Semester -VII (Fourth Year)

S.No	Course Code	Course Title	Hours Per Week		Scheme of Examination			Category
			L	P	Internal Marks	Sem End Exam Marks	Credits	
1	CO/IT 411	Humanities & Social Sciences Elective	3	0	30	70	3	HS
2	CO 412	Professional Elective – III	3	0	30	70	3	PE
3	CO 413	Professional Elective – IV	3	0	30	70	3	PE
4	CO 414	Professional Elective – V (MOOCS)	0	0	-	100	3	PE
5	CO 415	Open/Job-Oriented Elective – III	3	0	30	70	3	OE
6	CO 416	Open Elective – IV (MOOCS)	0	0	-	100	3	OE
7	CO 451	Industrial Internship / Professional Certification	-	-	100	-	3	PR
8	COSL5	Skill Oriented Course – V	1	2	100	-	2	SC
		TOTAL	**13**	**2**	**320**	**480**	**23**	

Category	CREDITS
Professional Elective Courses	9
Open Elective Course/Job Oriented Elective	6
Humanities And Social Science Elective	3
Skill Advanced Course	2
Industrial/Research Internship	3
TOTAL CREDITS	**23**

Humanities & Social Sciences Elective- Subjects		
S.NO	**Subject Code**	**Name of the Subject**
1.	HSEL01	Introduction to Industrial Management
2.	HSEL02	Economics for Engineers
3.	HSEL03	Human resources Behavior & Organizational Behavior
3.	HSEL04	Industrial Management & Entrepreneurship
4.	HSEL05	Project Management & Entrepreneurship

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HSEL01-INTRODUCTION TO INDUSTRIAL MANAGEMENT

L P C
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Course Objectives:
1. To provide the students a foundation in concepts and skills in management.
2. To make the students understand the concept of interest and evaluation of project alternatives.
3. Prepare the students for facing the changing environment, its implication on human resources and to achieve the corporate excellence.
4. Provide awareness about the materials requirement and procurement, in order to produce good quality products and maintain quality as desired by the consumer.

Course Outcomes:
1. The course helps the students to become aware of the inference of organization structure and performance of people working in organizations.
2. The course helps students to get knowledge about time value of money, evaluation of alternatives in the changing economic environment.
3. The course helps the students to understand the elements of human resource management to acquire competitive advantage.
4. The course helps the students to use right sort of material for delivering the right products and services to the market.

UNIT	**CO1**	**15 Periods**

GENERAL MANAGEMENT: Management Concept, Managerial levels, Managerial Skills, Managerial levels v/s skills, Brief treatment of managerial functions, Scientific Management Principles, Administrative Principles of Management.
FORMS OF BUSINESS ORGANISATION: Salient features of sole proprietorship. Partnership, Joint Stock Company, Private limited and Public limited companies.

UNIT II	**CO2**	**15 Periods**

FINANCIAL MANAGEMENT: Objectives of Financial Management – Concept of money - Simple interest – Compound interest Equivalent cash flow diagram.
ECONOMIC EVALUATION OF ALTERNATIVES: Basic methods – the annual equivalent method– Present worth method – future worth method.
DEPRECIATION: Purpose – Definition – types of depreciation – common methods of depreciation– The Straight Line Method – Diminishing Balance Method - the sum of the Years Digits Method.

UNIT III	**CO3**	**15 Periods**

HUMAN RESOURCE MANAGEMENT: Functions of Human Resource Management – Job Analysis – Human Resources Planning – Brief treatment of Recruitment - Selection – Placement - induction & Orientation – Training and Development - Performance Appraisal.

UNIT IV	**CO4**	**15 Periods**

MATERIAL MANAGEMENT: Functions of Materials Management - Material Requirement Planning – Purchasing – Objectives of Purchasing – Sources of Selection – Procurement Methods – Vendor Rating – Inventory Management – EOQ – EPG – ABC Analysis.
MARKETING MANAGEMENT: Functions of Marketing – Marketing Mix – Product life cycle – channels of distribution – Marketing Segmentation – Advertising & Sales promotion –

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Market Research.

Text Books:
1. KK Ahuja, Industrial Management and Organizational Behaviour, Khanna Publishers.
2. Pravin Kumar, Industrial Engineering and Management , Person Publications.
3. N.V.S.Raju, Industrial Engineering and Management, Cengage Learning.

Reference Books:
1. Philip Kotler, Marketing Management, 11th Edition, Pearson Education.
2. Gary Dessler, Human Resource Management, Pearson Education 11th Edition.
3. Heinz Weirich and Harold Koontz, Management, 10th Edition, TMH.

Web References:
1. www.managementstudyguide.com: Describes the Concepts of Management & Its Operational Functions.
2. www.1000 ventures.com: Describes about Management Gurus, Business Gurus.
3. www.citehr.com: Describes the Human Resource Management Topics.

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HSEL02- ECONOMICS FOR ENGINEERS

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Course Objectives:

1. To provide the students with knowledge of basic economic problems and the relationship between engineering technology and economics.
2. To make the students understand the demand determinants and the methods of demand forecasting of a product.
3. The students gain the knowledge about various cost concepts for determining the manufacturing of a product.
4. To sensitize the students about the changing environment of banking scenario and to understand the functions of RBI.

