CURRICULUM STRUCTURE

# FINAL YEAR UG: B.E.

## ELECTRONICS AND COMPUTER SCIENCE

REVISION: FRCRCE-1-24

Effective from Academic Year 2024-25

Board of Studies Approval: 09/03/2024

Academic Council Approval: 16/03/2024

| | | |
|---|---|---|
| Dr. DEEPAK BHOIR<br>Dean Academics | Dr. SAPNA PRABHU<br>HoD (ECS) | DR. SURENDRA RATHOD<br>Principal |

# Preamble:

Greetings and congratulations to all the education partners Fr Conceicao Rodrigues College of Engineering for getting autonomous status to the college from the year 2024-25. University Grant Commission vide letter No. F. 2-10/2023(AC-Policy) dated 23rd Nov 2023 conferred the autonomous status to Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Bandra (West), Mumbai 400050 affiliated to University of Mumbai for a period of 10 years from the academic year 2024-2025 to 2033-2034 as per clause 7.5 of the UGC (Conferment of Autonomous Status Upon Colleges and Measures for Maintenance of Standards in Autonomous Colleges) Regulations,2023. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Learner, Indian Society and Industries.

All India Council for Technical Education (AICTE) has made implementation of Internship policy mandatory for students. While applying for Extension of Approval (EoA) it is desired that institute has already implemented compulsory internship for all final year students.

The National Education Policy (NEP), 2020 suggests that students must actively engage with the practical side of their learning as part of a holistic education to further improve their employability. It states that students at all HEIs will be provided with opportunities for internships with local industry and businesses as well as research internships with faculty and researchers at their own or other HEIs/research institutions. In line with the NEP and tracing the provisions of NcrF, Government of Maharashtra has subsequently released two Government Resolutions (GRs) (NEP GR dated – 1. 20 April 2023, and 2. 4 July 2023) to reinforce NEP implementation and credit revision across Maharashtra HEIs. These GRs lay out detailed guidelines for curriculum interventions.

***Fr. CRCE has taken a strategic move as a response to the NEP's call for students to engage with practical learning through internships, a practice proven to enhance employability and refine skill sets for the final year students from academic year 2024-25.***

***Following two major changes applicable for Final Year Students of 2024-25 and 2025-26 batch:***

***1. Semester long internship option***

***2. Revised assessment in the form of ISE-1, MSE, ISE-2 and ESE to be taken by the college.***

# I. Internship:

**Following are the objectives of the Internships envisaged for the students:**

- ✓ Exposing students to industrial environments that cannot be replicated in a classroom or lab.
- ✓ Providing opportunities to acquire and refine analytical and managerial skills crucial for a professional career.
- ✓ Offering hands-on experience in teamwork, thereby enhancing professional skills like communication, work ethics, conflict resolution, etc., with a lasting impact on lifelong learning and professional development.
- ✓ The general idea is to enable students to undertake immersive assignments within the organizations for a limited period.
- ✓ Establishing links between students and potential future job or research opportunities.

**Methodology of Implementation of Internship Policy for Final Year Students of 2024-25:**

**A. Completion of Existing Credits:**

1. Semester VIII will be conducted in Fast Track Mode during first week of July and winter vacation for completing Institute Level Elective common course to all the departments.
2. Each course will be conducted in a continuous training format for 10days (3hrs theory+2hours lab).
3. Honors course will be taken for two hours each day during Fast Track Mode.
4. Major project will be continued till the official semester end. Assessment of major project will be conducted in phase-wise manner. Students need to compulsorily present in person for each of the phases of assessment.
5. If required then provision for SWAYAM courses to be explored by departments
6. Assessments to be completed immediately after completion of all courses.
7. Release of Gazette and score cards will be only at the end of academic year

**B. Internship Details:**

1. Training and placement department shall contact companies and strive for providing Six months internship to all the students. Preference should be given to Internship+PPO during regular placement cycle in SEM VII.
2. Internships should be an integral part of the academic curricula. But for 2024-25 and 2025-26 batch of Final Year students, credit framework is already given by University of Mumbai. For student of these batches internship is last moment value addition and therefor it will not be a part of credit

framework. College is providing this as an additional experiential learning opportunity for the students by considering Market demand, Industry demand, Government Resolutions and Student desire.

3. Following are the types of internship opportunities that can be explored by students:
    a. Offered by Industry Govt./ NGO/MSME
    b. Research Institutes like BARC, TIFR, SAMEER and IITs
    c. At various Incubation Centres
    d. Internships offered through academic collaborations with Foreign Universities
    e. Internships offered by reputed colleges with whom MoUs are signed for the collaboration and credit exchange
    f. Or any other internship approved by HoI based on the merit of offer
4. All internships are subjected to approval of Head of the Institute. Students must take prior approval from college before starting internship
5. Students opting for Entrepreneurship or Start-up are exempted from internship; however, they have to work in the pre-incubation centre of the college to work for their start-up initiative with demonstrable output.
6. Students who wish to work on academic / industry research project (Rather than other internships) assigned under a faculty of Fr CRCE is allowed to do so provided details of work to be done and outcomes are clearly stated and approved by the college authorities.
7. Students can proceed for Internships from 15th Jan.
8. On the request of student college will issue successful completion certificate after achieving predefined approved milestones of Internship/Entrepreneurship/Research Project etc.

## Student Resources:

**Government Internship Programs**:

- ✓ AICTE Internship: https://internship.aicte-india.org/
- ✓ NITI Ayog Internship: https://www.niti.gov.in/internship
- ✓ TULP Internship Program: https://smartcities.gov.in/The_Urban_Learning_Internship_Program
- ✓ Digital India Internship: https://www.meity.gov.in/writereaddata/files/Digital%20Internship%20Scheme%202023%20%281%29.pdf
- ✓ Directorate General of Foreign Trade Internship program: https://www.dgft.gov.in/CP/?opt=intership-scheme
- ✓ National Commission for Scheduled Tribes Internship: https://ncst.nic.in/sites/default/files/2021/Internship/3677
- ✓ Corporate Affairs Ministry Internship program: https://www.mca.gov.in/bin/dms/getdocument?mds=aC%252B%252F82boz%252FD%252FdHcFkAAJ0A%253D%253D&type=open
- ✓ Finance Ministry Internship program: https://dpe.gov.in/schemes/scheme-internship

- ✓ Women and Child Development Ministry Internship program: https://wcd.nic.in/sites/default/files/Internship%20Guideline.._0.pdf
- ✓ Ministry of Culture Internship programs: https://nationalmuseumindia.gov.in/en/national-museum-internship-programme

**Online Platforms for Internships:**

- ✓ Internshala: https://internshala.com/
- ✓ LetsIntern: https://letsintern.in/
- ✓ Twenty19: http://twenty19.com.testednet.com/
- ✓ HelloIntern: https://hellointern.co/
- ✓ Freshersworld: https://www.freshersworld.com/
- ✓ Youth4work: https://www.youth4work.com/
- ✓ Freshersnow: https://www.freshersnow.com/internships-in-delhi/
- ✓ Zuno by Foundit: https://www.foundit.in/zuno/
- ✓ LinkedIn: https://www.linkedin.com/jobs/internship jobs/?currentJobId=3647611763&originalSubdomain=in
- ✓ Well Found (earlier, AngelList Talent): https://wellfound.com/location/india
- ✓ Indeed: https://in.indeed.com/jobs?q=internships&l=&vjk=fd2d4f96a2564717
- ✓ Naukri.com: https://www.naukri.com/internship-jobs
- ✓ TimesJobs: https://www.timesjobs.com/jobs-by-roles/intern-jobs
- ✓ NGO Box: https://ngobox.org/job_listing.php
- ✓ CSR Box: https://csrbox.org/

## II. Honours and Minor Degree Eligibility Criteria for Students:

i. Following is the eligibility criteria for students opting the Honours/ Minor Degree program:

a. Students with no backlog in semester I, II, and III

b. The CGPI (based on semester I, II, and III) of the students must be 6.75 and above

c. For direct second year (DSE) admitted students - No backlog in semester III and CGPI must be 6.75 and above

ii) Each eligible student can opt for maximum one Honour's or one Minor Programs at any time.

iii) However, it is optional for leaners to take Honours/Minor degree program.

iv) The Honours/ Minor degree program can be opted only during regular engineering studies

v) The student have to complete the Honours/ Minor degree program in stipulated four semesters only.

**Note:**

1. Courses offered during internship semester shall be in online mode
2. Technical support team for registration of Academic Bank of Credits (ABC), registration of elective/optional courses, registration of online courses, registration for degree options etc. under supervision of Dean Academics.

# SEMESTERWISE CURRICULUM STRUCTURE

## FINAL YEAR Electronics and Computer Science Program:

| SEM-VII | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Course Code | Course Name | | Contact Hours | Examination Marks | | | | | Credits |
| | | | | ISE1 | MSE | ISE2 | ESE | Total | Total |
| ECC 701 | VLSI Design | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECC 702 | Internet of Things | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECC DO701 | Department Level Optional Course - III | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECC DO702 | Department Level Optional Course - IV | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECC IO701 | Institute Level Optional Course- I | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECL701 | VLSI Design Lab | PR | 2 | 20 | -- | 30 | -- | 50 | 1 |
| ECL702 | Internet of Things Lab | PR | 2 | 20 | -- | 30 | -- | 50 | 1 |
| ECL703 | Department Level Optional Course - III Lab | PR | 2 | 20 | -- | 30 | -- | 50 | 1 |
| ECP701 | Major Project - I | PR | 6 | 10 | -- | 20 | 20 | 50 | 3 |
| | **Total** | | **TH:TU:PR 15:0:12** | | | **-** | **-** | **700** | **21** |

**Department Level Optional Courses:**

| Department Level Optional Course -III (DO701) | Department Level Optional Course -IV (DO702) |
|---|---|
| 1. Deep Learning | 1. Cloud Computing |
| 2. Image Processing | 2. Mobile Communication |
| 3. Big Data Analytics | 3. Cyber Security |
| 4. Advanced Database Management Systems | 4. BlockChain Technology |

| SEM-VIII | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Course Code | Course Name | | Contact Hours | Examination Marks | | | | | Credits |
| | | | | ISE1 | MSE | ISE2 | ESE | Total | Total |
| ECC 801 | Robotics | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECC DO801 | Department Level Optional Course -V | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECC DO802 | Department Level Optional Course -VI | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECC IO801 | Institute Level Optional Course- II | TH | 3 | 20 | 30 | 20 | 30 | 100 | 3 |
| ECL 801 | Robotics Lab | PR | 2 | 20 | -- | 30 | -- | 50 | 1 |
| ECL 802 | Department Level Optional Course - V Lab | PR | 2 | 20 | -- | 30 | -- | 50 | 1 |
| ECP 801 | Major Project II | PR | 12 | 20 | -- | 30 | 100 | 150 | 6 |
| | **Total** | | **TH:TU:PR 12:0:16** | | | **-** | **-** | **650** | **20** |

**Department Level Optional Courses:**

| Department Level Optional Course -V (DO801) | Department Level Optional Course -VI (DO802) |
|---|---|
| 1. MEMS Technology | 1. Advanced Networking Technologies |
| 2. Natural Language Processing | 2. Multimedia and Virtual Reality |
| 3. 3-D Printing and Design | 3. Quantum Computing |
| 4. Advanced Algorithms | 4. System Security |

**Honors Degree Offered to ECS Students from SEM-V to SEM-VIII:**

**A. Name**: **Internet of Things**

1. SEM-V: HIoTC501: IoT Sensor Technologies
2. SEM VI: HIoTC601: IoT System Design
3. SEM VII: HIoTC701: Dynamic Paradigm in IoT
4. SEM VII: HIoTSBL701: Interfacing & Programming with IoT Lab (SBL)
5. SEM VIII: HIoTC801: Industrial IoT

**B. Name Artificial Intelligence and Machine Learning**

1. SEM-V: HAIMLC501: Mathematics for AI & ML
2. SEM VI: HAIMLC601: Game Theory using AI & ML
3. SEM VII: HAIMLC701: AI & ML in Healthcare
4. SEM VII: HAIMLSBL701: AI & ML in Healthcare: Lab
5. SEM VIII: HAIMLC801: Text, Web and Social Media Analytics

**C. Name: Data Science**

1. SEM-V: HDSC501: Mathematics for Data Science
2. SEM VI: HDSC601: Statistical Learning for Data Science
3. SEM VII: HDSC701: Data Science for Health and Social Care
4. SEM VII: HDSSBL701: Data Science for Health and Social Care Lab
5. SEM VIII: HDSC801: Text, Web and Social Media Analytics

**D. Name: Blockchain**

1. SEM-V: HBCC501: Bit coin and Crypto currency
2. SEM VI: HBCC601: Blockchain Platform
3. SEM VII: HBCC701: Blockchain Development
4. SEM VII: HBCSBL701: Private Blockchain Setup Lab (SBL)
5. SEM VIII: HBCC801: DeFi (Decentralized Finance)

**E. Name: Cyber Security**

1. SEM-V: HCSC501: Ethical Hacking
2. SEM VI: HCSC601: Digital Forensic
3. SEM VII: HCSC701: Security Information Management
4. SEM VII: HCSSBL601: Vulnerability Assessment Penetration Testing (VAPT) Lab
5. SEM VIII: HCSC801: Application Security

**Minors Degree Offered to ECS Students from SEM-V to SEM-VIII:**

**A. Name**: **Robotics**

1. SEM-V: HRC501: Industrial Robotics
2. SEM VI: HRC601: Mechatronics & IoT
3. SEM VII: HRC701: Artificial Intelligence & Data Analysis
4. SEM VII: HRSBL701: Robotics and Automation Lab
5. SEM VIII: HRC801: Autonomous Vehicle Systems

**B. Name: 3D Printing**

1. SEM-V: HC3DP501: Introduction to CAD
2. SEM VI: HC3DP601: 3D Printing: Introduction & Processes
3. SEM VII: HC3DP701: Applications of 3D Printing
4. SEM VIII: H3DPSBL801: Skill Based Lab– Digital Fabrication
5. SEM VIII: HC3DP801: 3D Printing in Medical Technology

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | L | T | P | Total |
| ECC701 | VLSI Design | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | | Total |
| | | Theory | 20 | 30 | 20 | 100(30% weight-age) | | 100 |

| | | |
|---|---|---|
| **Pre-requisite Course Codes** | Electronic Devices<br>Electronic Circuits<br>Digital Electronics | |
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| **Course Outcomes** | CO1 | Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models. |
| | CO2 | Design and analyze MOS based inverters |
| | CO3 | Realize MOS based circuits using different design styles |
| | CO4 | Realize semiconductor memories, adder, multiplier and shifter circuits using CMOS logic. |
| | CO5 | Understand the flow of IC Fabrication |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| **1. VLSI Design flow and Technology Trends** | **1.1** | VLSI Design Flow: Full custom and Semi custom IC design flow | [1],[2,], [3],[5] | 5 |
| | **1.2** | Semiconductor Manufacturing: Semiconductor technology trend, clean rooms, Wafer cleaning and Gettering. Fabrication flow chart for steps in IC fabrication | [1] | |
| | **1.3** | Scaling: Types of scaling, comparison of MOSFET Model levels | [1] | |
| | **1.4** | Technology Comparison: Comparison of BJT and MOS technologies, long channel and short channel MOS devices | [1] | |
| **2. MOSFET Inverters** | **2.1** | Introduction to MOS inverters: Active and passive load NMOS inverters, CMOS inverter and their comparison | [1] | 8 |
| | **2.2** | Circuit Analysis of MOS Inverters Static Analysis of Resistive nMOS and CMOS Inverters: Calculation Of Critical Voltages and noise margins | [1] | |
| | **2.3** | Design of symmetric CMOS inverter | [1] | |
| | **2.4** | Analysis of CMOS inverter: Calculation Rise Time,fall time propagation delay | [1] | |
| | **2.5** | Various components of power dissipation in CMOS circuits | [1] | |

| | | | | |
|---|---|---|---|---|
| **3 MOS Circuit Design Styles** | **3.1** | Static CMOS | [1],[3] | 7 |
| | **3.2** | Pseudo NMOS design styles | | |
| | **3.3** | Pass transistor, Transmission gate | | |
| | **3.4** | Dynamic:$C^2$MOS | | |
| | **3.5** | Significance of Stick diagram and Design rules, Layout of CMOS NAND, CMOS NOR | | |
| **4. Combinational and Sequential Circuit Realization** | **4.1** | Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realization using equivalent CMOS inverter for simultaneous switching, Complex Boolean function realization using various design styles and Basic Gates and MUX realization using pass transistor and transmission gate logic | [2] | 7 |
| | **4.2** | SRLatch ,JK FF,DFF, 1 Bit Shift Register realization using CMOS logic | [1] | |
| **5. Semiconductor Memories** | **5.1** | SRAM:6T SRAM operation,design strategy, read/write circuits, sense amplifier, | [1],[2] | 6 |
| | **5.2** | DRAM:1T DRAM, operation modes,leakage currents,refresh operation, Physical design | [2] | |
| | **5.3** | ROM Array: NAND and NOR based ROM array | [1] | |
| | **5.4** | Flash Memory :F- N tunneling | [1] | |
| **6 Data Path Design** | **6.1** | Adder: CL Aadder, MODL, Manchester carry chain, High-speed adders: carry skip, carry select and carry save | [1],[3] | 6 |
| | **6.2** | Multipliers and shifter: Array multiplier and barrel shifter | [1],[2] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Design Contest based on various styles: 10 Marks
Seminar on Research paper (IEEE /ACM): 10 Marks

**ISE-2:**

Activity: Layout model design ( Physical as well as simulation): 10 Marks
Assignment: 10 Marks
Orals: 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. CMOS Digital Integrated Circuits Analysis and Design , Sung-MoKang and Yusuf Leblebici, TataMcGraw Hill, Revised 4thEdition.
2. Introduction to VLSI Circuits and Systems, JohnP.Uyemura,WileyIndiaPvt.Ltd.
3. SorabK.Gandhi,"VLSI FabricationPrinciples", Wiley,StudentEdition.

