadoop file system: Reading, Writing and Copying
5. Writing User Defined Functions/Eval functions for filtering unwanted data in Pig
6. Retrieving user login credentials from /etc/passwd using Pig Latin
7. Working with HiveQL.
8. Writing User Defined Functions in Hive
9. Perform classification & clustering in Mahout Hadoop
10. Building a Mahout Recommendation System on a Hadoop Cluster

Suggested reading:
1. Tom White, "Hadoop: The Definitive Guide", 4th Edition, O'Reilly Media Inc, April 2015.
2. Alan Gates, "Programming Pig", O'Reilly Media Inc, 2011.

Course Code	Course Title						Core / Elective
PW 761 IT	**Project Work - I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	4	50	-	2

Course Objectives
- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes
1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:
- Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

Each group will be required to:
1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes' presentation followed by 10 minutes' discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:
- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity) charts
- Presentation- oral and written.

Course Code	Course Title						Core / Elective
SI 762 IT	**Summer Internship**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	-	**50**	-	**2**

Course Objectives
- ➢ To train and provide hands-on experience in analysis, design, and programming of information systems by means of case studies and projects.
- ➢ To expose the students to industry practices and team work.
- ➢ To provide training in soft skills and also train them in presenting seminars and technical report writing.

Course Outcomes
After completing this course, the student will be able to
1. Get Practical experience of software design and development, and coding practices within Industrial/R&D Environments.
2. Gain working practices within Industrial/R&D Environments.
3. Prepare reports and other relevant documentation.

Summer Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Government or Private Organisations/Computer Industry/Software Companies/R&D Organization for a period of 4-6 weeks. This will be during the summer vacation following the completion of the III-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co-ordinate (person from industry).

The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship
- Overview of company/project
- Safety training
- Discussions with project teams
- Background research, review of documents, white papers, and scientific papers
- Planning, designing, and reviewing the planned work
- Executing the plans
- Documenting progress, experiments, and other technical documentation
- Further team discussions to discuss results
- Final report writing and presentation

After the completion of the project, each student will be required to:
1. Submit a brief technical report on the project executed and
2. Present the work through a seminar talk (to be organized by the Department)

Award of sessionals are to be based on the performance of the students at the workplace and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will co-ordinate the overall activity of Industry Attachment Program.

Note: Students have to undergo summer internship of 4-6 weeks at the end of semester VI and credits will be awarded after evaluation in VII semester.

SCHEME OF INSTRUCTION& EXAMINATION
B.E. VIII - SEMESTER
(INFORMATION TECHNOLOGY)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	Credits
Theory Courses										
1		Professional Elective – III	3	-	-	3	30	70	3	3
2		Professional Elective – IV	3	-	-	3	30	70	3	3
3		Professional Elective – V	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
4	**PW961 IT**	Project Work – II	-	-	16	16	50	100	-	8
			09	**-**	**16**	**25**	**140**	**310**		**17**

Professional Elective – III			Professional Elective – IV		
S. No.	Course Code	Course Title	S. No.	Course Code	Course Title
1	**PE 821 IT**	Distributed Systems	1	**PE 825 CS**	Computational Intelligence
2	**PE 824 CS**	Web Services and Architecture	2	**PE 832 IT**	Adhoc and Sensor Networks
3	**PE 833 CS**	Machine Learning	3	**PE 834 CS**	Natural Language Processing
4	**PE 835 CS**	Data Science Using R Programming	4	**PE 834 IT**	Information Storage and Management

Professional Elective – V		
1	**PE 832 CS**	Information Retrieval System
2	**PE 841 IT**	Distributed Databases
3	**PE 842 IT**	Cloud Computing
4	**PE 843 CS**	Human Computer Interaction

PC: Professional Course   PE: Professional Elective
L: Lectures   T: Tutorials   P: Practical   D: Drawing
CIE: Continuous Internal Evaluation   **SEE:** Semester End Examination (Univ. Exam)

Note: 1) Each contact hour is a Clock Hour
2) The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment

Course Code	Course Title						Core / Elective
PE 821 IT	**Distributed Systems**						**Elective**
Prerequisites	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- To acquire an understanding of the issues in distributed systems
- To study architectures and working of distributed file systems
- To expose the students to distributed transaction management, security issues and replication

Course Outcomes
After completing this course, the student will be able to
1. Describe the problems and challenges associated with distributed systems.
2. Implement small scale distributed systems.
3. Understand design trade-offs in large-scale distributed systems

UNIT-I
Introduction: Goals and Types of Distributed Systems
Architectures: Architectural Styles, System Architectures, Architectures versus Middleware, and Self-Management in Distributed Systems.
Processes: Threads, Virtualization, Clients, Servers, and Code Migration.
Communication: Fundamentals, Remote Procedure Call, Message-Oriented Communication, Stream-Oriented Communication, and Multicast Communication.

UNIT-II
Naming: Names, Identifiers and Addresses, Flat Naming, Structured Naming, and Attribute-Based Naming.
Synchronization: Clock Synchronization, Logical Clocks, Mutual Exclusion, Global Positioning of Nodes, and Election Algorithms.
Consistency and Replication: Introduction, Data-Centric Consistency Models, Client- Centric Consistency Models, Replica Management, and Consistency Protocols.