Course Outcomes:

After successful completion of the course, the students are able to

1. Understand the basic economic problems and objectives of a firm.
2. Get knowledge about overall functions and concepts of Demand elasticity of the firm and forecasting.
3. Linkage of various cost concepts and to understand how to sustain break even for a business.
4. Know the overview of Liberalization, Privatization and Globalization and their impact on Indian economy.

| **UNIT I** | **CO1** | **15 Periods** |

ENGINEERING ECONOMICS: Economics definition - Functions & Scope of Engineering economics- Basic economic problem - Relationship between Science - Engineering - Technology - Economics.

FIRMS OBJECTIVE: Theories of Maximization - Profit Maximization - Wealth Maximization - Growth Maximization - Sales Revenue Maximization - Utility Maximization.

| **UNIT II** | **CO2** | **15 Periods** |

THEORY OF DEMAND: Demand Definition - Nature and Characteristics of Demand - Demand schedule Law of demand - Limitations to the law of demand - Various concepts of Demand Elasticity– Price Elasticity - Income Elasticity - Cross elasticity - Demand Forecasting definition - Factors determining Demand Forecasting - Methods of Demand forecasting.

| **UNIT III** | **CO3** | **15 Periods** |

COST CONCEPTS: Introduction - Types of costs - Fixed cost - Variable cost - Average cost – Marginal cost - Real cost - Opportunity cost - Accounting cost - Economic cost - Break - Even analysis.

| **UNIT IV** | **CO4** | **15 Periods** |

INDIAN ECONOMY - AN OVERVIEW: Nature and characteristics of Indian economy – Banking - Structure of Indian Banking- RBI functions - Functions of Commercial banks - Merits and Demerits of Liberalization - Privatization – Globalization (LPG) - Elementary concepts of WTO - GATT- GATS - TRIPs - TRIMs - Monetary Policy - Fiscal Policy.

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Text Books:
1. Riggs, Bedworth and Randhwa, Engineering Economics, McGraw-Hill EducationIndia.
2. S.C. Sharma and T.R. Banga, Industrial Organization and Engineering Economics,Khanna Publishers.
3. S.K.Misra and V.K.Puri, Economic Environment of Business, Himalaya PublishingHouse. H.L.Ahuja, Managerial Economics, S.Chand Publishing.

Reference Books:
1. Singh A and Sadh A.N., Industrial Economics , Himalaya Publishing House , Bombay
2. R.L.Varshney & K.L.Maheswari, Managerial Economics, S.Chand Publishing ,2003Edition
3. Datt & Sundharam, Indian Economy ,S.Chand Publishing, 2014 Edition

Web Resourses:
1. www.managementstudyguide.com: Describes about the amalgamation of economic theory with business practices.
2. www.tutorialspoint.com: Provides a platform to learn various courses discussed inthe syllabus.

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HSEL03-HUMAN RESOURCES & ORGANISATIONAL BEHAVIOR   L P C
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Course Objectives:
1. To familiarize the student with the fundamental aspects of various issues associated with Human Resource Management and Organizational Behavior.
2. This course aims to give a comprehensive overview about Career Planning, theories of Motivation and styles of Leadership.
3. To introduce the basic concept of Individual Behavior.
4. To enhance the awareness of Group Behavior.

Course Outcomes:
After successful completion of the course, the students are able to
1. know the Functions of Human Resource Management, Job Description and Job Specification
2. familiarize with the concepts in Compensation, Motivation and styles of Leadership
3. understand the Behavior of people at individual level through the concepts of Perception, Learning and Personality
4. comprehend the Group and Team Dynamics in an Organization
.

UNIT I   **CO1**   **15 Periods**
Human Resource Management: Nature - significance - functions of HRM - .Job Analysis – Objectives and methods of Job Analysis - Job Description - Job Specification - Job Rotation - Job Enlargement - Job Enrichment - Job Evaluation & its Methods.

UNIT II   **CO2**   **15 Periods**
Career Planning & Motivation: Career Planning and Development - Career Stages- Compensation - Components of Pay Structure - Wage and Salary administration - Incentives and Employee Benefits - Motivation: Maslow's Theory - Herzberg's Two Factors Theory of Motivation - McGregor's Theory X and Y - Vroom's Expectancy Theory - Leadership: Theories of Leadership and its Styles.

UNIT III   **CO3**   **15 Periods**
Introduction to Organizational Behavior: Meaning- Importance - Nature & Scope of OB – Contribution of other Disciplines to OB - Need for Development of individual Skills; Perception - Process of Perception - Enhancing Perceptual Skills - Learning - Theories of learning - Personality - Stages of personality Development - Determinants of personality.

UNIT IV   **CO4**   **15 Periods**
Groups and Teams: Meaning & Definition of Group and Group Dynamics - Dynamics of Group Formation - Reasons for Group Formation - Types of Groups - Concept and Definition of Team - Types of Teams - Work Teams - Cross-functional Teams - Virtual Teams - Group/Team Effectiveness
- How to make Teams more Effective - Team Building - Collaboration - Group Leadership.

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Text Books:
1. Aswathappa.K., Human Resource Management, Text and Cases 8th Edition, McGraw Hill, New Delhi.
2. De Cenzo. & Stephen P. Robbins, Personnel/ Human Resource Management, Pearson Publications.
3. Stephen P. Robbins, Organisational Behavior, PHI, 9th edition
4. Fred Luthans, OrganisationalBehaviour, Tata McGraw Hill.-12th Edition.