4. Digital Integrated Circuits: A DesignPerspective, JanM.Rabaey,Anantha Chandrakasan Borivoje Nikolic, Pearson Education, 2nd Edition
5. Basic VLSI Design, Douglas Pucknell, Kamran Eshraghian, Prentice Hall of India Private Ltd.
6. Logical Effort: Designing Fast CMOS Circuits, Ivan Sutherland BobSproulln
7. Basics of CMOS Cell Design,Etienne Sicardand Sonia Delmas Bendhia, TataMacGrawHill
8. CMOS VLSI Design: A Circuits and Systems Perspective, Neil H.E. Weste, David Harrisand Ayan Banerjee,Pearson Education
9. Analysis and Design of Digital Integrated Circuits, David Hodges, Horace Jackson ,Resve Saleh, McGraw-Hill,Inc.
10. Advanced Semiconductor Memories: Architectures, Designs,and Applications, Ashok. Sharma, Wiley Publication
11. Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond, Denny D.Tang, Chi-FengPai, Wiley online Library
12. Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications, Daniel Ielmini, Rainer Waser, Wiley online Library

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECC 702 | Internet of Things | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | | Total |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | | 100 |

| Pre-requisite Course Codes | Computer Networks Embedded Systems, Web Technologies | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand concepts, functional blocks and communication methodology relevant to IoT |
| | CO2 | Identify various components of IoT |
| | CO3 | Compare various communication protocols for IoT. |
| | CO4 | Understand various methods for data handling in IoT-based systems. |
| | CO5 | Design basic applications based on IoT using specific components. |
| | CO6 | Introduce various security issues in IoT |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction to IoT | 1.1 | Definition and Characteristics of IoT | [1],[2] | 5 |
| | 1.2 | IoT Protocols | [1] | |
| | 1.3 | IoT Functional Blocks | [1] | |
| | 1.4 | IoT Communication Models | [1] | |
| | 1.5 | IoT Communication APIs :-REST and WebSockets | [1] | |
| | 1.6 | IoT Enabling Technologies | [1] | |
| | 1.7 | Introduction to M2M and Difference between IoT and M2M | [1] | |
| 2. Components (Things) in IoT | 2.1 | Sensor Technology, Examples of Sensors | [1] | 5 |
| | 2.2 | Actuators | [1] | |
| | 2.3 | Applications of RFID and WSN in IoT | [1] | |
| | 2.4 | Exemplary Device:-R–Piandits Interfaces, PCDuino, BeagleBone | [1] | |
| 3 Data Handling in IoT | 3.1 | Data Acquiring and Storage, Organizing the Data, Transactions and Business Processes, Analytics | [1][3] | 9 |
| | 3.2 | Data Collection, Storage and Computing Using Cloud Platform,Introduction to Cloud Computing, Virtualization, Cloud Models, Cloud Services IoT Cloud-based DataCollection, Storage, Computing using Xively | [1] | |
| 4. | 4.1 | Communication Technologies–Comparison | [2] | 10 |

| | | | | |
|---|---|---|---|---|
| **Design Principles for Web Connectivity** | **4.2** | Web Communication Protocols for connected devices:- CoRE Environment,CoAP, LWM2M,MQTT,XMPP,HTTP,SOAPProtocols | [1] | |
| | **4.3** | LPWAN Fundamentals: LORA and NBIoT | [1] | |
| **5. IoT Design Methodology** | **5.1** | Defining Specifications About**:**-Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration:-Case Studies of Home automation, Weather Monitoring | [2], [3] | 6 |
| | **5.2** | IoT Levels and Deployment Templates | [1] | |
| | **5.3** | Supply Chain Management | [1] | |
| **6 IoT Security and Vulnerabilities Solutions** | **6.1** | Iot Security Tomography and Layered Attacker Model | [1] | 4 |
| | **6.2** | Identity Management, Establishment, Access Control and Secure Message Communication | [1] | |
| | **6.3** | Security Protocols | | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Assignment 10 Marks

**ISE-2:**

Activity: Quiz 10 marks
Assignment 10 marks
Seminar on research paper 10 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.
2. Raj Kamal, " Internet of Things: Architecture and Design Principles", McGraw HillEducation,First edition
3. David Haines,Gonzalosalgueiro"IoTFundamentals Networking Technologies ,Protocols and Use Cases for Internet of Tings",Cisco Press,Kindle 2017 Edition
4. Andrew Minteer,"Analytics for the Internet of Things (IoT)", Kindle Edition
5. Adrian McEwen,Hakim Cassimally,: Designing the Internet of things",Paperback, Frst Edition
6. Yashavant Kanetkar, Shrirang Korde: Paperback "21 Internet of Tings (IOT) Experiments", BPB Publications

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO 701 | Department Level Optional Course-III (Deep Learning) | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Basic Mathematics, Linear Algebra, Machine Learning | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Solve simple classification problems using Neural Networks |
| | CO2 | Explain the process of training, optimization and Regularization of Deep Neural Networks |
| | CO3 | Design supervised models for DNN |
| | CO4 | Design unsupervised model for DNN |
| | CO5 | Select suitable DNN model for a given application |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction | 1.1 | Biologicalneuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non-separable classes. | [3,4] | 5 |
| | 1.2 | Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning<br>Basic Terminologies of Deep Learning | [1] | |
| 2. Training, Optimization and Regularization of Deep Neural Network | 2.1 | **Training Feedforward DNN**<br>Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function | [1,3,4] | 8 |
| | 2.2 | **Optimization**<br>Learning with back propagation, LearningParameters :GradientDescent(GD),Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp | [1,2,3,5] | |

| | | | | |
|---|---|---|---|---|
| | **2.3** | **Regularization**<br>Overview of Over fitting, Types of biases, Bias Variance Tradeoff.Regularization Methods:L1,L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding Noise to input and output. | | |
| **3**<br>**Convolutional Neural Networks(CNN):Supervised Learning** | **3.1** | Convolution Operation, Motivation, Basic structure of a convolutional neural network: Padding, strides, pooling, fully connected layers,interleaving between layers | [1,2,3] | 8 |
| | **3.2** | Training a convolution network: Back propagation through convolution,Backpropagation as convolution with inverted filter, Convolution/ back propagation as matrix multiplication. | [1,2] | |
| | **3.3** | Modern Deep Learning Architectures:<br>LeNet, AlexNet, ZF-Net,VGGNet, GoogLe Net, ResNet | [1,2] | |
| **4.**<br>**Recurrent Neural Networks(RNN)** | **4.1** | Sequence Learning Problem, Unfolding Computational Graphs, Recurrent Neural Network, Bidirectional RNN, Backpropagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT | [1,2] | 6 |
| | **4.2** | Long Short Term Memory: Selective Read, Selective write, Selective Forget,Gated Recurrent Unit | [1,2] | |
| **5.**<br>**Autoencoders: Unsupervised Learning** | **5.1** | Introduction, Linear Autoencoder, Undercomplete Autoencoder,Overcomplete Autoencoders, Regularization in Autoencoders. | [1,2,3] | 6 |
| | **5.2** | Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders | [1,2,3] | |
| **6**<br>**Recent Trends and Applications** | **6.1** | Generative Adversarial Network(GAN): Architecture | [1,2] | 6 |
| | **6.2** | Applications: Image Compression, Brain Tumor Detection, Fraud Detection, Expression identification | [1,2] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Assignment 10 Marks

**ISE-2:**

Activity: Assignment 10 Marks
Article Discussion 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Ian Goodfellow and YoshuaBengio and Aaron Courville. Deep Learning. An MIT Press book.2016.
2. Li Deng and Dong Yu,“ Deep Learning Methods and Applications”, now publishers Inc (30June2014)
3. Satish Kumar "Neural Networks: A Classroom Approach"TataMcGraw-Hill.
4. J M Zurada “ Introduction to Artificial Neural Systems”, Jaico Publishing House
5. M.J. Kochenderfer, Tim A.Wheeler.“ Algorithms for Optimization”, MIT Press.
6. Jon Krohn, Grant Beyleveld, Aglae Bassens,“ Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence”, Pearson Education.
7. Buduma, N.and Locascio, N.,“ Fundamentals of deep learning: Designing next generation machine intelligence algorithms" 2017. O'ReillyMedia,Inc.".
8. François Chollet,“ Deep Learning with Python”, Manning Publications,2018.
9. Douwe O singa.“Deep Learning Cookbook”,O’REILLY, SPD Publishers,Delhi.
10. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International,Inc.

**Online References:**

WebsiteLinks

1. https://nptel.ac.https://deeplearning.cs.cmu.edu/S21/index.html
2. http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3. https://nptel.ac.in/courses/106/106/106106184/
4. https://www.deeplearningbook.org/
5. http://introtodeeplearning.com/
6. http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECC DO701 | Department Level Optional Course-III Image Processing | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Engineering Mathematics, Digital Signal Processing | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Represent image in its numerical and graphical form. |
| | CO2 | Perform different image enhancement approaches for improving image quality. |
| | CO3 | Elucidate the mathematical modeling of image segmentation and morphology. |
| | CO4 | Apply the concept of image compression. |
| | CO5 | Understand computer vision system elements. |
| | CO6 | Develop a computer vision system based on requirement. |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Fundamentals of Digital Image Processing | 1.1 | Introduction: Background, Representation of a Digital Image, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System. | [1], [2] | 4 |
| | 1.2 | Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Two-dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Introduction to Color Model (RGB,CMYK,YIQ,HSI). | [1] | |
| 2. Enhancement in Spatial and Frequency domain | 2.1 | Enhancement in the spatial domain: Intensity Transformations, Histogram Processing, Arithmetic and logical operations. | [1] | 10 |
| | 2.2 | Spatial Domain Filters: Smoothing Filters, Sharpening Filters, Highboost Filter. | | |
| | 2.3 | Image Transforms: 2D-DFT, FFT, DCT and Haar Transform. Frequency domain enhancement, Homomorphic filtering. | | |
| 3 Image Segmentation And Morphology | 3.1 | Image Segmentation: Detection Of Discontinuities, Edge linking and Boundary detection, Thresholding, Region Based Segmentation. | [1] | 6 |
| | 3.2 | Image Morphology: Dilation, Erosion, Opening, Closing, Hit-Or-Miss Transformation, Boundary Detection, Thinning, Thickening. | | |
| 4. Image Compression | 4.1 | Need of compression, Redundancy, Objective and subjective fidelity criteria. Lossless compression: Run Length Coding, VLC (Huffman coding), Arithmetic | [1] | 6 |

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|---|---|---|---|---|
| | | coding, LZW Coding, Vector Quantization.Lossy compression: Bit plane coding, Predictive Coding, Transform Coding, JPEG Compression standard. | | |
| **5. Computer VisionBasics** | **5.1** | Introduction, definition , Computer vision components, Boundary Pre-processing: Chaincode, Boundary approximation, Signatures, Skeletonization. | [1] | 9 |
| | **5.2** | Image Feature Extraction: Corners-Harrisand Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, Gabor Filters and DWT. Boundary feature descriptors: Basic descriptors, Shaped descriptor, Fourier descriptors, Statistical moments. Region Feature Descriptors: color, intensity and texture. | | |
| **6 Computer Vision Applications** | **6.1** | Computer Vision applications: Visual inspection of equipment, object detection like locating pedestrians, face detection and recognition, counting vehicles, content-based image retrieval, applications of computer vision in agriculture, health care, industry, sports etc. | [1] | 4 |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

**ISE-2:**

Activity: Oral 10 Marks
Assignment 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Rafael C.Gonzalez and Richard E.Woods,"Digital Image Processing," Pearson Education, edition 4,2018.
2. Anil K. Jain,"Fundamentals of Digital Image Processing," Pearson Education, 2010.
3. S. Jayaraman, T. Veerakumar, A. Esakkirajan,"Digital Image Processing,"First Edition,McGraw Hill Education,2017
4. Robert J. Schallkoff, "Digital Image Processing and ComputerVision", John Wiley and Sons,1989.
5. J. R. Parker , "Algorithms for Image Processing and Computer Vision" John Wiley and Sons,1997.
6. Computer Vision:A Modern Approach,D.A. Forsyth, J.Ponce, Pearson Education,2003
7. B.Chanda D.Dutta Majumder,"Digital Image Processing and Analysis,"Prentice Hall of India, 2002
8. William K.Pratt,"Digital Image Processing," John Wiley& Sons,2nd edition,2004
9. AlanC.Bovik,"HandbookofImage and Video Processing,"Elsevier Science Publishing CoInc,2009

10. Richard Szeliski,"Computer Vision: Algorithms and Applications,"2nd edition,The University of Washington, 2022
11. Kenneth R.Castleman, "Digital Image Processing," Pearson Education,2006.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDLO7014 | Department Level Optional Course-III Big Data Analytics | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

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|---|---|---|
| **Pre-requisite Course Codes** | Basic knowledge of Database Management System | |
| **Course Outcomes (CO):** | At the End of the course students will be able to : | |
| **Course Outcomes** | CO1 | Understand the key issues in big data management and its associated applications in intelligent business and scientific computing. |
| | CO2 | Acquire fundamental enabling techniques and scalable algorithms like Hadoop, Map reduce Nosql In Big data analytics. |
| | CO3 | Interpret business models and scientific computing paradigms, and apply software tools for big data analytics. |
| | CO4 | Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media application sect. |
| | CO5 | Develop applications for Big Data analysis using Hadoop and NoSQL etc. |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| **1. Introduction to Big Data Analytics** | **1.1** | Introduction to BigData, BigData characteristics, Types of Big Data, Traditionalvs. BigData a business approach | [1], [2] | 3 |
| | **1.2** | Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions. | [1] | |
| **2. Hadoop** | **2.1** | Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem- Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop Limitations | [1] | 5 |
| **3 NoSQL** | **3.1** | Introduction to NoSQL, NoSQL business drivers, NoSQL database case studies. | [2] | 6 |
| | **3.2** | NoSQL data architecture patterns: Key-value stores, graph stores, Column family (Bigtable) stores, Document stores,Variations of NoSQL architecture patterns. | [1] | |
| | **3.3** | Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models : master-slave vs peer-to-peer; Four ways that NoSQL systems handle big data problems, Managing MongoDB database with CRUD operations. | [2] | |