UNIT-III
Fault Tolerance: Introduction to Fault Tolerance, Process Resilience, Reliable Client-Server Communication, Reliable Group Communication, Distributed Commit, and Recovery.
Distributed Object-Based Systems: Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, and Security.

UNIT-IV
Distributed File Systems: Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, and Security.
Distributed Web-Based Systems: Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, and Security.

UNIT-V
Distributed Coordination-Based Systems: Introduction to Coordination Models, Architecture, Processes, Communication, Naming, Synchronization, Consistency and Replication, Fault Tolerance, and Security.
Map-Reduce: Example, Scaling, programming model, Apache Hadoop, Amazon Elastic Map Reduce,Mapreduce.net, Pig and Hive.

Suggested Readings:
1. Andrew S. Tanenbaum and Maarten Van Steen, *Distributed Systems*, PHI 2nd Edition, 2009
2. R. Hill, L. Hirsch, P. Lake, S. Moshiri, *Guide to Cloud Computing*, Principles and Practice, Springer, 2013.
3. R. Buyya, J. Borberg, A. Goscinski, *Cloud Computing-Principles and Paradigms*, Wiley 2013.

Course Code	Course Title						Core / Elective
PE 824 CS	**Web Services and Architecture**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

To make the student familiar with the concepts of
  ➢ To study the evolution of SOA and Web Services
  ➢ To understand the principles of service orientation, Service layers
  ➢ To learn about WS* Specifications, messaging with SOAP and Service composition
  ➢ To learn about service oriented analysis and service oriented design
  ➢ Gained knowledge on various open standards available for developing SOA compliant web services

Course Outcomes

After completing this course, the student will be able to
  1. Understand web service framework with respect to SOA
  2. Develop SOA compliant web services using open standards and various technologies
  3. Model and implement businesses processes using service oriented approach

UNIT- I

SOA and Web Services Fundamentals: Introducing So, The Evolution of SOA, Web services and primitive SOA.

UNIT-II

SOA and WS-*Extensions: Web Services and Contemporary SOA (I: Activity Management and Composition), Web Services and Contemporary SOA (II: Advanced Messaging, Metadata, and Security).

UNIT-III

SOA and Service-Orientation: Principles of Service-Orientation, Service Layers.

UNIT-IV

Building SOA (Planning and Analysis): SOA Delivery Strategies, Services-Oriented Analysis (I: Introduction), Service-Oriented Analysis (II: Service Modelling).

UNIT-V

Building SOA (Technology and Design): Service-Oriented Design (I: Introduction), Service-Oriented Design (II: SOA Composition Guidelines), Service-Oriented Design (III: Service-Design), Service- oriented Design (IV: Business Process Design), Fundamentals WS-*Extensions, SOA Platforms.

Suggested Readings:
  1. Thomas Eri*," Service-Oriented Architecture(SOA): Concepts, Technology, and Design*, Prentice Hall PTR, 2005
  2. James McGovern and Sameer Tyagi, *Java Web Services Architecture*, Morgan Kaufmann-May 2003.

Course Code	Course Title						Core / Elective
PE 833 CS	**Machine Learning**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- ➢ To introduce the basic concepts of machine learning and range of problems that can be handled by machine learning
- ➢ To introduce the concepts of instance based learning and decision tree induction
- ➢ To introduce the concepts of linear separability, Perceptron and SVM
- ➢ To learn the concepts of probabilistic inference, graphical models and evolutionary learning
- ➢ To learn the concepts of ensemble learning, dimensionality reduction and clustering

Course Outcomes
After completing this course, the student will be able to
1. Explain the strengths and weaknesses of many popular machine learning approaches
2. Recognize and implement various ways of selecting suitable model parameters for different machine learning techniques
3. Design and implement various machine learning algorithms in a range of real-world applications

UNIT-I
Introduction: Learning, Types of Machine Learning.
Concept learning: Introduction, Version Spaces and the Candidate Elimination Algorithm.
Learning with Trees: Constructing Decision Trees, CART, Classification Example

UNIT-II
Linear Discriminants: The Perceptron, Linear Separability, Linear Regression
Multilayer Perceptron (MLP): Going Forwards, Backwards, MLP in practices, Deriving back
Propagation SUPPORT Vector Machines: Optimal Separation, Kernels

UNIT-III
Some Basic Statistics: Averages, Variance and Covariance, The Gaussian, The Bias-Variance Tradeoff
Bayesian learning: Introduction, Bayes theorem. Bayes Optimal Classifier, Naive Bayes Classifier.
Graphical Models: Bayesian networks, Approximate Inference, Making Bayesian Networks, Hidden Markov Models, The Forward Algorithm.