Reference Books:
1. VSP Rao, Human Resource and Personnel Management, PHI
2. Edwin B. Flippo, Personnel Management, McGraw-Hill.
3. Aswathappa.K., Organizational Behavior , Himalaya Publishing House, New Delhi
4. Jai, B.P.Sinha, "Culture and Organizational Behavior", Sage Publications

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HSEL04- INDUSTRIAL MANAGEMENT & ENTREPRENEURSHIP   L P C
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Course Objectives:
1. To enable the student to demonstrate a thorough working knowledge of Management and Organizations.
2. To alert the students in regular business activity on Time values of money and depreciation.
3. To motivate the students on Entrepreneurial Perspectives at present business.
4. To enable the student on the MSME sector and motivate the startup of MSME and support agencies.

Course Outcomes:
After successful completion of the course, the students are able to
1. To gain insight into contemporary issues in Management and Business Organization
2. Ability to identify, analyze and interpret various concepts of time values of money and depreciation.
3. An understanding of the impact of knowledge on Entrepreneurship to enable the student to meet the needs of Industry
4. Recognition of the needs and ability to MEME and Support Agencies

UNIT I   **CO1**   **15 Periods**
Management and Business Organization: Management concept-Managerial and operational functions of management-Scientific management-Job Design-Job description and job specification. Sole Proprietorship, Partnership Firm, Limited Liability Partnership (LLP), Joint Stock Company, One Person Company (OPC), Private Company; Public Limited Company, Forms of Organization, Co- Operatives.

UNIT II   **CO2**   **15 Periods**
Time values of money and depreciation: Simple interest -Compound interest-Present worth factors Future worth factors-Depreciation Concept-Straight-line method of depreciation-Diminishing method of depreciation-Sum of the year digits method of depreciation etc. along with problems

UNIT III   **CO3**   **15 Periods**
Entrepreneur and Entrepreneurship: Concept of Entrepreneur-Characteristics of an Entrepreneur Distinction between an Entrepreneur and Entrepreneur and a Manager – Functions of an Entrepreneur-– Types of entrepreneurs- Recent Trends of Women Entrepreneurship – Rural Entrepreneurship Entrepreneurial process – Growth of Entrepreneurship in India

UNIT IV   **CO4**   **15 Periods**
MSME and Support Agencies: Meaning of MSME-Definitions of MSME, Characteristics of MSME- – Relationships of MSME- Certificate of MSME –Make in India concept of MSME- Commercial Banks financial institutions – (KVIC) Khadi and Village Industries Commission- (SIDO) Small Industries Development Corporation –(NSIC) National Small Industries Corporation-(NPC) National productivity council- (DIC) District Industries Centre- (SFC) State Financial corporation.

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Text Books:
1. KK Ahuja, Industrial Management, Vol. I & II, Dhanpat Rai, 1978.
2. E.Paul Degarmo, John R Chanda, William G Sullivan, Engineering Economy, Mac Millan Publishing Co, 1979. B.Tech.(HS)/R-18/2018-2019 Page 1/ 2.
3. Poornima M Charantimath, Entrepreneurship Development Small business environment, Pearson Education
4. Shivganesh Bhargav, Entrepreneurial Management, Sage Publications, 2008.
5. Prasanna Chandra, Project Management, Tata McGraw-Hill Education, 2013 Edition,

Reference Books:
1. Philip Kotler, Marketing Management, 11th Edition, Pearson Education, 2004.
2. P. Gopalakrishnan, Hand Book of Materials Management, PHI, 1999.
3. Gary Dessler, Human Resource Management, 11th Edition, 2008.
4. Heinz Weirich and Harold Koontz, Management, 10th Edition, TMH, 2004.

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HSEL05 - PROJECT MANAGEMENT & ENTREPRENEURSHIP   L P C
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Course Objectives:
1. To grasp the project identification, Planning and execution of the projects.
2. To understand the project analysis, apply appropriate project tools and techniques.
3. To develop Entrepreneurial creativity and Entrepreneurial initiative, adopting the key steps in the elaboration of business idea.
4. To be aware the growth and development of Entrepreneurial process and the resources needed for the successful development of Entrepreneurial ventures.

Course Outcomes:
After successful completion of the course, the students are able to
1. Understand the conceptual clarity about project identification, formulation and feasibility analysis.
2. Analyze the learning and implementation of the project techniques for project planning, scheduling and execution.
3. Utilize the ideas to create value.
4. Self-advocacy and problem solving skills and manage strong identity purpose.

Course Content:

| UNIT I | CO1 | 15 Periods |

Project Identification and Formulation: Meaning and definition of Project - concepts - Project Life cycle - Project Identification - Project Selection - Source of Finance for a Project- Project appraisal (Theory) - Technical, Financial, Market appraisal - preparation of detailed project report.

| UNIT II | CO2 | 15 Periods |

Implementation of project: An overview of Project Planning and Scheduling - Management and Control of Projects - Network Analysis - PERT and CPM (Problems).

| UNIT III | CO3 | 15 Periods |

Entrepreneurship: An overview of Entrepreneurship - Characteristics and competencies of Entrepreneur - Entrepreneurial traits - Classification of Entrepreneurs - functions of Entrepreneur - Distinction between Entrepreneur, Intrapreneur and Manager - Entrepreneurial decision process

| UNIT IV | CO4 | 15 Periods |

Entrepreneurship growth and Development: Factors affecting Entrepreneurial Development – Economic and Non-Economic factors - Entrepreneurial Development Programs - Need and objectives of EDP – EDP programs in India - Entrepreneurial Motivation - theories of Maslow's and Mc Clelland's -MSME an introductory framework

Text Books:
1. Prasanna Chandra, Project Planning, Analysis, Selection, Implementation and Review, Tata McGraw Hill.
2. Rao. P.C.K., Project Management & Control, S. Chand, New Delhi.
3. Dr. S.S Khanka, Entrepreneurial Development, S. Chand and Company limited, New Delhi.
4. H. Nandan, Fundamentals of Entrepreneurship, PHI, New Delhi.