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|---|---|---|---|---|
| **4. Map Reduce** | **4.1** | MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization. | [1] | 6 |
| | **4.2** | MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures | [2] | |
| | **4.3** | Algorithms Using Map Reduce: Map Reduce Word Count Program,Matrix-Vector Multiplication by Map Reduce , Relational-Algebra Operations by Map Reduce, Matrix Operations,Matrix Multiplication by Map Reduce. | [1] | |
| **5. Techniques in Big Data Analytics** | **5.1** | Finding Similar Item: Nearest Neighbor Search,Similarity of Documents, Distance Measures: Euclidean, Jaccard, Cosine, Editand Hamming Distance with its Examples | [2].[1] | 13 |
| | **5.2** | Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis .Filtering Streams: The Bloom filter. | [1] | |
| | **5.3** | Link Analysis: Page Rank Definition, Structure Of The Web,deadends,Using Pagerank search engine , Efficient computation of Page Rank: Page Rank Implementation Using Map Reduce | [2] | |
| | **5.4** | Frequent Itemset Mining: Market- Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu | [1] | |
| **6 Big Data Analytics Applications** | **6.1** | Recommendation Systems: Introduction, AModel for Recommendation Systems: Collaborative-Filtering System, Content based system and its Examples. | [1] | 6 |
| | **6.2** | Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using Map Reduce. | [2] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Assignment -1 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks
Mind Map Activity 03 Marks

**ISE-2:**

Activity: Quiz 05 Marks Mind map Activity 5 Marks
Assignment 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Radha Shankarmani and M Vijayalakshmi ―Big Data Analytics‖, Wiley
2. Alex Holmes―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan,Mc Creary and AnnKelly―Making Sense of NoSQL–A guide for managers and their status, Manning Press.
4. Bill Franks, ―Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
5. Chuck Lam,―Hadoop in Action‖, Dreamtech Press

**E-Resources:**

1. https://www.analyticsvidhya.com/blog/2014/05/hadoop-simplified
2. https://www.analyticsvidhya.com/blog/2014/05/introduction-mapreduce/
3. https://www.pdfdrive.com/big-data-analytics-a-hands-on-approach-e158549112.html
4. https://www.pdfdrive.com/data-science-and-big-data-analytics-e58447171.html

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO701 | Department Level Optional Course-III Advanced Database Management Systems | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| | | |
|---|---|---|
| **Pre-requisite Course Codes** | Database Management System. | |
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| **Course Outcomes** | CO1 | Measure query costs and design alternate efficient paths for query execution. |
| | CO2 | Apply sophisticated access protocols to control access to the database. |
| | CO3 | Implement alternate models like Parallel and Distributed databases and Design applications using advanced models like mobile, spatial databases |
| | CO4 | Apply indexing techniques on large data in database |
| | CO5 | Apply Big data concepts in real world applications |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| **1. Query Processing and Optimization** | **1.1** | Query Optimization Overview, Measures of Query Cost Selection Operation | [1], [2] | 6 |
| | **1.2** | Sorting, Join Operation, Other Operations, Evaluation of Expressions | [1] | |
| | **1.3** | Transformation of Relational Expressions Estimating Statistics of Expression Results, Choice of Evaluation Plans | [2] | |
| **2. Advanced Data Management Techniques** | **2.1** | Advanced Database Access protocols: Discretionary Access Control Based on Granting and Revoking Privileges; | [1] | 6 |
| | **2.2** | Mandatory Access Control and Role-Based Access Control. | [3] | |
| | **2.3** | Overview of Advanced Database models like Mobile databases, Temporal databases, Spatial databases. | [1] | |
| **3 Indexing** | **3.1** | Indexed Sequential Access Method (ISAM)B+ Trees: A Dynamic Index Structure, Format of a Node | [1], [2] | 7 |
| | **3.2** | Search, insert, delete operations in B+ Tree | [1] | |
| | **3.3** | Hashing Techniques; Types of Indexes: Single Level Ordered Indexes; Multilevel Indexes; Overview of B-Trees and B+-Trees | [2] | |
| **4. Parallel Databases** | **4.1** | Architectures for Parallel Databases, Parallel Query Evaluation and Optimization, | [1] | 6 |
| | **4.2** | Data Partitioning, Parallelizing Sequential Operator Evaluation Code | [2] | |
| | **4.3** | Parallelizing Individual Operations: Bulk Loading and Scanning, sorting, joins | [2] | |

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|---|---|---|---|---|
| **5. Distributed Databases** | **5.1** | Introduction: Distributed Data Processing, What is a Distributed Database System? | [3] | 6 |
| | **5.2** | Design Issues, Distributed DBMS Architecture. | [3] | |
| | **5.3** | Distributed Database Design: Top-Down Design Process, Distribution Design Issues, Fragmentation, Allocation. | [3], [2] | |
| | **5.4** | Overview of Query Processing: Query Processing Problem, Objectives of Query Processing | [3] | |
| | **5.5** | Characterization of Query Processors, Layers of Query Processing, Query Optimization in Distributed Databases; | [2] | |
| **6 Introduction to BigData** | **6.1** | Sources and Uses of Big Data, Querying BigData | [3] | 8 |
| | **6.2** | Big Data Storage Systems: Distributed File Systems, Key-Value Storage Systems | [1], [3] | |
| | **6.3** | The Map Reduce Paradigm: Map Reduce in Hadoop with the example of word count | [1] | |
| | **6.4** | Streaming Data: Querying Streaming Data Introduction to Graph Databases | [1] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

**ISE-2:**

Activity: Assignment 10 Marks
database querying on real world application mini project 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Korth, Slberchatz, Sudarshan,:"Database System Concepts", 6thEdition, McGraw– Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition McGraw Hill
4. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom "Database System Implementation", Pearson Ltd. 1/e
5. Thomas M. Connolly Carolyn Begg, Database Systems: A Practical Approach to Design Implementation and Management, 4/e, Pearson Ltd.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO702 | Cloud Computing | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Computer networks, Basics of operating system (O.S.) | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Define cloud computing and understand different cloud services and deployment models. |
| | CO2 | Implement different types of virtualization. |
| | CO3 | Use several cloud computing services |
| | CO4 | Design of open source cloud |
| | CO5 | Identification of threats and cloud-based risks for cloud security. |
| | CO6 | Understand cloud applications and recent trends. |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 0 | | **Pre-requisites:** Basics of operating system (O.S.), ISO-OSI model and its layers | | 02 |
| 1. Introduction to Cloud Computing | 1.1 | Definition of cloud computing and cloud data centre, NIST model and cloud cube model, and characteristics of cloud computing. | [1], [2] | 04 |
| | 1.2 | Cloud deployment models (private, public, hybrid, and community) and service models (SaaS, PaaS, and IaaS). | [1], [2] | |
| | 1.3 | Impact of cloud computing on business, key drivers for cloud computing. | [1], [2] | |
| | 1.4 | Advantages and disadvantages of cloud computing | [1], [2] | |
| | | **Self-learning topics:** Comparison between cloud service providers with traditional IT service providers. | | |
| 2. Virtualization | 2.1 | Introduction and benefits of virtualization, implementation levels of virtualization, VMM. | [1], [2] | 08 |
| | 2.2 | Virtualization at O.S. level, middleware support for virtualization, virtualization structure/tools and mechanisms, hypervisor and xen architecture, binary translation with full virtualization, para virtualization with compiler support | [1], [2] | |
| | 2.3 | CPU virtualization, memory virtualization and I/O virtualization, virtualization in multicore processors, demonstration of virtualization using type II hypervisor. | [1], [2] | |

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|---|---|---|---|---|
| | | **Self-learning topics:** Comparison between virtualization and containerization (docker). | | |
| **3 Cloud Computing Services** | **3.1** | Exploring different cloud computing services: Software-as-a-Service (SaaS) (e.g., Dropbox, Google Workspace, Salesforce, etc.), Platform-as-a-Service (PaaS) (e.g., AWS Elastic Beanstalk, Windows Azure, Heroku, Google App Engine, etc.), Infrastructure-as-a-Service (IaaS) (e.g., Digital Ocean, AWS, Microsoft Azure, Google Compute Engine (GCE), etc.). | [1], [2] | 05 |
| | **3.2** | Anything-as-a-Service or Everything-as-a-Service (XaaS), Security-as-a-Service, Identity Management-as-a-Service, and Database-as-a-Service. | [1], [2] | |
| | **3.3** | Storage-as-a-Service, Collaboration-as-a Service, Compliance-as-a Service, Monitoring-as-a-Service, Communication-as-a Service, Network-as-a- Service Disaster Recovery-as-a-Service, Analytics-as-a-Service, and Backup-as-a- Service | [1], [2] | |
| | | **Self-learning topics:** Explore any 10 services offered by AWS/Microsoft Azure. | | |
| **4. Open Source Cloud Implementation of OpenStack and Eucalyptus** | **4.1** | OpenStack Cloud Architecture, Features of OpenStack, Components of OpenStack, Mode of Operations of OpenStack | [1], [2] | 07 |
| | **4.2** | Eucalyptus Architecture, Features of Eucalyptus, Components of Eucalyptus, Mode of Operations of Eucalyptus | [1], [2] | |
| | **4.3** | Installation and configuration process of OpenStack and Eucalyptus | [1], [2] | |
| | | **Self-learning topics**: Explore open source cloud and edge computing platform for an enterprise: Open Nebula. | | |
| **5. Cloud Security** | **5.1** | Security overview, cloud security challenges and risks, SaaS security, cloud computing security architecture, architectural considerations. | [1], [2] | 07 |
| | **5.2** | General issues in securing cloud, securing data, application, and virtual machine security. | [1], [2] | |
| | **5.3** | AAA model, automatic security establishing trusted cloud computing, secure execution environments and communications, access control, disaster recovery in clouds. | [1], [2] | |
| | | **Self-learning topics**: Cloud security in AWS/Microsoft Azure/Google Cloud Platform. | | |
| **6 Cloud Applications** | **6.1** | **Cloud Applications:** | [1], [2] | 06 |
| | | **Scientific Applications**:<br>**Healthcare:** ECG analysis in cloud<br>**IoT-enabled Cloud Applications:** Smart Agriculture | | |

| | | | | |
|---|---|---|---|---|
| **and Recent Trends** | | **Business and Consumer Applications:** CRM and ERP, Productivity, networking, media applications, multiplayer online gaming. | | |
| | **6.2** | **Recent Trends:** | | |
| | | Mobile cloud computing, autonomic cloud computing, multimedia cloud, energy aware cloud computing. | [1], [2] | |
| | | **Self-learning topics:** Jungle computing, Fog computing, Quantum computing | | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

(a)Assignments for 10 marks

(b)Multiple choice questions (MCQ) quiz of 10 marks for a 1 hour duration

**ISE-2:**

Student seminars based on case study application in practical, real-life domains for 20 marks, 1 hour duration

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education
2. Cloud Computing and Services by Arup Vithal, Bhushan Jadhav, StarEdu Solutions, SYBGEN Learning India Pvt. Ltd.
3. Cloud Computing: A Practical Approach forLearning and Implementation by A. Srinivasan, J.Suresh, Pearson
4. Cloud Security: A Comprehensive Guide to Secure Cloud Computing by Ronald L. Krutz,Russell Dean Vines, Wiley & Sons.
5. Cloud Computing Bible by Barrie Sosinsky, Wiley Publishing.
6. Cloud Computing Black Book by Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Deven Shah, Dreamtech Press.
7. Amazon Web Services in Action by Michael Wittig, Andreas Wittig, Manning Publisher.
8. To the cloud: cloud powering an Enterprise, Arora Pankaj, Tata Mc Graw Hill Education
9. Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Morgan Kaufmann.

**Useful Digital Links:**

1. NPTEL:https://onlinecourses.nptel.ac.in/noc22_cs20/preview
2. OpenStack Installation Guide: https://docs.openstack.org/install-guide/
3. Eucalyptus Installation: https://docs.eucalyptuscloud.org/eucalyptus/4.4.4/install-guide-4.4.4.pdf
4. AWS Management Console: https://aws.amazon.com/console/
5. https://ndl.iitkgp.ac.in NOC: Cloud Computing https://rb.gy/wyjtjx
6. https://ndl.iitkgp.ac.in NOC :Cloud Computing and Distributed Computing –Virtualization https://rb.gy/uuyzq3

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO702 | Mobile Communication | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| | | |
|---|---|---|
| **Pre-requisite Course Codes** | Analog and Digital Communication<br>Communication Networks<br>Digital Electronics | |
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| **Course Outcomes** | CO1 | Analyse the design parameters of cellular communication system |
| | CO2 | Examine various multiple access techniques and design PN-sequence generator |
| | CO3 | Describe and compare GSM and IS-95 CDMA technologies. |
| | CO4 | Summarize the underlying fundamentals of cellular technologies from 2G to 4G. |
| | CO5 | Explain services provided by network, transport and application layer in mobile communication |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| **1. Concept of Cellular Communication** | **1.1** | Introduction to cellular communications, basic propagation mechanisms and multipath fading | [1], [2] | 07 |
| | **1.2** | **Cellular System design fundamentals**: Cluster, frequency reuse, Call setup, Handoff strategies, interference and system capacity, cluster size and system capacity and Channel assignment strategies | [1], [2] | |
| | **1.3** | **Traffic Theory:** Trunking and Grade of service, Improving Coverage and capacity | [1], [2] | |
| **2. Multiple Access Techniques** | **2.1** | Multiplexing and Multiple Access: Time Division Multiple Access, Frequency Division Multiple Access, Space division multiple access technique | [1], [2] | 06 |
| | **2.2** | Spread spectrum Multiple Access: Need for and concept of spread spectrum (SS) modulation, PN-sequence generation, properties of PN-sequence, Gold-sequence generation, Direct-sequence SS, Frequency-hopping SS | [1], [2] | |
| **3 2G Technologies** | **3.1** | **GSM**: Services and features, GSM air specifications, GSM network architecture, Physical and Logical Channels, Frame structure, Identifiers, Authentication and security, call procedure, Hand-off procedure | [1], [2] | 10 |

| | | | | |
|---|---|---|---|---|
| | **3.2** | **IS-95 (CDMA):** Air specifications of IS-95, Forward and Reverse CDMA channels, Forward and Reverse CDMA channel modulation process block diagram, power control subchannel, Handoffs in IS 95 CDMA and RAKE receiver. | [1], [2] | |
| **4. Evolution from 2G to 5G** | **4.1** | GPRS, EDGE technologies, W-CDMA (UMTS), CDMA2000: features and network architectures | [1], [2] | 06 |
| | **4.2** | **LTE**: LTE System Overview, Evolution from UMTS to LTE, LTE/SAE Requirements, SAE Architecture, EPS: Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE), Introduction to 5G | [1], [2] | |
| **5. Mobile Network Layer** | **5.1** | **Mobile IP:** IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation | [1], [2] | 05 |
| | **5.2** | **Mobility Management:** Introduction, IP Mobility, Optimization, IPv6, Micro Mobility: Cellular IP | [1], [2] | |
| **6 Mobile Transport and Application Layer** | **6.1** | Mobile TCP: Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Selective Retransmission | [1], [2] | 05 |
| | **6.2** | WAP: Architecture, WDP, WTLS, WTP, WSP, WAE, WML | [1], [2] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