UNIT-IV
Evolutionary Learning: Genetic Algorithms, Genetic Operators, Genetic Programming
Ensemble learning: Boosting, Bagging
Dimensionality Reduction: Linear Discriminant Analysis, Principal Component Analysis

UNIT-V
Clustering: Introduction, Similarity and Distance Measures, Outliers, Hierarchical Methods, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes, Comparison

Suggested Readings:
1. Tom M. Mitchell, *Machine Learning*, Mc Graw Hill, 1997
2. Stephen Marsland, *Machine Learning - An Algorithmic Perspective*, CRC Press, 2009
3. Margaret H Dunham, *Data Mining*, Pearson Edition., 2003.

4. Galit Shmueli, Nitin R Patel, Peter C Bruce, *Data Mining for Business Intelligence*, Wiley India Edition, 2007
5. Rajjan Shinghal, *Pattern Recognition*, Oxford University Press, 2006.

Course Code	Course Title						Core / Elective
PE 824 IT	**Data Science using R Programming**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

➢ To learn basics of R Programming environment: R language, R- studio and R packages
➢ To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting
➢ To learn Decision tree induction, association rule mining and text mining

Course Outcomes

After completing this course, the student will be able to

1. Use various data structures and packages in R for data visualization and summarization
2. Use linear, non-linear regression models, and classification techniques for data analysis
3. Use clustering methods including K-means and CURE algorithm

UNIT-I

Introduction to R: Introduction, Downloading and Installing R, IDE and Text Editors, Handling Packages in R.

Getting Started with R: Introduction, Working with Directory, Data Types in R, Few Commands for Data Exploration.

Loading and Handling Data in R: Introduction, Challenges of Analytical Data Processing, Expression, Variables, Functions, Missing Values Treatment in R, using as 'Operator to Change the Structure of the Data, Victors, Matrices, Factors, List, Few Common Analytical Tasks, Aggregation and Group Processing of a Variable, Simple Analysis Using R, Methods for Reading Data, Comparison of R GUI's for Data Input, Using R with Databases and Business Intelligence Systems.

UNIT-II

Exploring Data in R: Introduction, Data Frames, R Functions for Understanding Data in Data Frames, Load Data Frames, Exploring Data, Data Summary, Finding the Missing Values, Invalid Values and Outliers, Descriptive Statistics, Spotting Problems in Data with Visualization.

UNIT-III

Linear Regression Using R: Introduction, Model Fitting, Linear Regression, Assumptions of Linear Regression, Validating Linear Assumption.

Logistic Regression: Introduction, What Is Regression? Introduction to Generalized Linear Model, Logistic Regression, Binary Logistic Regression, Diagnosing Logistic Regression, Multinomial Logistic Regression Model.

UNIT-IV

Decision Tree: Introduction, What Is a Decision Tree? Decision Tree Representation in R, Appropriate Problems for Decision Tree Learning, Basic Decision Tree Learning Algorithm, Measuring Features, Hypothesis Space Search in Decision Tree Learning, Inductive Bias in Decision Tree Learning, Why Prefer Short Hypotheses, Issues in Decision Tree Learning.

Time Series in R: Introduction, What Is Time Series Data, Reading Time Series Data, Decomposing Time Series Data, Forecasts Using Exponential Smoothing, ARIMA Models.

UNIT-V

Clustering: Introduction, What Is Clustering, Basic Concepts in Clustering, Hierarchical Clustering, K-Means Algorithm, CURE Algorithm, clustering in Non-Euclidean Space, Clustering for Streams and Parallelism.

Association Rules: Introduction, Frequent Itemset, Data Structure Overview, Mining Algorithm Interfaces, Auxiliary Functions, Sampling from Transaction, Generating Synthetic Transaction Data, Additional Measures of Interestingness, Distance Based Clustering Transaction and Association.

Text Mining: Introduction, Definition of Text Mining, A Few Challenges in Text Mining, Text Mining Verses Data Mining, Text Mining in R, General Architectures of Text Mining Systems, Pre-Processing of Documents in R, Core Text Mining Operations, Using Background Knowledge for Text Mining, Text Mining Query Languages.

Mining Frequent Patterns, Associations and Correlations: Basic Concepts and Methods. Frequent Itemset, Closed Itemset and Association Rules. Frequent Itemset: Mining Methods, Pattern Evaluation Methods, Sentiment Analysis

Suggested Readings:

1. Nina Zumel, Practical Data Science with R, Manning Publications, 2014.
2. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017.
3. Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly, 2017.
4. Roger D Peng, R Programming for Data science, Lean Publishing, 2016.
5. Rafael A Irizarry, Introduction to Data Science, Lean Publishing,2016.
6. Seema Acharya, Data Analytics using R, McGraw Hill, 2018.
7. Crawley, Michael J., The R book, John Wiley & Sons, 2017.