Professional Elective–III - Subjects		
CO412		
1.	EL09	Neural Networks
2.	EL10	Privacy and Security for IoT
3.	EL11	Software Testing Tools
3.	EL12	Augmented and Virtual Reality

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CO 412   **EL09: Neural Networks**   **L P C**

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Course Objectives:

1. To introduce some of the fundamental techniques and principles of neural computation.
2. To investigate some common models and their applications.

Course Outcomes:

On completion of this course, a student should be able to:

1. Explain the features of single and multi layer neural networks.
2. Discuss different learning mechanisms of Hopfield, Kohonen, SOM and LVQ networks.
3. Implement common learning algorithms Adaptive responance theory.
4. Describe back propagation neural networks to classification and recognition problems.

Course Content:

UNIT I   **CO1**   **13 Periods**
Introduction, Simple Neural Networks for Pattern Classification : General Discussion , HebbNet, Perceptron, Adaline.

UNIT II   **CO2**   **13 Periods**
Discrete Hopfield Net, Hamming Net, Kohonen Self-Organizing Maps, Learning Vector Quantization.

UNIT III   **CO3**   **10 Periods**
Adaptive Resonance Theory: Introduction, ART1, ART2.

UNIT IV   **CO4**   **14 Periods**
Standard Back Propagation Neural Net, Gaussian Machine, Cauchy Machine, Boltzmannwith Machine Learning, Simple Recurrent Net.

Learning Resources:
  Text Book:

   1.Fundamentals of Neural Networks–Laurence Fausett, Pearson Education.2004.

  Reference Books:

1. Introduction to Neural Networks Using Matlab6.0- S.N. Sivanandam, S.Sumathi,S.N.Deepa.
2. Neural Networks –James A.Freeman/ David A.Skapura, Pearson Education.
3. Neural Networks –Simon Haykin–2nd edition, Pearson Education.

CO 412   **EL10: Privacy and Security for IoT**   **L P C**

                                                                             4 0 3

Course Objectives:
1. To know the state-of-the-art methodologies in Cyber Physical system.
2. To impart knowledge on Model threats and counter measures.
3. To explore the Privacy Preservation and Trust Models in Internet of Things(IoT) To apply the concept of Internet of Things Security in the real-world scenarios

Course Content:

Unit I   **CO1**   **13 Periods**
CYBER PHYSICAL SYSTEMS AND INTER CONNECTION OF THREATS:
IoT and cyber-physical systems, IoT security (vulner abilities, attacks, and counter measures), security engineering for IoT development, IoT security lifecycle. Network Robustness of Internet of Things-Sybil Attack Detection in Vehicular Networks-Malware Propagation and Control in Internet of Things-Solution-Based Analysis of Attack Vector son Smart Home Systems.

Crypto Foundations:
Block ciphers, message integrity, authenticated encryption, hash functions, Merkletrees , elliptic curves, public-key crypto(PKI), signature algorithms.

Unit II   **CO2**   **10 Periods**
CRYPTO FOUNDATIONS:
Privacy Preservation Data Dissemination- Privacy Preservation Data dissemination – Social Features for Location Privacy Enhancement in Internet of Vehicles-Light weight and Robust Schemes for Privacy Protection in Key Personal IoT Applications: Mobile WBSN and Participatory Sensing

Unit III   **CO3**   **11 Periods**
TRUST MODELS FOR IOT
Authentication in IoT- Computational Security for the IoT- Privacy-Preserving time Series Data Aggregation- Secure Path Generation Scheme for Real-Time Green Internet of Things-Security Protocols for IoT Access Networks- Framework for Privacy and Trust in IoT-Policy-Based Approach for Informed Consent in Internet of Things.

Unit IV   **CO4**   **12 Periods**
INTERNET OF THINGS SECURITY
Security and Impact of the Internet of Things (IoT) on Mobile Networks- Networking Function Security-IoT Networking Protocols, Secure IoT Lower Layers, Secure IoT Higher Layers, Secure Communication Links in IoTs, Back-end Security -Secure Resource Management, Secure IoT Databases, Security Products –Existing Test bed on Security and Privacy of IoTs, Commercialized Products.

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Text Books:

1. Russell,Brian, and Drew VanDuren. Practical Internet of Things Security, 1ˢᵗedition, Packt Publishing Ltd, 2016.
2. Hu, Fei. Security and privacy in Internet of things (IoTs): Models, Algorithms, and Implementations,1ˢᵗedition, CRC Press, 2016.

Reference Books:

1. White house O. Security of things: An implementers' guide to cyber-security for internet of things devices and beyond,1ˢᵗ edition, NCC Group, 2014
2. Da Costa, Francis, and Byron Henderson. Rethinking the Internet of Things: ascalable approach to connecting everything, 1ˢᵗ edition, Springer Nature, 2013.

CO 412   **EL11: Software Testing Tools**   **L P C**

                                                                                                          3 0 3

Course Objectives:

At the end of the course, the student will understand
   1. Software testing process effectively.
   2. Design of high quality tests during all phases of software development.
   3. Criteria-based test design
   4. Automation tools used in software development

Course Outcomes:

At the end of the course the students will be able to
   1. Apply software testing knowledge and engineering methods.
   2. Design and conduct a software test process for a software testing project.
   3. Uses of t ware testing methods and modern software testing tools for their testing projects.
   4. Identify and use various automation testing tools, and develops test cases for object oriented and web based systems.