**ISE-2:**

Activity: Mobile computing protocol simulations 10 Marks
Assignment 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Theodore Rappaport, "Wireless Communications: Principles and Practice, 2nd Edition, Pearson Publication
2. Jochen Schiller, "Mobile Communications", 3e, Pearson Publication
3. William Stallings, "Wireless Communication and Networking", PHI Publication.
4. Vijay Garg, "IS-95 CDMA and CDMA 2000: Cellular/PCS System Implementation", Pearson Publication.
5. T.L Singal, "Wireless Communication", Tata McGraw Hill ,2010.
6. Upena Dalal, "Wireless Communication", Oxford University Press, 2009.
7. Andreas F Molisch, "Wireless Communication", John Wiley, India 2006.
8. Vijay Garg, "Wireless communication and Networking", Pearson Publication.
9. Christopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications", Wiley publications.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO702 | Cyber Security | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Computer Networks | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand the need of Cyber Security and its aspects. |
| | CO2 | Illustrate the various tools and techniques used by attackers to launch their attacks. |
| | CO3 | Identify cyber attacks and its countermeasures. |
| | CO4 | Identify various web application and Network vulnerability scanning techniques and defence methodologies |
| | CO5 | Describe the various Privacy and standard compliances with the help of real world application. |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 0 | | **Prerequisite** : Computer Networks | | 02 |
| 1. Introduction to Cyber space | 1.1 | **Cyber Crime:** Cybercrime definition, Types of Cybercrime. Classifications of cybercrime, Cyber Hygiene, Types of Hackers - Hackers and Crackers - Cyber-Attacks and Vulnerabilities - Malware threats - Sniffing - Gaining Access - Escalating Privileges - Executing Applications- Hiding Files - Covering Tracks - Worms - Trojans - Viruses - Backdoors | [1], [2] | 08 |
| | 1.2 | **Cyber Attacks**: Cyber-attack Lifecycle, social engineering, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Attacks on Wireless and mobile Networks. | [1], [2] | |
| 2. Cyber crime Attacks and Techniques | 2.1 | **Attacks Techniques**: Password Cracking, Key loggers and Spywares Steganography, Identity Theft (ID Theft),, Banner Grabbing Techniques, ransom wares, Crypto wares | [1], [2] | 08 |
| | 2.2 | network information gathering, vulnerability scanning, Virtual Private Networks(VPN),Open Port Identification, Social engineering, Types of social engineering, How cyber criminal works?, Prevention from being victim of social engineering. | [1], [2] | |
| 3 | 3.1 | attacks on WIFI and prevention, traditional techniques, theft of internet hours, Wi-Fi measures | [1], [2] | 06 |

| | | | | |
|---|---|---|---|---|
| **Cyber Attacks and Preventions** | **3.2** | attacks on Mobile phone and prevention, mobile phone theft, mobile virus, mishing, vishing, smishing, hacking bluetooth | [1], [2] | |
| **4. Web and Network Security** | **4.1** | Web Security: OWASP, Web Security Considerations, Management, Cookies, Privacy on Web, Web Browser Attacks, Web Bugs, Clickjacking, Session Hijacking and Management, Phishing and Pharming Techniques, Web Service Security | [1], [2] | 08 |
| | **4.2** | Network security:Syn-DOS:,DDOS, defenses against Denial of Service Attacks. Virtual Private Networks(VPN) | [1], [2] | |
| **5. Cyber Laws** | **5.1** | **Information Security Privacy and Standard Compliances (WR)** HIPPA,FISMA, PCI DSS, GDPR, Intellectual Property Aspect of Cyber Law, Creative Commons Library, Data Protection Laws in India. | [1], [2] | 04 |
| **6 Cyber Security Initiatives-(case studies)** | **6.1** | Online Banking, Mobile Banking Security, Security of Debit and Credit Card, UPI Security | [1], [2] | 03 |
| | **6.2** | Role of AI/ML in Cyber Security | [1], [2] | |
| | | | **Total** | **39** |

**Course Assessment:**

Theory:

**ISE-1:**

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

**ISE-2:**

Activity: Technical Report on Case study (10M)
Assignment 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Nina Godbole, Sunit Belapure, "Cyber Security-Understanding Cyber Crimes,Computer Forensics and Legal Perspective",Wiley-India,2011.
2. The Complete Cyber Security Course -Volume 1- Nathan House
3. Network Security Bible, Eric Cole, Second Edition, Wiley
4. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi
5. James Graham, Richard Howard ,Ryan Olson "Cyber Security Essentials,CRC Press,2018 print.
6. Build your own Security Lab, Michael Gregg, Wiley India
7. Computer Security, Dieter Gollman, Third Edition, Wiley

**Web References:**

1. Virtual Penetration Testing Labs- https://pentesterlab.com
2. OWASP- https://owasp.org/
3. DVWA- https://dvwa.co.uk
4. FISMA - https://csrc.nist.gov/projects/risk-management/fisma-background
5. PCI DSS ttps://www.itgovernance.eu/blog/en/a-guide-to-the-4-pci-dss-compliance-levels
6. GDPR -https://gdpr.eu/what-is-gdpr

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO702 | Blockchain Technologies | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Computer Network, Operating System, Cryptography | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Describe the primitives of the cryptography related to blockchain. |
| | CO2 | Understand and explore the working of Blockchain technology |
| | CO3 | Illustrate the concepts of Bitcoin and their usage. |
| | CO4 | Implement Ethereum block chain contract. |
| | CO5 | Explore Hyperledger Fabric and its working |
| | CO6 | Investigate security features in blockchain technologies |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction of Cryptography | 1.1 | Basic Cryptographic primitives used in Blockchain - Public Key cryptosystem, Cryptographic Hash functions: Properties of Hash, MD5, SHA 256, Hash Pointers and Data Structures, Digital Signatures: ECDSA, Public Keys as Identities, Cryptocurrencies: Goofycoin | [1], [2] | 04 |
| 2. Introduction to Blockchain | 2.1 | Centralization vs. Decentralization, What is Blockchain, History of Blockchain, Blockchain defined- peer to peer, Distributed Ledger, Cryptographically Secure, Append-only, Updatable via consensus, How Blockchain Works, Benefits and Limitations of Blockchain, Types of Blockchain, The Structure of a Block, Block header, Genesis block, Mining , Rewards, Consensus, Types of Consensus Mechanisms, Consensus in Blockchain. | [1], [2] | 07 |
| 3 Bitcoin and Cryptocurrency | 3.1 | What is Bitcoin, Private keys in Bitcoin, Public Keys in Bitcoin, Addresses in Bitcoin, Transactions, The Bitcoin Network,Bitcoin Wallets, Scripting language in Bitcoin, Bitcoin Mining- task of Bitcoin miners, Mining Hardware, Crypto Currencies, Anonymity and Pseudonymity in Bitcoin | [1], [2] | 06 |
| | 3.2 | Self Study - Alt Coins | [1], [2] | |
| 4. Introduction to Ethereum | 4.1 | Introduction to Ethereum, Ethereum's Consensus Mechanisms, MetaMask Setup, Ethereum Accounts, Ethers, Gas, Introduction to Smart Contracts, Remix IDE, Writing smart contracts using Solidity | [1], [2] | 10 |
| | 4.2 | Self Study- Geth, Ganache-Creating Wallets | [1], [2] | |

| | | | | |
|---|---|---|---|---|
| **5. Introduction to Hyperledger** | **5.1** | What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer, Transaction Flow. | [1], [2] | 06 |
| | **5.2** | Self study: Case Study of Supply Chain Management using Hyperledger | [1], [2] | |
| **6 Privacy, Security issues in Blockchain** | **6.1** | Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains (Sybil attacks, selfish mining, 51% attacks), prevention of attacks | [1], [2] | 06 |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks

Assignment 10 Marks

**ISE-2:**

Activity: Technical Paper Proposal writing on innovative techniques in blockchain 10 Marks

Assignment 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
2. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.
3. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas M Antonopoulos 2018
4. D. Drescher, Blockchain Basics. Apress, 2017.
5. Merunas Grinčelaitis, "Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum-supported Tools, Services, and Protocols", Packt Publishing.
6. Blockchain with Hyperledger Fabric,Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing.

**OTHER ONLINE REFERENCES**

1. http://www.coursera.org/learn/ibm-blockchain-essentials-for-developers
2. https://www.nptel.ac.in/courses/106105184/
3. https://www.tutorialspoint.com/blockchain/index.htm
4. https://www.udemy.com/course/build-your-blockchain-az/
5. https://www.ibm.com/downloads/cas/3EGWKGX7.
6. https://www.hyperledger.org/use/fabric
7. https://onlinecourses.nptel.ac.in/noc19_cs63/preview
8. https://andersbrownworth.com/blockchain/blockchain

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL701 | VLSI Design Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | VLSI Theory, Electronic Devices, Digital Electronics | |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course Outcomes | CO1 | Demonstrate transfer, dynamic characteristics of various digital circuits. |
| | CO2 | Understand the circuit design using various simulation tools |
| | CO3 | Demonstrate layouts for various circuits and do simulations. |
| | CO4 | Understand the variation in the behavior after extraction. |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Plot Transfer and output characteristics of NMOS and PMOS | [1] |
| 2 | For NMOS as well as PMOS devices use the ITRS technology node 32nm, 45nm, 65nm and 90nm.Simulate the device and download customized nominal model cards | [1] |
| 3 | Design CMOS inverter. Carryout static as well as transient simulation with different aspect ratio Of pull up and pull-down devices | [1] |
| 4 | Comparative analysis of the NMOS Inverter with different types of loads. | [1] |
| 5 | Find the equivalent CMOS inverter for the given 2-inputNANDandNORgates | [1] |
| 6 | Implement the given equation using various logic design style | [1] |
| 7 | Implementation of any Flip-Flop using various logic design styles | [1] |
| 8 | Simulate Minimum Sized CMOS INVERTER circuit to calculate PHLand τPLH | [1] |
| 9 | Design and Simulate 4:1 multiplexer using NMOS pass transistor | [1] |
| 10 | Design and simulate 4-bit adder/ subtractor | [1] |
| 11 | Design CMOS transmission gate and perform all the analysis to verify its Characteristics. | [1] |
| 12 | Design and Simulate 4-bit multiplier | [1] |
| 13 | Simulate and carry out comparative analysis for 6T SRAM cell with a)β= 1.5 and α=1,andb)β=1andα=1 | [1] |
| 14 | Draw the CMOS schematic and Layout of the inverter circuit, simulate layout | [1] |
| 15 | Extraction of CMOS layout and simulation of the extracted Inverter | [1] |
| 16 | Draw and simulate layout for CMOS NAND and CMOS NOR gate | [1] |

**Laboratory Assessment:**

**ISE:**

**1. ISE-1** will be conducted for four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**

a. Four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Activity: Simulation of the novel devices (10 marks)

**Recommended Books:**

1. CMOS Digital Integrated Circuits Analysis and Design , Sung-MoKang and Yusuf Leblebici, TataMcGraw Hill, Revised 4thEdition.
2. Introduction to VLSI Circuits and Systems, JohnP.Uyemura,WileyIndiaPvt.Ltd.
3. SorabK.Gandhi,"VLSI FabricationPrinciples", Wiley,StudentEdition.
4. Digital Integrated Circuits: A DesignPerspective, JanM.Rabaey, Anantha Chandrakasan Borivoje Nikolic, Pearson Education, 2nd Edition
5. Basic VLSI Design, Douglas Pucknell, Kamran Eshraghian, Prentice Hall of India Private Ltd.
6. Logical Effort: Designing Fast CMOS Circuits, Ivan Sutherland BobSproull
7. Basics of CMOS Cell Design,Etienne Sicardand Sonia Delmas Bendhia, TataMacGrawHill
8. CMOS VLSI Design: A Circuits and Systems Perspective, Neil H.E. Weste, David Harrisand Ayan Banerjee,Pearson Education
9. Analysis and Design of Digital Integrated Circuits, David Hodges, Horace Jackson ,Resve Saleh, McGraw-Hill,Inc.
10. Advanced Semiconductor Memories: Architectures, Designs,and Applications, Ashok. Sharma, Wiley Publication
11. Magnetic Memory Technology: Spin-Transfer-Torque MRAM and Beyond, Denny D.Tang, Chi-FengPai, Wiley online Library
12. Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications, Daniel Ielmini, Rainer Waser,Wiley online Library

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL702 | Internet of Things Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | | Programming Using Arduino IDE, Python programming |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course Outcomes | CO1 | Interface various sensors to any IoT device and push data onto the cloud. |
| | CO2 | Remotely control various devices using Blynk App and Node-red environment. |
| | CO3 | Implement IoT protocols to control devices remotely. |
| | CO4 | Implement services like Google Assistance, Adafruit I/O, IFTTT, Fire base etc in IoT. |
| | CO5 | Configure AWS Cloud and its Application in IoT |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Interfacing Various Sensors like LDR, ultrasonic, DHT etc (data collection) and pushing data onto Thingspeak Cloud | [1] |
| 2 | Controlling IoT devices/sensors remotely using Node-red and rpi. | [2] |
| 3 | Application of MQTT in node red | [3] |
| 4 | Control a LED Remotely Monitor Temperature values with a Raspberry Pi using Node-RED | [2] |
| 5 | Controlling IoT devices using Blynk App. | [4] |
| 6 | Temperature and Humidity monitor using Blynk | [4] |
| 7 | ESP8266 Voice Control with Google Assistant and Adafruit IO and IFTTT. | [5, 6] |
| 8 | Implementing Publish-Subscribe model using MQTT protocol and DHT11 sensor | [3, 7] |
| 9 | Google Firebase: - controlling LED using Android App | [8] |
| 10 | Publishing sensor data from ESP32 to AWS IoT Cloud. | [9] |
| 11 | Device controlling over cloud on android mobile app:-Monitoring sensor and different data on mobile phone | [9] |
| 12 | Creating an emergency push button to upload status on Facebook | [10] |
| 13 | To send Push notification to IoT device (R-pi to smartphone) | [11] |
| 14 | Google Assistant Controlled Switch Using Node MCU | [12] |
| 15 | AWS and SNS service | [13] |

**Laboratory Assessment:**

**ISE:**

**1. ISE-1** will be conducted for four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**

a. Four experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Activity: Mini- Project (10 marks)

**Recommended Books:**

1. Margolis, Michael, Brian Jepson, and Nicholas Robert Weldin. Arduino cookbook: recipes to begin, expand, and enhance your projects. O'Reilly Media, 2020.
2. https://nodered.org/
3. https://mqtt.org/
4. https://blynk.io/
5. https://www.espressif.com/sites/default/files/documentation/0a-esp8266ex_datasheet_en.pdf
6. https://io.adafruit.com/
7. https://learn.adafruit.com/dht/overview
8. https://firebase.google.com/
9. https://docs.aws.amazon.com/iot/latest/developerguide/what-is-aws-iot.html
10. https://www.facebook.com/help/977869848936797
11. https://www.raspberrypi.com/
12. https://www.nodemcu.com/index_en.html
13. https://docs.aws.amazon.com/sns/latest/dg/welcome.html

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL703 | Department Level Optional Course-III Lab (Deep Learning) | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | | Python Programming, Engineering Mathematics |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course Outcomes | CO1 | Implement basic neural network models to solve simple classification problems. |
| | CO2 | Design and train feed-forward neural networks using various optimization algorithms. |
| | CO3 | Build and train suitable deep learning models to solve a real-world problem |
| | CO4 | Select and train a suitable deep learning model to solve the real-world problem and evaluate the performance of the model with respect to the estimation of test error. |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 Based on Module1 (Any two) using Virtual Lab | Implement Perception algorithm to simulate any logic gate. | online Ref. 6 |
| | Implement Multilayer Perceptron algorithm to simulate XOR gate. | |
| | To explore python libraries for deep learning e.g. Theano, TensorFlow etc. | |
| 2 Module2 (Any Two) | Apply any of the following learning algorithms to learn the parameters of the supervised single layer feed-forward neural network.<br>a. Stochastic Gradient Descent<br>b. Mini Batch Gradient Descent<br>c. Momentum GD<br>d. Nestorev GD<br>e. Adagrad GD<br>f. Adam Learning GD | [1],[2] online ref. [2] |
| 3 Module3 (Any One) | Implement a back-propagation algorithm to train a DNN with at least 2 hidden layers. | [1],[2] online ref. [2] |
| | Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function and loss function. | |
| 4 Module4 (Any One) | Design and implement CNN model for digit recognition application. | [1],[2] online ref. [2] |
| | Design and implement CNN model for image classification. | |

| | | |
|---|---|---|
| **5 Module5 (Any One)** | Design the architecture and implement the auto-encoder model for Image Compression. | [1],[2] online ref. [2] |
| | Design the architecture and implement the auto-encoder model for Image denoising. | |
| **6 Module6 (Any One)** | Design and implement LSTM for Text/Image/Audio/Video/etc. | [1],[2] online ref. [2] |
| | Design and implement GRU for Text/Image/Audio/Video/etc. | |
| | Design and implement RNN for Text/ Image/Audio/ Video/etc. | |

**Laboratory Assessment:**

**ISE:**

**1.ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**

a. Five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Activity: Mini- Project for 10 marks

**Recommended Books:**

1. François Chollet,“ Deep Learning with Python”, Manning Publications,2018.
2. Douwe O singa.“Deep Learning Cookbook”,O’REILLY, SPD Publishers,Delhi.