Course Code	Course Title						Core / Elective
PE 825 CS	**Computational Intelligence**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

To make the student familiar with the concepts of
- ➢ To introduce the concepts of Biological and Artificial neural networks
- ➢ To understand different neural architectures with supervised learning and their learning mechanisms
- ➢ To study different neural architectures with unsupervised learning such as PCA Networks Kohenen's Self-Organizing Maps
- ➢ To introduce Markov decision processes, Q-Learning and TD-Learning
- ➢ To study different models of evolution and learning, neuro-fuzzy techniques, rough set theory and their applications

Course Outcomes

After completing this course, the student will be able to
1. Design single and multi-layer feed-forward neural networks
2. Implement various unsupervised learning networks
3. Design new evolutionary operators, representations and fitness functions for specific practical problems
4. Apply fuzzy logic and rough sets to handle uncertainty and vagueness in practical problems

UNIT-I

Introduction to Computational Intelligence / Soft computing: Soft versus Hard Computing, Various paradigms of computing

Foundations of Biological Neural Networks: Introduction to Neural Networks, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models, Hodgkin-Huxley Neuron Model, Integrate-and-Fire Neuron Model, Spiking Neuron Model, Characteristics of ANN (Learning, Generalization, Memory, Abstraction, Applications), McCulloch-Pitts Model, Historical Developments

Essentials of Artificial Neural Networks: Introduction, Artificial Neuron Model, Operations of Artificial Neuron, Types of Neuron Activation Function, ANN Architectures, Classification Taxonomy of ANN – Connectivity (Feed forward, feedback, Single and Multi-layer), Neural Dynamics (Activation and Synaptic), Learning Strategy (Supervised, Unsupervised, Reinforcement), Learning Rules (Error Correction, Hebbian, Competitive, Stochastic), Types of Application (Pattern Classification, Pattern Clustering, Pattern Association / Memory, Function Approximation, Prediction, Optimization)

UNIT-II

Neural Architectures with Supervised Learning: Single Layer Feed Forward Neural Networks(Perception), Multilayer Feed Forward Neural Networks (Back propagation learning), Radial Basis Function Networks, Support Vector Machines, Simulated Annealing, Boltzmann Machine, Feedback (Recurrent) Networks and Dynamical Systems

Associative Memories: Matrix memories, Bidirectional Associative Memory, Hopfield Neural Network,

UNIT-III

Neural Architectures with Unsupervised Learning: Competitive learning, Principal Component Analysis Networks (PCA), Kohonen's Self-Organizing Maps, Linear Vector Quantization, Adaptive Resonance Theory (ART) Networks, Independent Component Analysis Networks (ICA)

UNIT-IV

Reinforcement Learning: Markov Decision Processes, Value Functions, Bellman Optimality Criterion, Policy and Value Iterations, Q-Learning, TD Learning

UNIT-V
Fuzzy Logic: Basic concepts, fuzzy set theory, basic operations, fuzzification, defuzzification, neurofuzzy approach, applications
Evolutionary and Genetic Algorithms: Basic concepts of evolutionary computing, genetic operators, fitness function and selection, genetic programming, other models of evolution and learning, ant colony systems, swarm intelligence, applications
Rough Set Theory: Basic concepts, indiscernability relation, lower and upper approximation, decision systems based on rough approximation, applications

Suggested Readings:
1. Jacek M. Zurada. Introduction to Artificial Neural Systems, Jaico Publishers, 1992.
2. S. Haykin. Neural Networks: A Comprehensive Foundation, Prentice Hall, 1999.
3. P. S. Churchland and T. J. Sejnowski. The Computational Brain. MIT Press, 1992.
4. A. M. Ibrahim. Introduction to Applied Fuzzy Electronics. PHI, 2004
5. Z. Pawlak. Rough Sets, Kluwer Academic Publishers, 1991.

Course Code	Course Title						Core / Elective
PE 832 IT	**Adhoc and Sensor Networks**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- ➢ To provide students with an understanding of wireless ad-hoc and sensor networks
- ➢ To enable them to recognize the wide range of applicability of these networks
- ➢ To provide an understanding of the major design issues, including topics such as protocol mechanisms and resource constraints.

Course Outcomes
After completing this course, the student will be able to
1. Understand the needs of Wireless Adhoc and Sensor Network in current scenario of technology.
2. Describe current technology trends for the implementation and deployment of wireless adhoc/sensor networks.
3. Discuss the challenges in designing MAC, routing and transport protocols for wireless ad-hoc/sensor networks.
4. Explain the principles and characteristics of wireless sensor networks.

UNIT-I
Wireless Transmission Technology and Systems: Introduction, Radio Technology Primer, Available Wireless Technologies. Medium Access Control Protocols for Wireless Networks: Introduction, Background, Fundamentals of MAC Protocols.

UNIT-II
Adhoc Networks: Introduction and Definitions, Adhoc Network Applications, Design Challenges. Evaluating Adhoc Network Protocols -the Case for a Test bed. Routing in Mobile Adhoc Networks: Introduction, Flooding. Proactive Routing. On Demand Routing. Proactive Versus On Demand Debate. Location based Routing.

UNIT-III
Multicasting in Adhoc Networks: Introduction, Classifications of Protocols, Multicasting Protocols, Broadcasting. Protocol Comparisons, Overarching Issues. Transport layer Protocols in Adhoc Networks: Introduction, TCP and Adhoc Networks, Transport Layer for Adhoc Networks: Overview, Modified TCP, TCP-aware Cross-Layered Solutions. Adhoc Transport Protocol.