Course Content:

UNIT I   **CO1**   **15 Periods**
Software Testing: Introduction, Evolution, Myths & Facts, Goals, Psychology, Definition, Model for testing, Effective Vs. Exhaustive Software Testing.
Software Testing Terminology and Methodology: Software Testing Terminology, Software Testing Life Cycle, Software Testing Methodology.

Verification and Validation: Verification & Validation Activities, Verification, Verification of Requirements, High level and low level designs, How to verify code, Validation.

UNIT II   **CO2**   **15 Periods**
Dynamic Testing, I: Black Box testing techniques: Boundary Value Analysis, Equivalence class Testing, State Table based testing, Decision table-based testing, Cause-Effect Graphing based testing, Error guessing
Dynamic Testing II: White-Box Testing: need, Logic coverage criteria, Basis path testing, Graph matrices, Loop testing, data flow testing, mutation testing

UNIT III   **CO3**   **15 Periods**
Static Testing: inspections, Structured Walk throughs, Technical reviews
Validation activities: Unit testing, Integration Testing,. Function testing, system testing, acceptance testing
Regression testing: Progressives Vs regressive testing, Regression testability, Objectives of regression testing, when regression testing done? Regression testing types, Regression testing techniques.
Debugging: an Artor Technique? Debugging Process, Debugging Is Difficult, Debugging Techniques, Correcting the Bugs, Debuggers.

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UNIT IV   **CO4**   **15 Periods**

Automation and Testing Tools: need for automation, categorization of testing tools, selection of testing tools, Cost incurred, Guidelines for automated testing, overview of some commercial testing tools.
Testing Object Oriented Software: basics, Object oriented testing
Testing Web based Systems: Challenges in testing for web based software, quality aspects, web engineering, testing of web based systems.

Learning Resources:

Text Books:

1. Software Testing, Principles and Practices, Naresh Chauhan, Oxford University Press, 2011.

Reference books:

1. Software testing techniques-Baris Beizer, International Thomson computer press,second edition.
2. Software Testing, Principles, techniques and Tools, MG Limaye, TMH
3. Effective Methods for Software testing, WillianE Perry,3ed, Wiley
4. Foundations of Software testing, Aditya PM athur,2ed,Pearson
5. Software Testing-Yogesh Singh, CAMBRIDGE

CO 412   **EL12: Augmented and virtual Reality**   **L P C**

                                                                              3 0 3

Course Objectives:
> The main objectives of this course are to:
> 1. Recognize the basic components of Virtual Reality technology.
> 2. Acquire Knowledge on Computing Architecture and Modeling concepts of Virtual Reality.
> 3. Distinguish the factors that influence the system performance in virtual reality.
> 4. Relate the Virtual Realty Applications in various domains.

Course Outcomes:

> After successful completion of the course, students will be able to:
> 1. Distinguish the fundamental technologies and equipment used in virtual reality;
> 2. Investigate the theoretical contexts relevant to computing and modeling features in VR development.
> 3. Analyze the current generation systems for creating VR environments.
> 4. Identify the current VR technologies and next generation applications across all fields.

Course Content:

UNIT I   **CO1**   **12 Periods**
Introduction: The Three l's Virtual Reality, A short History of Early Virtual Reality, Early commercial VR Technology, VR Becomes an Industry, The five classic Components of a VR system.
Input Devices: Trackers, Navigation and Gesture Interfaces: Three- Dimensional Position Trackers, Navigation and Manipulation Interfaces, Gesture Interfaces.
Output Devices: Graphics, Three-Dimensional Sound and Hap tic Displays: Graphics Displays Sound Displays, Hap tic Feedback.

UNIT II   **CO2**   **14 Periods**

Computing Architectures for VR: The Rendering Pipe line Rendering, PC Graphics Architecture Workstation-Based Architectures, Distributed VR Architectures.

Modelling: Geometric modelling, Kinematics Modelling, Physical Modelling, Behaviour Modelling, Model Management.

UNIT III   **CO3**   **12 Periods**
VR Programming: Toolkits and Scene Graphs, World Toolkit, JAVA3D, General Hap tics Open Software Toolkit,, People shop.
Human Factors in VR: Methodology and Terminology, User Performance Studies, VR Health and Safety Issues, VR and Society.

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UNIT   **CO 4**   **12 Periods**

Traditional VR Applications: Medical Applications of VR, Education, Arts and Entertainment, Military VR Applications.

Emerging Applications of VR : VR Applications in Manufacturing, Applications of VR in Robotics, Information Visualization.

Learning   Resources:

Text Book:
     1. Grigore C. Burdea, Philippe Coiffet. "VirtualReality" Second Edition, Wiley India.

Reference Books:

1. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002

2. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.

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Professional Elective–IV – Subjects		
CO413		
1.	EL13	Optimization Techniques
2.	EL14	Big Data Analytics
3.	EL15	Block Chain Technologies
3.	EL16	Deep Learning

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CO 413   **EL13: Optimization Techniques**   **L P C**

3 0 3

Course Objectives:

At the end of the course, the student will understand and

Course Outcomes:

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

Course Content:

UNIT I	CO1	12 Periods

Convex Optimization with Sparsity-Inducing Norms: Introduction, Generic Methods, Proximal Methods, Coordinate Descent Algorithms, Reweighted-l2 Algorithms, Working-Set Methods, Quantitative Evaluation, Extensions.