**Online References:**

1. https://nptel.ac.https://deeplearning.cs.cmu.edu/S21/index.html
2. http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3. https://nptel.ac.in/courses/106/106/106106184/
4. https://www.deeplearningbook.org/
5. http://introtodeeplearning.com/
6. http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL703 | Image Processing Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | | Engineering Mathematics, Digital Signal Processing |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course Outcomes | CO1 | Enhance the quality of image in spatial and frequency domain. |
| | CO2 | Apply lossless or lossy compression techniques to reduce the size of an image. |
| | CO3 | Segment image components based on discontinuity and similarity criteria. |
| | CO4 | Extract various features from the scene for specified computer vision applications. |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Gray Level Transformation: Negative, Log, Power Law, gray level slicing, Contrast Stretching. | [1] |
| 2 | Histogram Equalization. | [1] |
| 3 | Neighborhood Processing. | [1] |
| 4 | Filtering in Frequency domain- Smoothing and sharpening. | [1] |
| 5 | 2D-DFT and DCT spectrum analysis. | [1] |
| 6 | Compression using Transform Coding(JPEG Baseline coding) with parameter evaluation(CR, MSE, PSNR etc.). | [1] |
| 7 | Morphological Operations: erosion, dilation, opening, closing, boundary detection | [1] |
| 8 | Segmentation based on discontinuity and similarity. | [1] |
| 9 | Use of transforms for face recognition. | [1] |
| 10 | Object detection using statistical moments. | [1] |
| 11 | CBIR using color, shape and texture (as an application). | [1] |
| 12 | Feature Extraction using HOG. | [1] |

**Laboratory Assessment:**

**1.ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**

a. Five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
b. Activity: Mini- Project for 10 marks

**Recommended Books:**

1. Rafael C.Gonzalez and Richard E.Woods,"Digital Image Processing," Pearson Education, edition 4,2018.
2. Anil K. Jain,"Fundamentals of Digital Image Processing," Pearson Education, 2010.
3. S. Jayaraman, T. Veerakumar, A. Esakkirajan,"Digital Image Processing,"First Edition,McGraw Hill Education,2017
4. Robert J. Schallkoff, "Digital Image Processing and ComputerVision", John Wiley and Sons,1989.
5. J. R. Parker , "Algorithms for Image Processing and Computer Vision" John Wiley and Sons,1997.
6. Computer Vision:A Modern Approach,D.A. Forsyth, J.Ponce, Pearson Education,2003
7. B.Chanda D.Dutta Majumder,"Digital Image Processing and Analysis,"Prentice Hall of India, 2002
8. William K.Pratt,"Digital Image Processing," John Wiley& Sons,2nd edition,2004
9. AlanC.Bovik,"HandbookofImage and Video Processing,"Elsevier Science Publishing CoInc,2009
10. Richard Szeliski,"Computer Vision: Algorithms and Applications,"2nd edition,The University of Washington, 2022
11. Kenneth R.Castleman, "Digital Image Processing," Pearson Education,2006.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL703 | Big Data Analytics Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | | Data warehouse and mining. |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course Outcomes | CO1 | Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop Map reduce and NoSQL in big data analytics. |
| | CO2 | Collect, manage, store, query and analyze various forms of Big Data. |
| | CO3 | Interpret business models and scientific computing paradigms, and apply software tools for big data analytics. |
| | CO4 | Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc. |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Hadoop HDFS Practical:-HDFS Basics, Hadoop Ecosystem Tools Overview. -InstallingHadoop. -Copying File to Hadoop. -Copy from Hadoop File system and delete file. –Moving and displaying files in HDFS. | [1] |
| 2 | To install and configure MongoDB/Cassandra/HBase/ Hyper table to execute NoSQLCommands. | [1] |
| 3 | Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins,Sorting, Searching, etc. | [1] |
| 4 | Write a program to implement a word count program using Map Reduce. | [1] |
| 5 | Implement Page Rank using Map-Reduce. | [1] |
| 6 | Implementing any one Clustering algorithm (K-Means/CURE) using Map-Reduce. | [1] |
| 7 | Implement Bloom Filter using any programming language | [1] |
| 8 | Perform CRUD operations in MongoDB | [1] |
| 9 | To demonstrate use of recommendation system for movie rating prediction | [1] |
| 10 | To find common friends in a social network graph using Map-Reduce. | [1] |

**Laboratory Assessment:**

**1.ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**

a. Five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Activity: Mini- Project for 10 marks

**Recommended Books:**

1. Radha Shankarmani and M Vijayalakshmi ―Big Data Analytics‖, Wiley
2. Alex Holmes―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan,Mc Creary and AnnKelly―Making Sense of NoSQL–A guide for managers and their status, Manning Press.
4. Bill Franks, ―Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
5. Chuck Lam,―Hadoop in Action‖, Dreamtech Press

**E-Resources:**

1. https://www.analyticsvidhya.com/blog/2014/05/hadoop-simplified
2. https://www.analyticsvidhya.com/blog/2014/05/introduction-mapreduce/
3. https://www.pdfdrive.com/big-data-analytics-a-hands-on-approach-e158549112.h

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL703 | Advanced Database Management Systems Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | Database Management System | |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course Outcomes | CO1 | Build index on database. |
| | CO2 | Analyze time series data using open source tools. |
| | CO3 | Perform partitioning tasks on the database. |
| | CO4 | Write codes using map-reduce technique. |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Create an index on the given tables, observe execution time of queries and record your observations. | [1] |
| 2 | Demonstrate use of grant and revoke access | [1] |
| 3 | Find the cost of queries using DBMS tools (Postgresql, MySQL, Oracle etc) | [1] |
| 4 | Data distribution and partitioning using Apache Ignite | [1] |
| 5 | Collocating computations with data using Apache Ignite | [1] |
| 6 | Time series data analysis using Temporal database like Timescale DB | [1] |
| 7 | Count number of words in a large file using map reduce | [1] |
| 8 | Compare the cost required for query execution and obtain the optimized query | [1] |
| 9 | Develop a distributed database application.(File Server Implementation using RMI) | [1] |
| 10 | Create anode and relationships using neo4j | [1] |
| 11 | Select and display data using neo4j | [1] |
| 12 | Create index and add constraints using neo4j | [1] |

**Laboratory Assessment:**

**1.ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**

a. Five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Activity: Mini- Project for 10 marks

**Recommended Books:**

1. Korth, Slberchatz, Sudarshan,:"Database System Concepts", 6thEdition, McGraw– Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition McGraw Hill
4. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom "Database SystemImplementation", PearsonLtd. 1/e
5. Thomas M. Connolly Carolyn Begg, Database Systems: A Practical Approach to Design Implementation and Management, 4/e, Pearson Ltd.

**References:**

1. https://docs.timescale.com/timescaledb/latest/tutorials/nyc-taxi-cab/#introduction-to-iot-new-york-city-taxicabs
2. https://neo4j.com/developer/get-started/
3. https://docs.timescale.com/install/latest/
4. https://hadoop.apache.org/

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO7011 | Product Life Cycle Management | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100 (30% weightage) | 100 | |

| Pre-requisite Course Codes | | -- |
|---|---|---|
| Course Outcomes (CO): | | At the End of the course students will be able to : |
| Course Outcomes | CO1 | Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation. |
| | CO2 | Illustrate various approaches and techniques for designing and developing products. |
| | CO3 | Apply Product Engineering Guidelines/ thumb rules in designing products for molding, machining, sheet metal working etc. |
| | CO4 | Acquire knowledge in applying virtual product development tools for components,machining and manufacturing plant |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction to Product Lifecycle Management (PLM): | 1.1 | Product Lifecycle Management(PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy, Change management for PLM | [1], [2] | 10 |
| 2. Product Design | 2.1 | Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post Design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process | [2] | 9 |

| | | | | |
|---|---|---|---|---|
| **3 Product Data Management (PDM):** | **3.1** | Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation | [1], [2] | 5 |
| **4. Virtual Product Development Tools** | **4.1** | For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital Mock-up, Model Building, Model analysis, Modeling and simulations in Product Design, Examples/ Case studies | [1] | 5 |
| **5. Integration of Environmental Aspects in Product Design** | **5.1** | Sustainable Development, Design for Environment, Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design | [1], [2] | 5 |
| **6 Life Cycle Assessment and Life Cycle Cost Analysis:** | **6.1** | Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution Models for Product Life Cycle Cost Analysis | [3] | 5 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. John Stark,"Product Life cycle Management: Paradigm for 21st Century Product Realization", Springer- Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice,Guido La Rosa,Antonino Risitano,"Product Design For The Environment-A Lifecycle approach", Taylor & Francis 2006, ISBN:0849327229
3. Antti, Immonen Anselmi,"Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve,"Product Life cycle Management: Driving the next generation of lean thinking", Tata Mc Graw Hill, 2006 , ISBN: 0070636265

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO7012 | Reliability Engineering | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Engineering Mathematics | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand and apply the concept of Probability to engineering problems |
| | CO2 | Apply various reliability concepts to calculate different reliability parameters |
| | CO3 | Estimate the system reliability of simple and complex systems |
| | CO4 | Carry out a Failure Mode Effect and Criticality Analysis |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. | 1.1 | **Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. | [1], [2] | 8 |
| | 1.2 | **ProbabilityDistributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. | [2] | |
| | 1.3 | **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation,Variance, Skewness and Kurtosis | [1] | |
| 2. | 2.1 | **Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, BathTub Curve. | [1] | 8 |
| | 2.2 | **Failure Data Analysis:** Hazardrate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. | [1], [2] | |
| | 2.3 | **Reliability Hazard Models:** Constant Failure Rate, Linearly Increasing, Time Dependent Failure Rate, Weibull Model. Distribution Functions And Reliability Analysis. | [2] | |
| 3 | 3.1 | **System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems. | [1] | 5 |
| 4. | 4.1 | **Reliability Improvement:** RedundancyTechniques: Element Redundancy, Unit Redundancy, And Standby Redundancies.Markov Analysis. System Reliability Analysis– Enumeration method, Cut-set method, Success Path method, Decomposition method. | [2], [3] | 8 |
| 5. | 5.1 | **Maintainability and Availability** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. | [1], [2] | 5 |

| | | | | |
|---|---|---|---|---|
| | | Availability–qualitative aspects. | | |
| **6** | **6.1** | **Failure Mode, Effects and Criticality Analysis: Failure Mode Effects Analysis, severity**/ criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fault tree analysis and Event tree Analysis | [3] | 5 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks
**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. L.S.Srinath, "Reliability Engineering", Affiliated East-West Press (P) Ltd., 1985.
2. Charles E.Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill.
3. B.S.Dhillon, C.Singh,"Engineering Reliability", John Wiley & Sons,1980.
4. P.D.T.Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985.
5. K.C. Kapur, L.R. Lamberson,"Reliability in Engineering Design", John Wiley& Sons.
6. Murray R. Spiegel, "Probability and Statistics", Tata Mc Graw-Hill Publishing Co. Ltd.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO7013 | Management Information System | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Data Warehouse and mining | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Explain how information systems Transform Business |
| | CO2 | Identify the impact information systems have on an organization |
| | CO3 | Describe IT infrastructure and its components and its current trends |
| | CO4 | Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making |
| | CO5 | Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. | 1.1 | Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, and Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS. | [1] | 4 |
| 2. | 2.1 | Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management.<br>Business Intelligence(BI): Managers and Decision Making, BI for Data analysis and Presenting Results | [1], [2] | 7 |
| 3 | 3.1 | Ethical issues and Privacy: Information Security.Threat to IS, and Security Controls | [1] | 7 |
| 4. | 4.1 | SocialComputing (SC): Web2.0 and 3.0, SCan business-shopping, Marketing, Operational and Analytical CRM, E-business and E-commerce – B2B B2C. Mobile commerce. | [2] | 7 |
| 5. | 5.1 | Computer Networks Wired and Wireless Technology, Pervasive Computing, Cloud computing model. | [3] | 6 |
| 6 | 6.1 | Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support Business Process, Acquiring Information Systems and Applications: Various System development lifecycle models. | [1] | 8 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Kelly Rainer, Brad Prince, Management Information Systems, Wiley
2. K.C. Laudon and J.P.Laudon, Management Information Systems: Managing The Digital Firm, 10thEd. Prentice Hall, 2007.
3. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall, 2008

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO7014 | Design of Experiments | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Plan data collection, to turn data into information and to make decisions that lead to appropriate action |
| | CO2 | Apply the methods taught to real life situations |
| | CO3 | Plan, analyze, and interpret the results of experiments |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction | 1.1 | Strategy of Experimentation | [1] | 6 |
| | 1.2 | Typical Applications of Experimental Design | [1] | |
| | 1.3 | Guidelines for Designing Experiments | [1] | |
| | 1.4 | Response Surface Methodology | [1] | |
| 2. Fitting Regression Models | 2.1 | Linear Regression Models | [1],[2] | 8 |
| | 2.2 | Estimation of the Parameters in Linear Regression Models | [1],[2] | |
| | 2.3 | Hypothesis Testing in Multiple Regression | [1],[2] | |
| | 2.4 | Confidence Intervals in Multiple Regression | [1],[2] | |
| | 2.5 | Prediction of new response observation | [1],[2] | |
| | 2.6 | Regression model diagnostics | [1],[2] | |
| | 2.7 | Testing for lack off it | [1],[2] | |
| 3 Two-Level Factorial Designs and Analysis | 3.1 | The $2^2$Design | [3] | 7 |
| | 3.2 | The $2^3$ Design | [3],[4] | |
| | 3.3 | The General $2^k$Design | [4] | |
| | 3.4 | A Single Replicate of the $2^k$Design | [1],[2] | |
| | 3.5 | The Addition of Center Points to the $2^k$Design, | [2] | |
| | 3.6 | Blocking in the$2^k$Factorial Design | [1] | |
| | 3.7 | Split-Plot Designs | [1],[2] | |
| 4. Two-Level Fractional Factorial Design And Analysis | 4.1 | The One-Half Fraction of the $2^k$Design | [3] | 7 |
| | 4.2 | The One-Quarter Fraction of the$2^k$Design | [2] | |
| | 4.3 | The General 2k-pFractionalFactorialDesign | [1],[2] | |
| | 4.4 | Resolution III Designs | [2] | |
| | 4.5 | Resolution IV and V Designs | [2] | |

| | | | | |
|---|---|---|---|---|
| | **4.6** | Fractional Factorial Split-Plot Designs | [3] | |
| **5. Conducting Tests** | **5.1** | Testing Logistics | [1],[2] | 7 |
| | **5.2** | Statistical aspects of conducting tests | [1] | |
| | **5.3** | Characteristics of good and bad datasets | [1],[2] | |
| | **5.4** | Example experiments | [1],[2] | |
| | **5.5** | Attribute Vs Variable datasets | [2] | |
| **6 Taguchi Approach** | **6.1** | Crossed Array Designs and Signal-to-Noise Ratios | [6] | 4 |
| | **6.2** | Analysis Methods | [6] | |
| | **6.3** | Robust design examples | [6] | |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley& Sons, New York, 2001
2. D.C.Montgomery, Design And Analysis Of Experiments,5th edition, John Wiley & Sons, New York, 2001
3. George EPBox, JStuart Hunter, William G Hunter, Statistics for Experimenters: Design, Innovation And Discovery, 2ndEd. Wiley
4. WJ Diamond, Practical Experiment Designs for Engineers and Scientists, John Willy and SonsInc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer texts in Statistics), Springer by A.M. Dean, and D. T. Voss
6. Phillip J Ross,"Taguchi Techniques for Quality Engineering,"McGraw Hill
7. Madhav Phadke,"Quality Engineering using Robust Design,"Prentice Hall

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO7015 | Operations Research | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | | Engineering Mathematics |
|---|---|---|
| Course Outcomes (CO): | | At the End of the course students will be able to : |
| Course Outcomes | CO1 | Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness. |
| | CO2 | Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change. |
| | CO3 | Solve specialized linear programming problems like the transportation and assignment problems; solve network models like the shortest path, minimum spanning tree, and maximum flow problems. |
| | CO4 | Understand the applications of integer programming and queuing model and compute important performance measures |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction to Operations Research | 1.1 | **Introduction to Operations Research**: Introduction, Structure of the Mathematical Model, Limitations of Operations Research<br>**Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method,Simplex Method Penalty Cost Method or BigM-method, Two Phase Method, Revised Simplex Method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complementary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis<br>**Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's Approximation Method. Optimality Test: the stepping stone method and MODI method.<br>**Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing Jobs Through Two Machines And Machines, Graphical Method of Two Jobsm Machines Problem Routing | [1] | 14 |

| | | | | |
|---|---|---|---|---|
| | | Problem, Travelling Salesman Problem<br>**Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's Cutting Plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms. | | |
| **2. Queuing models** | **2.1** | **Queuing Models**: queuing systems structures, single server multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population | [1], [2] | 5 |
| **3 Simulation**: | **3.1** | **Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Application of Simulation, Advantages of Simulation, Limitations of Simulation | [1] | 5 |
| **4. Dynamic programming** | **4.1** | **Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management Employment Smoothening, capital budgeting, Stagecoach/ Shortest Path, cargo loading and Reliability problems | [2] | 5 |
| **5. Game Theory** | **5.1** | **GameTheory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2X2 games | [1], [2] | 5 |
| **6 Inventory Models** | **6.1** | **Inventory Models**: Classical EOQModels, EOQModel with Price Breaks, EOQwith Shortage, Probabilistic EOQ Model, | [2] | 5 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**