UNIT-IV
QoS Issue in Adhoc Networks: Introduction, Definition of QoS, Medium Access Layer, Q0S Routing, Inter- Layer Design Approaches. Security in Mobile Adhoc Networks: Vulnerabilities of Mobile Adhoc Networks, Potential Attacks, Attack Prevention Techniques. Intrusion Detection Techniques.

UNIT-V
Basic Wireless Sensor Technology: Introduction, Sensor Node Technology, Sensor Taxonomy. Introduction and Overview of Wireless Sensor Networks: Introduction, Overview MAC Protocols for Wireless Sensor networks. Applications of Wireless Sensor Networks: Examples of Category 1 and Category 2 WSN applications.

Suggested Readings:
1. Prasant Mohapatra and Srihanamurthy, "Ad Hoc Networks Technologies and Protocols", Springer, Springer International Edition, 2009.

2. Kazem Sohraby, Daniel Minoli, Taieb Znati, "Wireless Sensor Networks", John Wiley & Sons.
3. Shivaram Murthy and B. S. Manoj, "Adhoc Networks – Principles and Protocols", Pearson Education, 2012.

Course Code	Course Title						Core / Elective
PE 834 CS	**Natural Language Processing**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

➢ To represent and analyse natural language both spoken and written, using statistical and finite sta[te] methods for modelling and classification. To use grammar for natural language processing.

➢ To study knowledge representation from its semantics view point with emphasis on applications. T[o] study basic logical form language to encode ambiguity.

➢ To study augmented grammars and parsers for feature systems.

➢ To resolve and encode ambiguity using statistical methods to estimate lexical probabilities along with critical study of probabilistic context free grammars and parsing.

➢ To interpret semantics covering ambiguity and link syntax to semantics.

Course Outcomes

After completing this course, the student will be able to

1. Use statistical and finite state methods for modelling and classification for representation and analysis of natural languages, and use grammars for natural language processing.
2. Apply knowledge representation and semantics to machine translation and database semantic interpretation.
3. Perform top-down and bottom-up parsing, and parsing with features.
4. Estimate lexical probabilities, resolve ambiguity, and use probabilistic context-free grammar.
5. Able to encode ambiguity in logical form language and deal with word-sense and ambiguity and to link syntax to semantics.

UNIT- I

Natural Language Processing: Introduction to Natural Language Processing, the study of Language, Applications of NLP, Evaluating Language Understanding Systems, Different levels of Language Analysis, Representations and Understanding, Organization of Natural Language Understanding Systems, Linguistic Background: An outline of English syntax Spoken Language input and output Technologies. Written language Input – Mathematical Methods – statistical Modelling and classification Finite State Methods.
Grammar for Natural Language Processing – Parsing – Semantic and Logic Form –

UNIT- II

Introduction to Semantics and Knowledge Representation: some applications like Machine translation, database interface Semantic Interpretation, word senses and ambiguity, Basic logical form language, Encoding ambiguity in logical from, Thematic roles, Linking syntax and semantics, Recent trends in NLP.

UNIT- III

Grammars and Parsing: Grammars and sentence Structure, Top-Down and Bottom-Up Parsers, Transition Network Grammars, Top- Down Chart Parsing. Feature Systems and Augmented Grammars: Basic Feature system for English, Morphological Analysis and the Lexicon, Parsing with Features, Augmented Transition Networks.

UNIT- IV

Semantic Interpretation: word senses and ambiguity, Basic logical form language, Encoding ambiguity in logical from, Thematic roles, Linking syntax and semantics, Recent trends in NLP.

UNIT-V

Ambiguity Resolution: Statistical Methods, Probabilistic Language Processing, Estimating Probabilities, Part-of-Speech tagging, Obtaining Lexical Probabilities, Probabilistic Context- Free Grammars, Best First Parsing. Semantics and Logical Form, Word senses and Ambiguity, Encoding Ambiguity in Logical Form.

Suggested Readings:

1. James Allen, "Natural Language Understanding", Pearson Education
2. Christopher D Manning and Hinrich Schutze, "Foundations of Statistical Natural Language Processing" MIT Press, 1999.
3. Akshar Bharti, Vineet Chaitanya and Rajeev Sangal, "NLP: A Paninian Perspective", Prentice Hall, New Delhi
4. D. Jurafsky, J. H. Martin, "Speech and Language Processing", Pearson

Course Code	Course Title						Core / Elective
PE 834 IT	**Information Storage and Management**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives

- ➢ To introduce the concept of storage, emphasize the significance of storage technologies in IT infrastructure.
- ➢ To provides a comprehensive understanding of the various storage infrastructure components in data center environments.
- ➢ To learn about the architectures, features, and benefits of Intelligent Storage Systems.
- ➢ To understand various storage networking technologies such as FC-SAN, NAS, and IP-SAN; long-term archiving solution – CAS.
- ➢ To know about various business continuity solutions such as backup and replication.
- ➢ To understand information security role in storage networks and the emerging field of storage virtualization including storage resource management.