Interior-Point Methods for Large-Scale Cone Programming: Introduction, Primal-Dual Interior-Point Methods, Linear and Quadratic Programming, Second-Order Cone Programming, Semi definite Programming.

UNIT II	CO2	12 Periods

Incremental Gradient, Sub gradient, and Proximal Methods for Convex Optimization: Introduction, Incremental Sub gradient-Proximal Methods, Convergence for Methods with Cyclic Order, Convergence for methods with Randomized Order, Some Applications.

First-Order Methods for Non smooth Convex Large-Scale Optimization, I: Introduction, Mirror Descent Algorithm: Minimizing over a Simple Set, Problems with Functional Constraints, Minimizing Strongly Convex Functions, Mirror Descent Stochastic Approximation, Mirror Descent for Convex-Concave Saddle-Point Problems, Setting up a Mirror Descent Method.

UNIT III	CO3	12 Periods

First-Order Methods for Non smooth Convex Large-Scale Optimization, II: Introduction, Saddle-Point Reformulations of Convex Minimization Problems, Mirror-Prox Algorithm, Accelerating the Mirror-Prox Algorithm, Accelerating First-Order Methods by Randomization.

Cutting-Plane Methods in Machine Learning: Introduction to Cutting-plane Methods, Regularized Risk Minimization, Multiple Kernel Learning, MAP Inference in Graphical Models.

UNIT IV	CO4	12 Periods

Introduction to Dual Decomposition for Inference: Introduction, Motivating Applications, Dual Decomposition and Lagrangian Relaxation, Sub gradient Algorithms, Block Coordinate Descent Algorithms, Relations to Linear Programming Relaxations, Decoding: Finding the MAP Assignment.

Augmented Lagrangian Methods for Learning, Selecting, and Combining Features: Introduction, Background, Proximal Minimization Algorithm, Dual Augmented Lagrangian (DAL) Algorithm, Connections, and Application.

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Learning Resources:

Text Books:

1. Optimization in Machine Learning, Suvrit Sra, Sebastian Nowozin, Stephen J. Wright, MIT Press, 2011.

CO 413   **EL14: Big Data Analytics**   **L P C**

3 0 3

Course Objectives:
At the end of the course the students will understand
1. Big data analytics techniques.
2. Techniques required to manage and analyze big data problems.
3. Principles in achieving big data analytics with scalability and streaming capability.
4. Techniques to solve complex real-world analytics problems.

Course Outcomes:
At the end of this course a student will be able to
1. Demonstrate the key issues in big data management and its associated applications.
2. Apply fundamental enabling techniques and scalable algorithms in big data analytics.
3. Interpret models for similarity and distance measures.
4. Build data stream models and apply analytics principles.

Course Content:

UNIT I   **CO1**   **10 Periods**
Overview of Big Data: What is Big Data, Structuring Big Data, Elements of Big Data, Big Data Analytics.
Understanding Hadoop Eco-system: Hadoop Eco System, Hadoop Distributed File System, Hadoop YARN, Introducing H Base, Combining H Base and HDFS, Hive, Pig, Sqoop, Zoo Keeper, Flume.
No SQL Data Management: Introduction to No SQL, Types of No SQL data models, Key Value Data Model, Column Oriented Data Model, Document Data Model, Graph Databases, Schema-Less Databases, Materialized Views, Distribution Models, Sharding.

UNIT II   **CO2**   **15 Periods**
Data Mining: What is Data Mining?, Statistical Limits on Data Mining. Things useful to know.
Map Reduce Software Stack: Distributed File Systems, Map Reduce, Algorithms Using Map Reduce, Extensions to Map Reduce, The Communication Cost Model.
Finding Similar Items: Applications of Near- Neighbor Search, Shingling of Documents, Similarity- Preserving Summaries of Sets, Locality-Sensitive Hashing for Documents, Distance Measures.

UNIT III   **CO3**   **15 Periods**
Mining Data Streams: The Stream Data Model, Sampling Data in a Stream, FilteringStreams. Mining, Counting Distinct Elements in a Stream.
Link Analysis: Page Rank, Efficient Computation of Page Rank, Topic- Sensitive Page Rank, Link Spam.
Social-Network Graphs: Social Networks as Graphs, Clustering of Social-Network Graphs, Direct Discovery of Communities, Partitioning of Graphs.

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UNIT IV   **CO4**   **10 Periods**

Understanding Analytics and Big Data: Comparing Reporting and Analysis, Types of Analytics, Points to consider during Analysis, Developing an Analytic Team, Understanding Text Analytics.

Exploring R: Variables in R, Working with Vectors, Storing and Calculating values in R, Creating and using objects, Executing Scripts,, Creating Plots.

Reading Data set and Exporting Data from R: c()command, scan() Command, Reading multiple data values from large files, exporting data from R, creating sub sets in data frames.

Learning Resources:

Text Books:

1. BIG DATA Black Book, Dream tech Press, 2015.
2. Jure Leskovec, Anand Raja raman, Jeffrey David Ullman, Mining of Massive Datasets, 2nd Edition, 2014.

Reference Books:
1. Taming the Big Data Tidal Wave: Finding Opportunities in huge data streams with advanced analytics, Bill Franks, Wiley Publishers,2010.
2. Understanding Big data: Analytics for enterprise class Hadoop and streaming data, Paul Zikopoulos, Chiris Eaton ,Mc Graw Hill Education.