Assignments for 10 marks

Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**

Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Taha, H. A. "Operations Research- An Introduction",Prentice Hall, (7thEdition),2002.
2. Ravindran, A, Phillips, D. Tand Solberg,J.J."Operations Research: Principles and Practice", John Willey and Sons, 2nd Edition, 2009.
3. Hiller, F.S.and Liebermann,G.J."Introduction to Operations Research", Tata Mcgraw Hill, 2002.
4. Operations Research, S. D.Sharma, Kedar Nath Ram Nath- Meerut.
5. Operations Research, Kanti Swarup, P.K. Gupta and Man Mohan, Sultan Chand & Sons.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO7016 | Cyber Security and Laws | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Computer Networks and cyber security | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand the concept of cyber crime and its effect on outside world |
| | CO2 | Interpret and apply IT law in various legal issues |
| | CO3 | Distinguish different aspects of cyber law |
| | CO4 | Apply Information Security Standards compliance during software design and development |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction to Cyber crime | 1.1 | Cyber crime definition and origins of the world, Cybercrime And Information security, Classifications Of Cyber Crime,Cybercrime And The Indian ITA2000, A Global Perspective On Cyber Crimes. | [1] | 4 |
| 2. Cyber offenses & Cybercrime | 2.1 | How criminal plan the attacks, Social Engg, Cyberstalking, Cybercafé and Cybercrimes, Botnets, Attackvector, Cloud Computing, Proliferation of Mobile and Wireless Devices,Trends In Mobility, Credit Card Frauds Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/CellPhones, Mobile Devices:Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues,Organizational Security Policy and Measure in Mobile Computing Era, Laptops | [1], [2] | 9 |
| 3 Tools and Methods Used in Cyberline | 3.1 | Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQLInjection, Buffer OverFlow, Attacks onWireless Networks, Phishing, Identity Theft (IDTheft) | [1], [2] | 6 |
| 4. The Concept of Cyberspace | 4.1 | E-Commerce, The Contract Aspects In Cyber Law, The Security Aspect of Cyber Law , The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law ,The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking, The Need for an Indian Cyber Law | [3] | 8 |

| | | | | |
|---|---|---|---|---|
| **5. Indian IT Act.** | **5.1** | Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, ITS Act. 2008 and its Amendments | [1], [2] | 6 |
| **6 Information Security Standard compliances** | **6.1** | SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI. | [1] | 6 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2**:
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi
2. The Indian Cyber Law by Suresh T. Vishwanathan ; Bharat Law House New Delhi
3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi.
4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
5. Nina Godbole, Information Systems Security, Wiley India, New Delhi
6. Kennetch J. Knapp, Cyber Security & Global Information Assurance Information Science Publishing.
7. William Stallings,Cryptography And Network Security, Pearson Publication

Website References

1. The Information Technology ACT 2008-TIFR : https://www.tifrh.res.in
2. Website For More Information , A Compliance Primer for IT professional
3. https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO7017 | Disaster Management and Mitigation measures | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | | Total |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | | 100 |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Get to know natural as well as man made disasters and their extent and possible effects on the economy. |
| | CO2 | Plan of national importance structures based upon the previous history. |
| | CO3 | Get acquainted with government policies, acts and various organizational structures associated with an emergency. |
| | CO4 | Get to know the simple do's and don'ts in such extreme events and act accordingly. |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction | 1.1 | Definition of Disaster, hazard, global and Indianscenario, and general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change. | [1], [2] | 3 |
| 2. Natural Disaster and Man made disasters: | 2.1 | Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion | [2] | 9 |
| | 2.2 | Man Made Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of man made disasters. | [1], [2] | |
| 3 Disaster Management, Policy and Administration | 3.1 | Disaster Management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm Shift in disaster management. | [1] | 6 |
| | 3.2 | Policy and administration:<br>Importance and principles of disaster management policies, command and co-ordination of disaster management, rescue operations-how to start with and how to proceed in due course of time, study of low charts showing the entire process. | [1], [2] | |

| | | | | |
|---|---|---|---|---|
| **4. Institutional Framework for Disaster Management in India:** | **4.1** | Importance Of Public Awareness, Preparation and Execution Of Emergency Management programme. Scope and responsibilities of National Institute of Disaster Management (NIDM) and National Disaster Management Authority (NDMA) in India. Methods and measures to avoid disasters, Management of casualties, set up facilities, importance of effective communication amongst different agencies in such situations. | [3] | 6 |
| | **4.2** | Use of Internet and software for effective disaster management. Applications of GIS, Remote sensing and GPSin this regard. | [2] | |
| **5. Financing Relief Measures:** | **5.1** | Ways To Raise Finance For Relief Expenditure, role of government agencies and NGOs in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGOs and the works they have carried out in the past on the occurrence of various disasters, Ways To Approach these teams. | [5], [6] | 9 |
| | **5.2** | International relief aid agencies and their role in extreme events. | | |
| **6 Preventive and Mitigation Measures:** | **6.1** | Pre-disaster, during disaster and post-disaster measures in some events in general | [1], [2] | 6 |
| | **6.2** | Structural mapping: Risk Mapping, assessment analysis, seawalls and embankments, Bioshield, shelters, early warning and communication | [2] | |
| | **6.3** | Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. | [1], [3] | |
| | **6.4** | Do's and don'ts in case of disasters and effective implementation of relief aids. | [3] | |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. 'Disaster Management' by HarshK.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India by. S.Dagur, publishedby Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by By Damon Coppola, Butterworth Heinemann Elsevier Publications.
4. Disaster Management Handbook biJak Pinkowski, CRCPress Taylor and Francis Group.
5. Disaster Management & rehabilitation Rajdeep Dasgupta, Mittal Publications, NewDelhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation–RBSingh, Rawat Publications
7. Concepts and Techniques of GIS–C.P.Lo Albert, K.W.Yonng–PrenticeHall (India) Publications.

(Learners are expected to refer reports published at national and International level and updated information available on authentic websites)

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO 7018 | Energy Audit and Management | L | T | P | L | T | P | Total |
| | | 03 | -- | -- | 03 | -- | -- | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | To identify and describe the present state of energy security and its importance. |
| | CO2 | To identify and describe the basic principles and methodologies adopted in energy audit of a utility. |
| | CO3 | To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. |
| | CO4 | To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities |
| | CO5 | To analyze the data collected during performance evaluation and recommend energy saving measures |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Energy Scenario | 1.1 | Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance | [1] | 4 |
| 2. Energy Audit Principles | 2.1 | Definition, Energy audit-need, Types of energy audit , Energy management (audit) approach- understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, Maximizing System Efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring & targeting; Energy audit Instruments; Data And Information-analysis.<br>Financial Analysis Techniques: Simple Payback Period, NPV, Return on investment (ROI), Internal rate of return (IRR) | [2] | 8 |
| 3 Energy Management and Energy Conservation in Electrical System | 3.1 | Electricity Billing, Electrical load management and maximum demand Control Power Factor Improvement, Energy efficient equipment and appliances ,star ratings.<br>Energy Efficiency Measures In Lighting System, Lighting Control: Occupancy sensors, daylight integration, and use of intelligent controllers. | [1], [2] | 10 |

| | | | | |
|---|---|---|---|---|
| | | Energy Conservation Opportunities In: water pumps, industrial drives, induction motors, motor retrofitting,soft starters, variable speed drives. | | |
| **4. Energy Management and Energy Conservation in Thermal Systems** | **4.1** | Review Of Different Thermal Loads; Energy Conservation Opportunities In: Steam Distribution System, Assessment Of Steam Distribution Losses, Steam leakages, Steam Trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities. | [3] | 10 |
| **5. Energy Performance Assessment** | **5.1** | On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis. | [1], [2] | 4 |
| **6 Energy conservation in Buildings** | **6.1** | Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application Of Non-Conventional and Renewable Energy Sources | [6] | 3 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus
**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Handbook of Electrical Installation Practice,Geofry Stokes, Blackwell Science
2. Designing With Light: Lighting Handbook, ByAnil Valia,LightingSystem
3. Energy Management Handbook, By W.C. Turner, John Wileyand Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi,
5. Tata Energy Research Institute (TERI).
6. Energy Management Principles,C.B.Smith,Pergamon Press
7. Energy Conservation Guidebook, Dale R.Patrick,S.Fardo, Ray E.Richardson, Fairmont Press
8. Handbook of Energy Audits, Albert Thumann, W.J. Younger,T. Niehus, CRCPress

**Website References**

1. www.energymanagertraining.com
2. www.bee-india.nic.in

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ISP701 | Major Project – I | L | T | P | L | T | P | Total |
| | | | -- | 6 | | -- | 3 | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 10 | -- | 20 | 20 | 50 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Identify problems based on societal /research needs. |
| | CO2 | Apply Knowledge and skill to solve societal problems in a group. |
| | CO3 | Develop interpersonal skills to work as a member of a group or leader. |
| | CO4 | Draw the proper inferences from available results through theoretical/Experimental/simulations. |
| | CO5 | Analyze the impact of solutions in societal and environmental context for sustainable development. |
| | CO6 | Use standard norms of engineering practices |
| | CO7 | Excel in written and oral communication. |
| | CO8 | Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. |
| | CO9 | Demonstrate project management principles during project work. |

**Guidelines for Major Project**

- Students should form groups with minimum 2(two) and not more than 4 (four)
- Students should do survey and identify needs, which shall be converted into problem statements for major projects in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit an implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major projects.
- A log book to be prepared by each group, wherein the group can record weekly work progress, a guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during major project activity; however, focus shall be on self-learning.
- Students in a group shall understand problems effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

**Review/progress monitoring committee may consider the following points for assessment.**

In VII semester the entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on the presentation given by the student group.

First shall be for finalization of problem

Second shall be on finalization of the proposed solution of the problem.

**Assessment criteria of Major Project-I**

Major Project-I shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness

**Guidelines for Assessment of Major Project Practical/Oral Examination:**

Report should be prepared as per the guidelines issued by the University of Mumbai.

Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution. Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

**Major Project-I shall be assessed based on following points;**

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication

**Course Assessment:**

**ISE:** Final ISE marks will be average of ISE1 and ISE 2

1.**ISE-1** will be conducted in mid semester for 25 marks

2.**ISE-2**

a. will be conducted by the end of the semester for 25 marks.

**ESE:** Final Oral/Presentation 25 Marks

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECC801 | Robotics | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Engineering Mathematics, Controls and Instrumentation | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Describe the basics of Robotics |
| | CO2 | Describe and derive kinematics and dynamics of stationary and mobile robots. |
| | CO3 | Apply trajectory planning algorithms |
| | CO4 | Describe concepts of robot motion planning algorithms |
| | CO5 | Apply image processing in robotic vision |
| | CO6 | Identify suitable Robot language based on applications |

| Module No. | Unit No. | Topics | Ref. | Hrs |
|---|---|---|---|---|
| 1. Fundamentals of Robotics | 1.1 | Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Specification Notations, Applications | [1], [2,], [4], [5] | 4 |
| 2. Direct Kinematics | 2.1 | Dot and Cross Products, Co-ordinate frames, Rotations, Homogeneous Co-ordinates, Link Co-ordinates, Arm Equation (3 axis and4axisRobots) | [1] | 8 |
| 3. Inverse Kinematics and Work Space Analysis | 3.1 | General properties of solutions, Tool Configuration, Inverse kinematics of 3axis, 4 axis and 5 axis Robots, Work Space Analysis of 3 axis and 4 axis Robots, Work Envelope. | [1] | 7 |
| 4. Trajectory planning | 4.1 | Basics of Trajectory planning ,Joint-space trajectory planning, Pick and place operations, Continuous path motion, Interpolated motion, Straight line motion | [1] | 4 |
| 5. Task Planning | 5.1 | Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, BUG1,BUG2andTangent Bug Algorithms | [1] | 7 |
| 6. | 6.1 | Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform. | [1] | 9 |

| | | | | |
|---|---|---|---|---|
| **Robot Vision and Robot Languages** | **6.2** | Robot language, Classification of Robot languages, Computer control and Robot software, Variable Assembly Language system and language | [1] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

(a)Tutorial of 10 marks based on numerical examples related to preliminary mathematical concepts, forward & reverse kinematics & trajectory planning for a 2 hour duration

(b)Multiple choice questions (MCQ) quiz of 10 marks for a 1 hour duration

**ISE-2:**

(a)Student seminars based on case study application of robotics technology in practical, real-life domains for 15 marks, 1 hour duration

(b)Assignment (thought-provoking) for 05 marks, 30 minutes duration

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Robert Shilling, "Fundamentals of Robotics- Analysis and control, Prentice Hall of India,2009
2. Saeed Benjamin Niku, "Introduction to Robotics –Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011
3. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control", Wiley India Pvt. Ltd. 2006
4. Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications", McGraw Hill , New York, 2008
5. S. R. Deband Sankha Deb, "Robotics Technology and Flexible Automation", Second Edition. TMH
6. John J. Craig,"Introduction to Robotics –Mechanics & Control", Third Edition, Pearson Education,India,2009

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO801 | MEMS Technology | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| | | |
|---|---|---|
| **Pre-requisite Course Codes** | Controls and Instrumentation<br>Embedded Systems and RTOS | |
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| **Course Outcomes** | CO1 | Understand the different MEMS devices, working principles, materials and their properties. |
| | CO2 | Design and simulate MEMS devices using standard simulation tools. |
| | CO3 | Develop different concepts of MEMS sensors and actuators for real-world applications. |
| | CO4 | Understand the rudiments of Micro-fabrication techniques. |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| **1. Introduction to MEMS** | 1.1 | Introduction to MEMS and Micro Electronics Technologies. | [1], [2,], [4], [5] | 4 |
| | 1.2 | MEMS in Real world applications such as Air-Bag, DMD, Pressure Sensors, MEMS Challenges, MEMS Sensors in Internet of Things (IoT), Bio-medical applications. | [1] | |
| **2. MEMS Materials and Their Properties** | 2.1 | Use of Si, SiO2, SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt in building MEMS applications. | [1] | 7 |
| | 2.2 | Material properties such as Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Thermoelectricity. | [1] | |
| **3. MEMS Sensors and Actuators** | 3.1 | Types MEMS Sensing (Capacitive, Piezo electric Piezo resistive) | [1] | 8 |
| | 3.2 | Micro Actuation Techniques (Thermal, Piezo electric, Electro static), Shape Memory Alloys, Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps. | [1] | |
| **4.** | 4.1 | MEMS Processes & Process parameters: Bulk & Surface Micromachining, High Aspect Ratio MEMS (LIGA) . | [1] | 8 |

| | | | | |
|---|---|---|---|---|
| **MEMS Fabrication Processes** | 4.2 | X-Ray Lithography, Photolithography, PVD, Wet etching, Dry etching, Plasma etching, DRIE, Etch Stop Techniques, Die, Wire & Wafer Bonding, Dicing, Packaging. | [1] | |
| **5. MEMS Devices** | 5.1 | Construction and working and applications of basic Cantilever structure, Micro heaters, Accelerometers, Pressure Sensor , Micromirrors in DMD, Inkjet printer, Steps involved in fabrication of above devices. | [1] | 9 |
| | 5.2 | Pipelining, Pipeline Performance metrics, Pipeline Hazards | [1] | |
| **6. MEMS Reliability** | 6.1 | Reliability and various failure mechanisms for MEMS. | [1] | 3 |
| | 6.2 | Reliability curve. | [1] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Contest based type of fabrications, material and Applications: 10 Marks
Seminar on Research paper (IEEE /ACM): 10 Marks