Course Outcomes

1. Evaluate storage architecture; understand logical and physical components of a storage infrastructure including storage subsystems.
2. Describe storage networking technologies such as FC-SAN, NAS, IP-SAN and data archival solution – CAS.
3. Identify different storage virtualization technologies and their benefits.
4. Understand and articulate business continuity solutions including, backup and recovery technologies, and local and remote replication solutions.
5. Identify parameters of managing and monitoring storage infrastructure and describe common storage management activities and solutions

UNIT-I

Introduction to Information Storage: Information Storage, Evolution of Storage Architecture, Data Center Infrastructure, Virtualization and Cloud Computing. Data Center Environment: Application, Database Management System (DBMS), Host, Connectivity, Storage, Disk Drive Components, Disk Drive Performance, Host Access to Data, Direct-Attached Storage, Storage Design Based on Application, Disk Native Command Queuing, Introduction to Flash Drives.

UNIT-II

Data Protection: RAID, Implementation Methods, Array Components, Techniques, Levels, RAID Impact on Disk Performance, RAID Comparison, Hot Spares. Intelligent Storage Systems: Components of an Intelligent Storage System, Storage Provisioning, Types of Intelligent Storage **Systems.**

UNIT-III

Fibre Channel Storage Area Networks: Overview, The SAN and Its Evolution, Components of FC SAN, FC Connectivity, Switched Fabric Ports, Fibre Channel Architecture, Zoning, FC SAN Topologies, Virtualization in SAN. IP SAN and FCoE: iSCSI, FCIP, FCoE. Network-Attached Storage: General-Purpose Servers versus NAS Devices, Benefits of NAS, File Systems and Network File Sharing, Components of NAS, I/O Operation, Implementations, File-Sharing Protocols, Factors Affecting NAS Performance, FileLevel Virtualization. Object-Based and Unified Storage: Object-Based Storage Devices, Content Addressed Storage, CAS Use Cases.

UNIT-IV

Introduction to Business Continuity: Information Availability, BC Terminology, BC Planning Life Cycle, Failure Analysis, Business Impact Analysis, BC Technology Solutions. Backup and Archive: Backup Purpose, Backup Considerations, Backup Granularity, Recovery Considerations, Backup Methods, Backup Architecture, Backup and Restore Operations, Backup Topologies, Backup in NAS Environments. Local Replication: Replication Terminology, Uses of Local Replicas, Replica Consistency, Local Replication Technologies. Remote Replication: Modes of Remote Replication, Remote Replication Technologies, Three-Site Replication.

UNIT-V

Cloud Computing: Cloud Enabling Technologies, Characteristics of Cloud Computing, Benefits of Cloud Computing Cloud Service Models, Cloud Deployment Models, Cloud Computing Infrastructure, Cloud Challenges. Securing the Storage Infrastructure: Information Security Framework, Risk Triad, Storage Security Domains, Storage Security Domains. Managing the Storage Infrastructure: Monitoring the Storage Infrastructure, Storage Infrastructure Management Activities, Storage Infrastructure Management Challenges, Developing an Ideal Solution, Information Lifecycle Management.

Suggested Readings:

1. EMC Corporation, Information Storage and Management, Wiley India, 2nd Edition, 2011.
2. Robert Spalding, Storage Networks: The Complete Reference, Tata McGraw Hill, Osborne, 2003.
3. Marc Farley, Building Storage Networks, Tata McGraw Hill, Osborne,2nd Edition, 2001.
4. Meeta Gupta, Storage Area Network Fundamentals, Pearson Education Limited, 2002.

Course Code	Course Title						Core / Elective
PE 832 CS	**Information Retrieval Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- ➢ To understand indexing and querying in information retrieval systems
- ➢ To learn the different models for information retrieval
- ➢ To expose the students to text classification and clustering
- ➢ To learn about web searching

Course Outcomes

After completing this course, the student will be able to
1. Understand the algorithms and techniques for information retrieval (document indexing and retrieval, query processing)
2. Quantitatively evaluate information retrieval systems
3. Classify and cluster documents
4. Understand the practical aspects of information retrieval such as those in web search engines.

UNIT-I

Boolean Retrieval: An example information, Building an inverted index, Processing Boolean queries, The extended Boolean model versus ranked retrieval.

The term vocabulary and postings lists: Document delineation and character sequence decoding, determining the vocabulary of terms, Faster postings list intersection via skip pointers, Positional postings, and Phrase queries.

Dictionaries and tolerant retrieval: Search structures for dictionaries, Wildcard queries, Spelling correction.

Index construction: Hardware basics, blocked sort-based indexing, Single-pass in-memory indexing, Distributed indexing, Dynamic indexing, Other types of indexes.

UNIT-II

Index compression: Statistical properties of terms in information retrieval, Dictionary compression, Postings file compression.

Scoring, term weighting and the vector space model: Parametric and zone indexes, Term frequency and weighting, the vector space model for scoring, and Variant tf-idf functions.

Computing scores in a complete search system: Efficient scoring and ranking, Components of an information retrieval system, Vector space scoring and query operator interaction.

Evaluation in information retrieval: Information retrieval system evaluation, Standard test collections, Evaluation of unranked retrieval sets, Evaluation of ranked retrieval results, Assessing relevance.