Web-References:
1. Big Data computing course of Dr.Rajiv Misrais available
   @ https: //nptel.ac.in/courses/106104189/
2. Yahoo! Hadoop Tutorial available
   @https://developer.yahoo.com/hadoop/tutorial/
3. Google ld Apache tools Tutorials available
   @https://cloud.google.com/dataproc/docs/tutorials
4. IBM Hadoop Dev Tutorials available

   @https://developer.ibm.com/Hadoop/docs/biginsights-ibm-open-platform/getting- started/ tutorials

CO 413   **EL15 : Block Chain Technologies**   **L P C**
                                                          3 0 3

Course Objectives:
    The student should be made to
       1. Develop familiarity of current technologies, tools.
       2. Impart strong technical understanding of Block Chain technologies.
       3. Explore the Smart Contracts and Etherum implementation strategies
       4. Introduce the current scenario and practical application areas of Hyper ledger.

Course Outcomes:
    After successful completion of the course, the students are able to:
       1. Discuss the block chain technology in decentralized paradigm.
       2. Explore cryptography and trading Applications along with their implementation strategies.
       3. Discuss the implementation of smart contract and Etherum platform.
       4. Explain the importance and applications of Hyper ledger.

Course Content:

UNIT I   **CO1**   **15 Periods**
Block Chain101-Distributed Systems, History of block chain, Introduction to block chain, Types of block chain, CAP theorem and block chain, benefits and limitations of block chain,
Decentralization-Decentralization using block chain, Methods of decentralization, Routes to decentralization, Block chain and full eco system decentralization, Smart contract, Decentralized Organizations, Decentralized autonomous organizations, decentralized autonomous corporations, Decentralized autonomous societies, Decentralized applications, Platforms for Decentralization.

UNIT II   **CO2**   **15 Periods**
Cryptography and Technical Foundations-Introduction, Cryptographic primitives, Asymmetric Cryptography, Public and Private-keys, Financial-market and trading, Summary.

BITCOIN-Bitcoin, Transactions, Block chain, Bitcoin Payments.

UNIT III   **CO3**   **15 Periods**
Smart Contracts- History, Definition, Recardian Contracts,
Ethereum101-Introduction,Ethereum block chain, Elements of the Ethereum block chain, Precompiled contracts, Accounts, Block, Ether, Messages, Mining, Clients and Wallets, Trading and investment, The Yellow paper, The Ethereum Network, Applications developed on Ethereum, Scalability and security issues,.

UNIT IV   **CO4**   **15 Periods**
Hyper Ledger- Projects, Hyper ledger as a Protocol, Fabric, Hyper ledger Fabric, Saw tooth lake,Corda,
Alternative Block Chain- Block chains, Platforms.
Scalability and Other Challenges- Scalability, Privacy, Security,

Learning Resources:
   Text Book:

       1. Seberrius Jeffery, "Block Chain" 2nd Edition Publishers details 2015.

CO 413   **EL16: Deep Learning**   **L P C**
                                                                           3 0 3

Course Objectives:
The main objectives of this course are:
1. Introduce basic concepts and applications of neural networks and deep neural networks.
2. Discuss regularization and optimization techniques in neural networks.
3. Illustrate tools in convolutional neural networks.
4. Describe computational graphs to define recurrent neural networks
5. Demonstrate practical methodologies deep learning.

Course Outcomes:
After successful completion of the course, the students are able to:
1. Apply the regularization for deep learning
2. Implement optimization techniques for neural network training
3. Construct ,train and use recurrent neural networks.
4. Use deep learning to solve practical problems

CO-POMAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3							2
CO2	3	3	3	3	3							2
CO3	3	3	3	3	3							2
CO4	3	3	3	3	3							2

Course Content:

UNIT I   **CO1**   **15 Periods**
Deep Feed forward Networks: Example: Learning XOR, Gradient-Based Learning, Hidden Units, Architecture, Back-Propagation and Other Differentiation Algorithms.
Regularization for Deep Learning: Parameter Norm Penalties, Norm Penalties as Constrained Optimization, Regularization and Under-Constrained Problems, Data set Augmentation, Noise Robustness, Semi-Supervised Learning, Multi-Task Learning, Early Stopping, Parameter Tying and Parameter Sharing, Sparse Representations, Bagging and Other Ensemble Methods, Dropout, Adversarial Training, Tangent Distance, Tangent Prop, and Manifold Tangent Classifier.

UNIT II   **CO2**   **15 Periods**
Optimization for Training Deep Models: How Learning Differs from Pure Optimization, Challenges in Neural Network Optimization, Basic Algorithms, Parameter Initialization Strategies, Algorithms with Adaptive Learning Rates, Approximate Second-Order Methods, Optimization Strategies and Meta-Algorithms.
Convolutional Networks: The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Random or Unsupervised Features, The Neuro scientific Basis for Convolutional Networks, Convolutional Networks and the History of Deep Learning.

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UNIT III   **CO3**   **15 Periods**
Sequence Modeling: Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to-Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Challenge of Long-Term Dependencies, Echo State Networks, Leaky Units and Other Strategies for Multiple Time Scales, The Long Short-Term Memory and Other Gated RNNs, Optimization for Long-Term Dependencies, Explicit Memory

UNIT IV   **CO4**   **14 Periods**
Practical Methodology: Performance, Default Baseline Models, Determining Whether to Gather More Data, Selecting Hyper parameters, Debugging Strategies,
Example :Multi-Digit Number Recognition.
Applications: Large-Scale Deep Learning, Computer Vision, Speech Recognition, Natural Language Processing, Other Applications

Text Book:
Ian Good fellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.