**ISE-2:**

Activity: Quiz based on testing of MEMS devices: 10 Marks
Assignment: 10 Marks
Orals: 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. An Introduction to Micro-electromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc.
2. Micro-system Design - by S. Senturia; Publisher: Springer.
3. Introduction to Electromechanical system design –by James J Allen. Taylor & Francis Group, LLC publication
4. Fundamentals of Micro-fabrication - by M. Madou; Publisher: CRC Press; 2nd edition.
5. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDLO 8012 | Natural Language Processing | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Engineering Mathematics, Machine Learning | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Describe the mathematical and linguistic preliminaries necessary for various processes in NLP |
| | CO2 | Perform Word-Level and Syntax-Level analysis on a natural language |
| | CO3 | Analyze the natural language at the Semantic Level |
| | CO4 | Explain of Pragmatics in NLP |
| | CO5 | Apply NLP techniques to design real-world NLP applications |

| Module No. | Unit No. | Topics | Ref. | Hrs |
|---|---|---|---|---|
| 1. Introduction to Natural Language Processing | 1.1 | The need of NLP. Generic NLP system, Levels of NLP | 1 | 6 |
| | 1.2 | Stages in building a Natural Language Processing System. Challenges and ambiguities in NLP Design | 1 | |
| 2. Mathematical and Linguistic Preliminaries | 2.1 | Probability Theory, Conditional Probability and Independence, Bayes Rule, Random Variables, Probability Distributions, Statistics, Counting, Frequency, Mean and Variance | 1 | 6 |
| | 2.2 | English Grammar, Parts of Speech, Phrase Structures | 1,4 | |
| 3. Word Level Analysis | 3.1 | Tokenization, Segmentation, Lemmatization, Edit Distance, Collocations, Porter Stemmer, N-gram Language Model | 1,2 | 6 |
| | 3.2 | Morphological Analysis, Derivational and Reflectional Morphology | 1,2 | |
| 4. Syntax-Analysis | 4.1 | Tag set for English, Penn Tree bank, Introduction to Parts of Speech Tagging (POST) | 1,2 | 8 |
| | 4.2 | Markov Processes, Hidden Markov Models (HMM) | 1,2 | |
| | | Parts of Speech Tagging using Hidden Markov Models, Viterbi Algorithm | | |

| | | | | |
|---|---|---|---|---|
| **5. Semantic Analysis** | 5.1 | Lexical Semantics, ambiguous words, word senses, Relations between senses: synonym, antonym, reversives, hyponym, hypernym, meronym, structured polysemy, metonymy, zeugma | 1 | 8 |
| | 5.2 | Introduction to WordNet, gloss, synset, sense relations in WordNet. Cosine distance between documents. Word sense disambiguation. | 1 | |
| **6. Pragmatics and applications of NLP** | 6.1 | Reference resolution: Discourse model, Reference Phenomenon, Syntactic and Semantic Constraints on co reference | 1 | 5 |
| | 6.2 | Applications of NLP: Categorization, Summarization, Sentiment Analysis, Named Entity Recognition, Machine Translation, Information Retrieval, Question Answer System | 1,4 | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Assignment 10 Marks

**ISE-2:**

Activity: Assignment 10 Marks
Article Discussion 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Daniel Jurafsky, James H. Martin, Speech and Language Processing‖ Second Edition, Prentice Hall.
2. Christopher D. Manning & Hinrich Schutze, Foundations of Statistical Natural Language Processing, MIT Press.
3. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
4. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), The Handbook of Computational Linguistics and Natural Language Processing

**NPTEL / Swayam Course:**

1. Course: Natural Language Processing By Prof. Pawan Goyal, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_cs102/preview
2. Course: Applied Natural Language Processing By Prof. Ramaseshan R, CMI

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO801 | 3D Printing and Design | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Repeat the concept of Additive Manufacturing |
| | CO2 | Describe the Various different AM Processes |
| | CO3 | Demonstrate the concept of Direct Digital Manufacturing |
| | CO4 | Demonstrate the Concept of Design for Additive Manufacturing |
| | CO5 | Implement RE Technologies |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction | 1.1 | Additive Manufacturing Fundamentals, Historical Development, Commonly Used Terms, Definitions, AM Manufacturing Process, Classification of AM processes (As per ASTM F42 and ISO TC 261). Subtractive Manufacturing vs Additive manufacturing. Benefits of Additive Manufacturing. AM technology in Product Development | [1], [2,], [4], [5] | 5 |
| | 1.2 | Applications of AM: Engineering, Planning, Aerospace, Automotive, Jewellery, Architecture, Arts, Medical, Bio Engineering | [1] | |
| 2. Additive Manufacturing systems | 2.1 | Vat Polymerisation, Powder Bed Fusion Based AM, Material Extrusion based, Material Jetting Based, Binder Jetting Based, Sheet Lamination based, Direct Energy Deposition based | [1] | 10 |
| 3. Direct Digital Manufacturing | 3.1 | Direct Digital Manufacturing(DDM) : Concept of DDM, Applications with Case Studies, DDM Drivers, Cost estimation: Cost Model, Build Time Model, Life-cycle costing, Future of DDM | [1] | 6 |
| 4. Design for Additive Manufacturing | 4.1 | Design for Additive Manufacturing AM unique Capabilities: Shape Complexity, Heirarchical Complexity, Functional Complexity and Material Complexity. | [1] | 6 |

| | | | | |
|---|---|---|---|---|
| | 4.2 | Core DFAM Concepts and Objective : Complex Geometry, Integrated Assemblies, Customized Geometry, Multi-functional Design, Elimination of Conventional Design for Manufacturing Constraints | [1] | |
| **5. Rapid Proto-typing** | 5.1 | Rapid Prototyping Data Formats : STL, File Format Problems and Limitations, Consequence of Building valid and Invalid Tessellated model, | [1] | 6 |
| | 5.2 | STL File repair, Newly Proposed File Formats. Rapid Proto-typing software Features of various Software.. | [1] | |
| **6. Reverse Engineering** | 6.1 | Reverse Engineering (RE): Introduction to Generic RE Process, RE Hadware and Software. Integration of RE and RP for Layer Based Model Generaion, Application and Case Studies of RE in Automotive, Aerospace, Medical, Architectural industry, Barriers for adopting RE | [1] | 6 |
| | 6.2 | Other Related technologies: Reverse Engineering , Computer Aided Engineering, Haptic Feedback Based CAD | [1] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Assignment 10 Marks

**ISE-2:**

Activity: Assignment 10 Marks
Article Discussion 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Book:**

1. Fundamentals of Digital Manufacturing science, Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, Springer 2012
2. Additive Manufacturing Technologies, Ian Gibson, David Rosen, Brent Stucker, Springer
3. Understanding Additive Manufacturing, Andreas Gebhardt, Hanser Publication, ISBN-13:978-1-56990-507-4
4. Rapid Manufacturing: An Industrial Revolution fo the digital Age, N. Hopkins, R.J.M. Hague and P.M. Dickens (Eds.), John Wiley and Sons, 2006
5. Rapid Proto-typing Principles and Applications, Chua C. K., Leong K. F., and Lim C.S. , 2nd edition , World Scientific, 2003
6. Rapid Proto-typing Theory and Practice, Ali Kamrani and EmadAbouel Nasr (Eds.), Springer, 2006

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | L | T | P | **Total** |
| | | 3 | -- | | 3 | -- | | **3** |
| | | **Examination Scheme** | | | | | | |
| | | | **ISE1** | **MSE** | **ISE2** | **ESE** | **Total** | |
| **ECCDO801** | **Advanced Algorithms** | Theory | 20 | 30 | 20 | 100(30 % weightage) | 100 | |

| **Pre-requisite Course Codes** | Data structure concepts, Discrete structures | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Analyze the running time and space complexity of algorithms. |
| | CO2 | Describe, apply and analyze the complexity of divide and conquer, greedy and dynamic programming strategy. |
| | CO3 | Identify appropriate data structures and design techniques for different problems |
| | CO4 | Differentiate polynomial and non-deterministic polynomial algorithms. |
| | CO5 | Analyze various algorithms |

| Module No. | Unit No. | Topics | Ref. | Hrs |
|---|---|---|---|---|
| **1. Introduction to analysis of algorithm** | 1.1 | Mathematical background for algorithm analysis, Growth of function – Big – Oh, Omega, Theta notation, Complexity derivations, | [1], [2,],[4], [5] | 8 |
| | 1.2 | Solving recurrences using Substitution Method, Recursion tree method and Master method | [1] | |
| | 1.3 | Complexity Classes: P, NP, NP Hard, NP Complete | [1] | |
| | 1.4 | Amortized Analysis -Aggregate Method, Accounting Method, Potential Method | [1] | |
| **2. Divide and Conquer approach** | 2.1 | General method, Binary Search, Merge Sort, Quick Sort, Randomized quick sort, and Min-max algorithm | [1] | 4 |
| **3. Greedy Algorithms** | 3.1 | General Method, Knapsack Problem, Huffman's Codes , Minimum Spanning Tree, Kruskal's Algorithm , Prim's Algorithm , Dijkstra's Algorithm. | [1] | 6 |
| **4. Dynamic Programming Approach** | 4.1 | General Method, Making coin change, Principle of optimality, Knapsack Problem, Matrix Chain Multiplication, Activity Selection Problem, Longest common subsequence, All pair shortest path algorithm | [1] | 8 |

| | | | | |
|---|---|---|---|---|
| **5. Maximum Flow** | 5.1 | Flow networks, Ford Fulkerson method, Max bipartite matching, Push relabel algorithm, The relabel to front algorithm | | 7 |
| **6. Classical Problems in Algorithms** | 6.1 | Travelling Salesman problem, Subset Sum Problem, Matrix Multiplication, 15 puzzle , N-queens problem | | 6 |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Assignment on Online coding challenge on hackerrank rank10 Marks

**ISE-2:**

Activity: Article discussion /Research paper analysis 10 Marks
Assignment 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, The MIT Press, 2009.
2. Michael T Goodrich and Roberto Tamassia, "Algorithm Design: Foundations, Analysis and Internet Examples", John Wiley and Sons, 2002.
3. Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, "Algorithms", Tata McGraw-Hill, 2009
4. R. K. Ahuja, TL Magnanti and JB Orlin, "Network flows: Theory, Algorithms, and Applications", Prentice Hall Englewood Cliffs, NJ 1993.
5. M. R. Garey and D.S. Johnson, Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, 1979.
6. E. Horowitz and S. Sahni, Fundamentals of Computer Algorithms, Computer Science Press,1978.

**Online References:**

1. NPTEL course: https://nptel.ac.in/courses/106105164
2. Coursera link: https://www.coursera.org/specializations/algorithms

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO8021 | Advanced Networking Technologies | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Computer Networks | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Appreciate the need for Wireless networks and study the IEEE 802.11 Standards |
| | CO2 | Comprehend the significance of Asynchronous Transfer Mode(ATM). |
| | CO3 | Analyze the importance of Optical networking |
| | CO4 | Demonstrate knowledge of network design and security and management |
| | CO5 | Understand the concept of multimedia networks.. |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Wireless LAN and WAN Technologies | 1.1 | Introduction to Wireless Networks: Infrastructure networks, Ad-hoc networks | [1], [2,], [4], [5] | 8 |
| | 1.2 | IEEE 802.11 architecture and services | [1] | |
| | | Medium Access Control sub-layers | [1] | |
| | | CSMA/CA, Physical Layer, 802.11 Security considerations | [1] | |
| | | Architecture, ATM logical connections, ATM cells, ATM Functional Layers, Congestion control and Quality of service | [1] | |
| 2. Optical Networking | 2.1 | SONET : SONET/SDH, Architecture, Signal, SONET devices, connections,<br>SONET layers, SONET frames, STS Multiplexing, SONET Networks | [1] | 6 |
| | 2.2 | WDM, DWDM: Frame format, DWDM architecture ,Optical Amplifier ,<br>Optical cross connect Performance and design considerations. | [1] | |
| 3. Routing in the Internet | 3.1 | Intra and inter domain Routing, Unicast Routing Protocols: RIP, OSPF, BGP | [1] | 8 |

| | | | | |
|---|---|---|---|---|
| | 3.2 | Multicast Routing Protocols ,Drawbacks of traditional Routing methods | [1] | |
| **4. Network Security** | 4.1 | Security goal, Security threats, security safeguards, firewall types and design, IPTABLES | [1] | 8 |
| | 4.2 | Internet Security: Network Layer Security, Transport Layer Security, Application Layer Security | [1] | |
| **5. Multimedia Information and Networking** | 5.1 | Compression Fundamentals, Digital Representation, Compression techniques | [1] | 6 |
| | 5.2 | Multimedia Communication across networks, RTP, RTSP, SIP,H..323 | [1] | |
| **6. Network Design** | 6.1 | 3 tier Network design layers: Application layer, Access layer | [1] | 3 |
| | 6.2 | Backbone layers, Ubiquitous computing and Hierarchical computing | [1] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Assignment 10 Marks

**ISE-2:**

Activity: Assignment 10 Marks
Article Discussion 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Book:**

1. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition.
2. J F. Kurose & KW. Ross: Computer Networking- A Top-down Approach featuring the Internet, 3rd edition,
3. Darren L. Spohn , "Data Network Design" , McGraw Hill Education ,Third edition
4. William Stallings, "Data and Computer communications", Pearson Education, 10th Edition
5. K. R. Rao et al: Multimedia Communication Systems, Prentice-Hall of India,.
6. Deven Shah , Ambavade, "Advanced Communication Networking"
7. Beherouz A Forouzan , "TCP /IP Protocol Suite" , Tata McGraw Hill Education ,4th edition

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECC DO802 | Multimedia System and Virtual reality | L | T | P | L | T | P | **Total** |
| | | 3 | -- | | 3 | -- | | **3** |
| | | **Examination Scheme** | | | | | | |
| | | | **ISE1** | **MSE** | **ISE2** | **ESE** | **Total** | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| **Pre-requisite Course Codes** | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand the basics of multimedia and multimedia system architecture. |
| | CO2 | Analyse file formats and compression algorithms for different multimedia components. |
| | CO3 | Understand multimedia authoring system and apply different security techniques in multimedia environment. |
| | CO4 | Define the fundamentals of virtual reality and its related technologies. |
| | CO5 | Understand typical rendering pipeline and modelling techniques. |
| | CO6 | Design an application with the principles of virtual reality. |

| Module No. | Unit No. | Contents | Ref. | Hrs |
|---|---|---|---|---|
| **0 Pre-requisites** | | Computer Fundamentals, Graphics, Communication Theory, ISO-OSI Model, Java Class | [1] | 2 |
| **1 Introduction to Multimedia** | 1.1 | Definition of Multimedia, Characteristics of Multimedia System, History of Multimedia System, Difference between Multimedia and Hypermedia, Objects and Elements of Multimedia, Applications of Multimedia. | [1] | 5 |
| | 1.2 | Multimedia System Architecture: Workstation Architecture, IMA Architectural Framework, Network Architecture for Multimedia Systems, Types of Medium (Perception Media, Representation Media, Presentation Media, Storage Media, Transmission Media, Information Exchange Media), Interaction Techniques. | [1] | |
| 2 **Multimedia Types, File Formats and Compression Techniques** | 2.1 | **Digital Image:** Representation (2D format, resolution), Types of Images (monochrome, gray, color), File formats like BMP, JPG, Compression Techniques: fundamentals (coding, interpixel and psychovisual redundancies), Types –lossless and lossy, Lossless Compression; Algorithms– Shannon-Fano, CCITT Group 4 2D, Lossy Compression Algorithm – JPEG | [1] | 10 |

| | | | | |
|---|---|---|---|---|
| | 2.2 | **Digital Audio:** Computer representation of sound, File Formats – WAV, MPEG Audio, Compression: PCM, DM, DPCM | [1] | |
| | 2.3 | **Digital Video**: Digitization of Video, types of video signals (component, composite and S-video), File Formats: MPEG Video, H.261, Compression: MPEG | [1] | |
| **3 Multimedia Authoring and Security** | 3.1 | **Authoring System**: Overview, Introduction to Authoring Tools, Features of Authoring Tools, Design Issue of Multimedia Authoring, Types of Authoring Systems. | [1] | 6 |
| | 3.2 | **Digital Watermarking**: Concept, Visible and Invisible Watermarks, Watermarking Classification (Spatial Domain, Transform Domain, Feature Domain), Digital Watermarking Applications | [1] | |
| | 3.2 | **Steganography**: Concept and Types | [1] | |
| | 3.3 | **Image Authentication**: Issues and Digital Signature Based Image Authentication | [1] | |
| **4 Introduction to Virtual Reality** | 4.1 | Definition of Virtual Reality (VR), Classical Components of VR System, Important factors in a VR System, Types of VR Systems, VR Advantages, VR Input Output Devices, Applications of VR System | [1] | 4 |
| **5 VR Rendering Pipeline and Modelling** | 5.1 | Graphical Rendering Pipeline, Haptic Rendering Pipeline, OpenGL Rendering Pipeline, Geometric Modelling, Kinematic Modelling, Physical Modelling, Behaviour Modelling | [1] | 6 |
| **6 VR Programming** | 6.1 | VRML, Extensible 3D (X3D), Java 3D, OpenGL | [1] | 6 |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity:

Assignment: Apply the multimedia compression techniques to image/audio/video 10 Marks

Assignment: Apply different security techniques in multimedia environments. 10 Marks

**ISE-2:**

Activity: Assignment: Design and develop a 3d model using multimedia tool 10 Marks

Quiz 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Book:**

1. Prabhat K. Andleigh Kiran Thakrar, "Multimedia System Design", Pearson, 2015
2. Rajesh K. Maurya, "Computer Graphics with Virtual Reality Systems", 3rd Edition, Wiley, 2018
3. K.R.Rao,D.Milovanovic, Multimedia Communication Systems: Techniques, Standards and Networks, Pearson, 2012.
4. Koegel Buford, "Multimedia Systems", Pearson, 2002.
5. Steinmetz Ralf and NahrstedtKlara, "Multimedia: Computing, Communications and Applications", Pearson, 2008
6. AtulPuri, "Multimedia Systems, Standards, and Networks", 1st Edition, CRC Press, 2000.
7. Frank Y. Shih, "Multimedia Security: Watermarking, Steganography and Forensics", CRC Press, 2013.
8. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Wiley, 2003.
9. John Vince, "Virtual Reality Systems", Pearson, 2002.