UNIT-III

Relevance feedback and query expansion: Relevance feedback and pseudo relevance feedback, Global methods for query reformulation.

XML retrieval: Basic XML concepts, Challenges in XML retrieval, A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. data-centric XML retrieval.

Probabilistic information retrieval: Basic probability theory, The Probability Ranking Principle, The Binary Independence Model.

Language models for information retrieval: Language models, The query likelihood model.

UNIT-IV

Text classification and Naive Bayes: The text classification problem, Naive Bayes text classification, The Bernoulli model, Properties of Naive Bayes, and Feature selection.

Vector space classification: Document representations and measures of relatedness in vector spaces, Rocchio classification, k- nearest neighbour, Linear versus nonlinear classifiers.

Flat clustering: Clustering in information retrieval, Problem statement, Evaluation of clustering, k-means.

Hierarchical clustering: Hierarchical agglomerative clustering, Single-link and complete-link clustering, Group-average agglomerative clustering, Centroid clustering, Divisive clustering.

UNIT-V

Matrix decompositions and Latent semantic indexing: Linear algebra review, Term-document matrices and singular value decompositions, Low-rank approximations, Latent semantic indexing.

Web search basics: Background and history, Web characteristics, Advertising as the economic model, The search user experience, Index size and estimation, Near-duplicates and shingling.

Web crawling and Indexes: Overview, Crawling, Distributing indexes, Connectivity servers.

Link analysis: The Web as a graph, Page Rank, Hubs and Authorities.

Suggested Readings:
1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, *An Introduction to Information Retrieval*, Cambridge University Press, Cambridge, England, 2008
2. David A. Grossman, Ophir Frieder, *Information Retrieval–Algorithms and Heuristics*, Springer, 2nd Edition (Distributed by Universities Press), 2004.
3. Gerald J Kowalski, Mark T Maybury. *Information Storage and Retrieval Systems*, Springer, 2000
4. Soumen Chakrabarti, *Mining the Web: Discovering Knowledge from Hypertext Data*, Morgan-Kaufmann Publishers, 2002.

Course Code	Course Title					Core / Elective
PE 841 IT	**Distributed Databases**					**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Code	Course Title	Core / Elective
PE 841 IT	**Distributed Databases**	**Elective**

Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	30	70	3

Course Objectives
- ➢ To build on the previous background of database systems by Deepening the understanding of the theoretical and practical aspects of the database technologies,
- ➢ Showing the need for distributed database technology to tackle deficiencies of the centralized database systems
- ➢ Introducing the concepts and techniques of distributed database including principles, architectures, design, implementation and major domain of application.

Course Outcomes
After completing this course, the student will be able to
1. have good understanding of database design and computation techniques for parallel and distributed database technology, not only at the algorithmic level but also in a system setting.
2. Understand and calculate the cost of enforcing semantic integrity control
3. Understand the steps of query processing
4. Learn and understand various Query Optimization Algorithms
5. Understand Transaction Management & Compare various approaches to concurrency control in Distributed database
6. Understand various algorithms and techniques for deadlock and recovery in Distributed database

UNIT I
Introduction: Distributed Data Processing, Distributed database system (DDBMS), Promises of DDBMSs, Complicating factors and Problem areas in DDBMSs, Overview Of Relational DBMS Relational Database concepts, Normalization, Integrity rules, Relational Data Languages, Relational DBMS.

UNIT II
Distributed DBMS Architecture: DBMS Standardization, Architectural models for Distributed DBMS, Distributed DBMS Architecture.
Distributed Database Design: Alternative design Strategies, Distribution design issues, Fragmentation, Allocation.
Semantic Data Control: View Management, Data security, Semantic Integrity Control.

UNIT III
Overview of Query Processing: Query processing problem, Objectives of Query Processing, Complexity of Relational Algebra operations, characterization of Query processors, Layers of Query Processing.
Introduction to Transaction Management: Definition of Transaction, Properties of transaction, types of transaction.
Distributed Concurrency Control: Serializability theory, Taxonomy of concurrency control mechanisms, locking bases concurrency control algorithms.

UNIT IV
Parallel Database Systems: Database servers, Parallel architecture, Parallel DBMS techniques, Parallel execution problems, Parallel execution for hierarchical architecture.

UNIT V

Distributed Object Database Management systems: Fundamental Object concepts and Object models, Object distribution design. Architectural issues, Object management, Distributed object storage, Object query processing.

Transaction management. Database Interoperability: Database Integration, Query processing. Recent approaches, models and current trends in improving the performance of Distributed Database.

Suggested Readings:
1. Principles of Distributed Database Systems, Second Edition, M.Tamer Ozsu Patrick Valduriez
2. Distributed Databases Principles and Systems, Stefano Ceri, Giuseppe Pelagatti, Tata McGraw Hill.