Reference Books:
Charu C.Aggarwal, Neural Networks and Deep Learning A Textbook, Springer, 2018

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CO415	Job Oriented Elective III- Subjects	
S.NO	**Subject Code**	**Name of the Subject**
1.	JOEL09	Interface and Programming with IoT Gateway
2.	JOEL10	IoT cloud and Data Analytics
3.	JOEL24	Artificial Intelligence

CO415   **JOEL10: IoT cloud and Data Analytics**   **L P C**

3 0 3

Course Outcomes:
Upon completing this course, students should be able to:
1. Explain what "Data Analytics" term means
2. Differentiate between traditional Data Analytics and Data Analytics for IoT
3. Enumerate and describe the fundamental concepts of Data Analysis for IoT
4. Demonstrate the ability to translate IoT data in to action able business in sights
5. Evaluate the use of IoT data from acquisition through cleansing, warehousing,analytics, and visualization to drive business decisions
6. Apply Data Analytics to real-world IoT datasets

Course Contents:

UNIT I   **CO1**   **12 Periods**
Introduction to Data analytics and tools: Defining IoT analytics, defining the Internet of things, IoT analytics Challenges.
IoT Analytics for the Cloud : Building elastic analytics, elastic analytics concepts, designing for scale, cloud security and analytics, The AWS overview and Microsoft Azure overview.

UNIT II   **CO2**   **12 Periods**
IoT Data Collection Strategies and Techniques: Designing data processing for analytics, applying big data technology to storage, apache spark for data processing and To stream or not to stream.
EDA for IoT Data: Exploring and visualizing data, installing R and Rstudio and Using R for statistical analysis. Solving industry – specific analysis problems.
IoT Data set augmentation: adding internal and external datasets

UNIT III   **CO3**   **11 Periods**
IoT Data Visualization and Dash boarding: common Mistakes when designing visuals the hierarchy of questions method, Designing visual analysis for IoT Data, Creating a dashboard with Tableau.
Applying Geospatial analytics to IoT Data : Basics of geospatial analysis , Vector based methods and Raster based Methods storing geospatial data. Processing geospatial Data.

UNIT IV   **CO4**   **10 Periods**
Data Science for IoT Analytics : Machine Learning, Anomaly detection using R Forecasting using ARIMA and Deep Learning
Strategies to Organize Data for Analytics: Linked Analytical Datasets , Managing Data lakes and The data retention strategy.

Textbook:

1. Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices Paperback, Andrew Minteer.

CO415   **JOEL24: ARTIFICIAL INTILIGENCE**   **L P C**

                                                                                               3 0 3

Course Objectives:

The main objectives of this course are to:
1. Introduce fundamental concepts of artificial intelligence.
2. Impart knowledge on problem solving using uninformed, informed, local and adversarial search strategies.
3. Create awareness on formalization of knowledge and reasoning.

Course Outcomes:

After successful completion of the course, students will be able to:
1. Explain the fundamental concepts of artificial intelligence
2. Apply search strategies for solving real world problems
3. Utilize game playing strategies for solving problems
4. Infer knowledge using propositional and predicate logic
5. Discuss knowledge representation of the real world using on to logics
6. Summarize the algorithms for classical planning

Course Contents:

UNIT I   **CO 1**   **10 Periods**
Introduction to AI: What Is AI?, The Foundations of AI, The History of AI, The State of the Art.
Intelligent Agents: Agents and Environments, Good Behavior : The Concept of Rationality, The Nature of Environments, The Structure of Agents.
Problem Solving by Search: Problem-Solving Agents, Example Problems, Searching for Solutions, Uninformed Search Strategies, Informed(Heuristic) Search Strategies, Heuristic Functions.

UNIT II   **CO 2**   **14 Periods**
Beyond Classical Search: Local Search Algorithms and Optimization Problems, Searching with Non-Deterministic Actions.
Adversarial Search: Games, Optimal Decisions in Games, Alpha–Beta Pruning.
Constraint Satisfaction Problems: Defining Constraint Satisfaction Problems, Constraint Propagation, Back tracking Search for CSPs, Local Search for CSPs, The Structure of Problems.

UNIT III   **CO 3**   **12 Periods**
Logical Agents: Knowledge-Based Agents, The Wumpus World, Logic, Propositional Logic, Effective Propositional Model Checking, Agents Based on Propositional Logic.
First-Order Logic: Representation Revisited, Syntax and Semantics of First-Order Logic, Using First Order Logic, Knowledge Engineering in First-Order Logic.
Inference in First-Order Logic: Propositional vs. First-Order Inference, Unification and Lifting, Forward Chaining, Backward Chaining, Resolution.

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UNIT IV   **CO 4**   **14 Periods**

Knowledge Representation: Ontological Engineering, Categories and Objects, Events. Mental Events and Mental Objects, Reasoning Systems for Categories, Reasoning with Default Information.

Automated Planning: Definition of Classical Planning, Algorithms for Classical Planning and Acting in the Real World: Time, Schedules and Resources, Hierarchical Planning.

Learning Resources:

Text Books:

1. Artificial Intelligence-A modern Approach, Stuart Russell and Peter Norvig, Fourth Edition, Pearson Education

References:

1. Artificial Intelligence, E.Rich and K.Knight, 3rdEdition., (TMH)
2. Artificial Intelligence, 3rd Edition., Patrick Henny Winston, 3rd Edition., Pearson Education.
3. A First Course in Artificial Intelligence, Deepak Khemani, Tata Mc-Grah Hill.
4. Artificial Intelligence and Expert systems–Patterson, Pearson Education.
5. Artificial Intelligence, Saroj Kaushik, CENGAGE Learning.