Course Code	Course Title						Core / Elective
PE 842 CS	**Cloud Computing**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	L			
-	3	-	-	-	30	70	3

Course Objectives
- ➢ To introduce basic concepts cloud computing and enabling technologies
- ➢ To learn about Auto-Scaling, capacity planning and load balancing in cloud
- ➢ To introduce security, privacy and compliance issues in clouds
- ➢ To introduce cloud management standards and programming models

Course Outcomes
After completing this course, the student will be able to
1. Understand the architecture and concept of different cloud models: IaaS, PaaS, SaaS
2. Create virtual machine images and deploy them on cloud
3. Identify security and compliance issues in clouds.

UNIT- I

Introduction, Benefits and challenges, Cloud computing services, Resource Virtualization, Resource pooling sharing and provisioning

UNIT -II

Scaling in the Cloud, Capacity Planning, Load Balancing, File System and Storage

UNIT-III

Multi-tenant Software, Data in Cloud, Database Technology, Content Delivery Network, Security Reference Model, Security Issues, Privacy and Compliance Issues

UNIT-IV

Portability and Interoperability Issues, Cloud Management and a Programming Model Case Study, Popular Cloud Services

UNIT-V

Enterprise architecture and SOA, Enterprise Software, Enterprise Custom Applications, Workflow and Business Processes, Enterprise Analytics and Search, Enterprise Cloud Computing Ecosystem.

Suggested Readings:
1. Cloud Computing - Sandeep Bhowmik, Cambridge University Press, 2017.
2. Enterprise Cloud Computing - Technology, Architecture, Applications by Gautam Shroff, Cambridge University Press, 2016.
3. Kai Hwang, Geoffrey C. Fox, Jack J. Dongarra, ―*Distributed and Cloud Computing from Parallel Processing to the Internet of Things*, Elsevier, 2012.

Course Code	Course Title						Core / Elective
PE 843 CS	**Human Computer Interaction**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Reinforced Cement Concrete	3	-	-	-	30	70	3

Course Objectives
- ➢ To introduce interaction frameworks and styles
- ➢ To learn about interaction design process, design standards and principles
- ➢ To introduce the concept of usability and usability testing
- ➢ To familiarize interface components and technical issues of concern

Course Outcomes

Students who successfully complete this course will be able to:
1. Describe different types of interactive environments and interaction styles
2. Understand the user interface design process and the need for user-centred design
3. Describe techniques for developing prototypes of user interfaces and evaluation of user interfaces
4. Create an appropriate usability test plan
5. Understand the human and technical issues involved in the usage of text, icons and colours in user interfaces.

UNIT- I

Interaction Paradigms: Computing Environments, Analysing Interaction Paradigms, Interaction Paradigms
Interaction Frameworks and Styles: Frameworks for Understanding Interaction, Coping with Complexity, Interaction Styles.

UNIT- II

Interaction Design **Process:** Iterative Design, User-centred Design, Interaction Design Models, Overview of Interaction Design Models
Discovery: Discovery Phase Framework, Collection, Interpretation, Documentation
Design: Conceptual Design, Physical Design, Evaluation, Interface Design Standards, Designing the Facets of the Interface

UNIT- III

Design Principles: Principles of Interaction Design, Comprehensibility, Learn ability, Effectiveness/Usefulness, Efficiency/Usability, Grouping, Stimulus Intensity, Proportion, Screen Complexity, Resolution/Closure, and Usability Goals
Interaction Design Models: Model Human Processor, Keyboard Level Model, GOMS, Modelling Structure, Modelling Dynamics, Physical Models
Usability Testing: Usability, Usability Test, Design the Test, prepare for the Test, Perform the Test, Process the Data

UNIT- IV

Interface Components: The WIMP Interface, Other Components
Icons: Human Issues Concerning Icons, Using Icons in Interaction Design, Technical Issues Concerning Icons
Colour: The Human Perceptual System, Using Colour in Interaction Design, Colour Concerns for Interaction Design, Technical Issues Concerning Colour

UNIT- V

Text: Human Issues Concerning Text, Using Text in Interaction Design, Technical Issues Concerning Text

Speech and Hearing: The Human Perceptual System, Using Sound in Interaction Design, Technical Issues Concerning Sound

Touch and Movement: The Human Perceptual System, Using Hap-tics in Interaction Design, Technical Issues Concerning Hap-tics

Suggested readings:

1. Steven Heim, *The Resonant Interface: HCI Foundations for Interaction Design*, Addison-Wesley, 2007
2. J. Preece, Y. Rogers, and H. Sharp, *Interaction Design: Beyond Human-Computer Interaction*, Wiley & Sons, 2nd Ed., 2007
3. Ben Shneiderman, Catherine Plaisant, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 5th edition, Addison-Wesley, 2009

Course Code	Course Title						Core / Elective
PW 961 IT	**Project Work – II**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	-	-	-	16	50	100	8

Course Objectives
- ➢ To enhance practical and professional skills.
- ➢ To familiarize tools and techniques of systematic literature survey and documentation
- ➢ To expose the students to industry practices and team work.
- ➢ To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes
1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The aim of Project work –II is to implement and evaluate the proposal made as part of Project Work - I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:
1. Re-grouping of students - deletion of internship candidates from groups made as part of project Work-I
2. Re-Allotment of internship students to project guides
3. Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1st week of VIII semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

Note: Three periods of contact load will be assigned to each project guide.