**Online References:**

1. Multimedia Systems: https://nptel.ac.in/courses/117105083
2. Virtual Reality: https://nptel.ac.in/courses/106106138
3. Virtual Reality Specialization: https://www.coursera.org/specializations/virtual-reality

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDLO 7025 | Quantum Computing | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Explain basic concepts of quantum computing. |
| | CO2 | Explain mathematical fundamentals required for quantum computing. |
| | CO3 | Explain building blocks of quantum computing through architecture and programming models. |
| | CO4 | Explain quantum algorithms. |
| | CO5 | Explain quantum hardware building principles. |
| | CO6 | Explain usage of tools for quantum computing. |

| Module No. | Unit No. | Topics | Ref | Hrs |
|---|---|---|---|---|
| 1 Introduction to Quantum Computing | 1.1 | Motivation for studying Quantum Computing | [1] | 07 |
| | 1.2 | Origin of Quantum Computing | [1] | |
| | 1.3 | Quantum Computer vs. Classical Computer | [1] | |
| | 1.4 | Introduction to Quantum mechanics | [1] | |
| | 1.5 | Overview of major concepts in Quantum Computing Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition Quantum Entanglement | [1] | |
| | 1.6 | Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.) | [1] | |
| 2 Mathematical Foundations for Quantum Computing | 2.1 | Matrix Algebra: basis vectors and orthogonality, inner product and Hilbert spaces, matrices and tensors, unitary operators and projectors, Dirac notation, Eigen values and Eigen vectors. | [1] | 05 |
| 3 | 3.1 | Architecture of a Quantum Computing platform | [1] | 08 |

| | | | | |
|---|---|---|---|---|
| **Building Blocks for Quantum Program** | 3.2 | Details of q-bit system of information representation: Block Sphere Multi-qubpits Stateys Quantum - superposition of qpubits (vralid aind linvalid superposition) Quantum Entanglement Useful states from quantum algorithmic perceptive e.g. Bell State Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit No Cloning Theorem and Teleportation | [1] | |
| | 3.3 | Programming model for a Quantum Computing Program Steps performed on classical computer<br>Steps performed on Quantum Computer Moving data between bits and qubits. | [1] | |
| **4 Quantum Algorithms and Error correction** | 4.1 | Quantum Algorithms Shor's Algorithm Grover's Algorithm Deutsch's Algorithm Deutsch -Jozsa Algorithm | [1] | 06 |
| | 4.2 | Quantum error correction using repetition codes 3 qubit codes Shor's 9 qubit error correction Code | [1] | |
| **5 Quantum Hardware** | 5.1 | Ion Trap Qubits The DiVincenzo Criteria Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor | [1] | 10 |
| | 5.2 | Quantum Mechanics of a Free Rotor: A Poor Person's Atomic Model: Rotor Dynamics and the Hadamard Gate, Two-Qubit Gates<br>The Cirac-Zoller Mechanism: Quantum Theory of Simple Harmonic Motion, A Phonon-Qubit Pair Hamiltonian, Light-Induced Rotor-Phonon Interactions, Trapped Ion Qubits, Mølmer-Sørenson Coupling . | [1] | |
| | 5.3 | Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits | [1] | |
| | 5.3 | Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits | [1] | |
| | 5.4 | Quantum computing with spins: Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate. | [1] | |
| **6 OSS Toolkits for implementing Quantum program** | 6.1 | IBM quantum experience | [1] | 3 |
| | 6.2 | Microsoft Q Rigetti PyQuil (QPU/QVM) | [1] | |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

**ISE-2:**

Activity: Quiz 10 Marks
Assignment 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Book:**

1. Michael A. Nielsen, "Quantum Computation and Quantum Information", Cambridge University Press.
2. David McMahon, "Quantum Computing Explained", Wiley ,2008
3. Qiskit textbook https://qiskit.org/textbook-beta/
4. Vladimir Silva, Practical Quantum Computing for Developers,2018
5. Bernard Zygelman, A First Introduction to Quantum Computing and Information,2018
6. Supriyo Bandopadhyay and Marc Cahy, "Introduction to Spintronics", CRC Press, 2008.
7. The Second Quantum Revolution: From Entanglement to Quantum Computing and Other Super-Technologies, Lars Jaeger
8. La Guardia, Giuliano Gladioli "Quantum Error correction codes" Springer,2021.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECCDO802 | System Security | L | T | P | L | T | P | Total |
| | | 3 | -- | 2 | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Computer Networks | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand the concept of vulnerabilities, attacks and protection mechanisms. |
| | CO2 | Understand the working of various crypto algorithms. |
| | CO3 | Analyze various controls available for protection against internet attacks. |
| | CO4 | Evaluate different attacks on Open Web Applications and Web services. |
| | CO5 | Analyze mechanisms used to provide security in different infrastructure and networks |
| | CO6 | Perform security monitoring and testing of system. |

| Module No. | Unit No. | Contents | Ref. | Hrs |
|---|---|---|---|---|
| **1 The Need for System Security** | **1.1** | Risks, Threats, and Vulnerabilities, **Tenets of Information Systems Security (**Confidentiality, Integrity, Availability) | [1] | 4 |
| | **1.2** | **Malicious Attack** Birthday Attacks, Brute-Force Password Attacks, Dictionary Password Attacks, IP Address Spoofing Hijacking, Replay Attacks ,Man-in-the-Middle Attacks Masquerading, Eavesdropping, Social Engineering, Phreaking, Phishing, Pharming | [1] | |
| 2 **Cryptography** | **2.1** | Cryptography: Overview of Cryptography : What is cryptography, encryption and decryption techniques ,Symmetric and asymmetric key cryptography : AES, DES, RSA, Knapsack cryptosystem. | [1] | 6 |
| **3 Network Security** | **3.1** | Firewall: Need of Firewall, types of firewall- Packet Filters, Stateful Packet Filters, Application Gateways, Circuit gateways. Firewall Policies, Configuration, limitations, DMZ, VPN. | [1] | 9 |

| | | | | |
|---|---|---|---|---|
| | **3.2** | Intrusion Detection System Vulnerability Assessment, Misuse detection, Anomaly Detection, Network Based IDS, Host-Based IDS, Honeypots | [1] | |
| | **3.3** | Kerberos: Working, AS, TGS, SS | [1] | |
| | **3.4** | IP Security- Overview, Protocols- AH, ESP, Modes- transport and Tunnel. | [1] | |
| | **3.5** | Public key infrastructure Introduction, Certificates, (PKI): Certificate Authority, authority, Registration | [1] | |
| | **3.6** | X.509/PKIX certificate format. | [1] | |
| | **3.7** | Basic concepts of SNMP, SNMPv1 Community facility and SNMPv3 | [1] | |
| **4 Web Security** | **4.1** | Web Security Considerations, User Authentication and Session Management, Cookies, SSL, HTTPS, SSH, Privacy on Web, Web Browser Attacks, Account Harvesting, Web Bugs, Clickjacking, CrossSite Request Forgery, Session Hijacking and Management, Secure Electronic Transaction, Email Attacks, DNS Attacks, Web Service Security. | [1] | 7 |
| **5 Infrastructure Security** | **5.1** | **Physical Security**: Managerial, Technical And Physical Controls, Environmental Exposures And Controls, Physical Access Controls | [1] | 9 |
| | **5.2** | **Wireless network Security:** IEEE 802.11xWireless LAN Security, Wireless Intrusion Detection System (WIDS) | [1] | |
| | **5.3** | **Mobile Security:** Security Threats, Device Security, **Cloud Security:** Cloud Security Risks and Countermeasures, Cloud Identity and Access Management, Cloud Security as a Service, SAML, OAuth | [1] | |
| | **5.4** | **IOT Security:** IoT Concepts, IoT Attacks, IoT Hacking Methodology, IoT Hacking Tools, IoT Countermeasures | [1] | |
| **6 Security Auditing and Analysis** | **6.1** | How to define your audit plan?<br>What auditing benchmarks are ?<br>How to collect audit data?<br>Which post-audit activities you need to perform?<br>How to perform security monitoring?<br>Which types of log information you should capture? How to verify security controls ?<br>How to monitor and test your security systems? | [1] | 4 |
| | | | **Total** | **39** |

**Course Assessment:**

**Theory:**

**ISE-1:**

Activity: Quiz 10 Marks
Seminar on Research paper (IEEE /ACM) 10 Marks

**ISE-2:**

Activity: Assignment: Technical Report on Security Audit 10 Marks
Assignment 10 Marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Book:**

1. Computer Security Principles and Practice, William Stallings, Sixth Edition, Pearson Education
2. Security in Computing, Charles P. Pfleeger, Fifth Edition, Pearson Education .
3. Fundamentals of Information system security, Third Edition, David Kim, Michael G. Solomon 1. Jones & Bartlett Learning
4. Network Security and Cryptography, Bernard Menezes, Cengage Learning
5. Network Security Bible, Eric Cole, Second Edition, Wiley.
6. Web Application Hackers Handbook by Wiley.
7. Information Security The Complete Reference, 2nd Edition ,Mark Rhodes-Ousley,McGraw Hill Education
8. Computer Security, Dieter Gollman, Third Edition, Wiley
9. CCNA Security Study Guide, Tim Boyle, Wiley
10. Introduction to Computer Security, Matt Bishop, Pearson.
11. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif ,O'Reilly

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL 801 | Robotics Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | | Control Systems, Engineering Mathematics, Mechanics. |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course outcomes | CO1 | Use the acquired knowledge in solving direct and inverse kinematics problems |
| | CO2 | Select and Implement suitable task and trajectory planning algorithms. |
| | CO3 | Develop suitable programming tools for Robotic applications |
| | CO4 | Construct Robots/Robotic arms for automation applications |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Study/Demo of 4 axis robotic arm | [1],[2],[3] |
| 2 | Study/Demo of 5 axis robotic arm | [1],[2],[3] |
| 3 | Forward kinematics | [1],[2],[3] |
| 4 | Inverse kinematic | [1],[2],[3] |
| 5 | Joint-space trajectory | [1],[2],[3] |
| 6 | Cartesian-space trajectory | [1],[2],[3] |
| 7 | Template matching | [1],[2],[3] |
| 8 | Iterative processing | [1],[2],[3] |
| 9 | Segmentation | [1],[2],[3] |
| 10 | Mini project | [1],[2],[3] |

**Laboratory Assessment:**

**ISE-1:**
To be conducted for five experiments with continuous pre-defined rubrics-based evaluation for 20 marks.

**ISE-2:**
To be conducted for four & mini project experiments with continuous pre-defined rubrics-based evaluation for 30 marks

**Recommended Books:**

1. Robert Shilling, "Fundamentals of Robotics- Analysis and control, Prentice Hall of India,2009
2. Saeed Benjamin Niku, "Introduction to Robotics -Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011

3. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control", Wiley India Pvt. Ltd. 2006
4. Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications", McGraw Hill , New York, 2008
5. S.R. Deband Sankha Deb, "Robotics Technology and Flexible Automation", Second Edition. TMH
6. John J. Craig,"Introduction to Robotics –Mechanics & Control", Third Edition, Pearson Education,India,2009

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL 802 | MEMS Technology Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | | Electronics Devices, Electronics Circuits, VLSI |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course outcomes | CO1 | Determine various parameters for MEMS devices. |
| | CO2 | Plot characteristics of MEMS devices. |
| | CO3 | Select particular device for specific application. |
| | CO4 | Observe the effect of device parameters variation on its performance. |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Modeling and simulation of cantilever . | [1],[2],[3] |
| 2 | Modeling and simulation of pressure sensor . | [1],[2],[3] |
| 3 | Modeling and simulation of accelerometer . | [1],[2],[3] |
| 4 | Modeling and simulation of thermal actuator. . | [1],[2],[3] |
| 5 | Modeling and simulation of SMA . | [1],[2],[3] |
| 6 | Modeling and simulation of Piezoelectric sensor. . | [1],[2],[3] |
| 7 | Hardware experiment on MEMS devices. | [1],[2],[3] |
| 8 | Hardware experiment on MEMS devices | [1],[2],[3] |
| 9 | Case study on advance topic. | [1],[2],[3] |
| 10 | Case study of recent development in the subject. | [1],[2],[3] |

**Laboratory Assessment:**

**ISE:**

**1. ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**

a. Five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

b. Activity: Design of the size of mask for various structures such as V-shaped groove, Flat rectangle cavity etc (10 marks)

**Recommended Books:**

1. An Introduction to Micro-electromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc.
2. Micro-system Design - by S. Senturia; Publisher: Springer.
3. Introduction to Electromechanical system design –by James J Allen. Taylor & Francis Group, LLC publication
4. Fundamentals of Microfabrication - by M. Madou; Publisher: CRC Press; 2nd edition.
5. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL 802 | Natural Language processing | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | | Python Programming, Engineering Mathematics |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course outcomes | CO1 | Apply morphological analysis to a natural language.. |
| | CO2 | Analyze the syntactic structure of a language using syntax analysis techniques. |
| | CO3 | Perform semantic analysis on a natural language. |
| | CO4 | Apply NLP techniques to design real-world NLP applications |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Preprocessing of text (Tokenization, Filtration) | [1] |
| 2 | Preprocessing of text ( Script Validation) | [1],[2] |
| 3 | Preprocessing of text ( Stop Word Removal, Stemming) | [1],[2],[3] |
| 4 | Understanding the morphology of a word by the use of Add-Delete table. | [1],[2] |
| 5 | N-gram model | [1],[2],[3] |
| 6 | POS tagging | [1],[2],[3] |
| 7 | Calculation of emission and transition matrix which will be helpful for tagging Parts of Speech using Hidden Markov Model. | [1],[2] |
| 8 | Find POS tags of words in a sentence using Viterbi decoding. | [2],[3] |
| 9 | Chunking | [2],[3] |
| 10 | Named Entity Recognition | [1],[2],[3] |

**Note:**

1. Possible tools / language: R tool/ Python programming Language
2. Although it is not mandatory, the experiments can be conducted with reference to any Indian regional language.

**Laboratory Assessment:**

**ISE:**

**1.ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**

a. Five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
b. Activity: Mini- Project for 10 marks

**Recommended Books:**

1. Daniel Jurafsky, James H. Martin, Speech and Language Processing‖ Second Edition, Prentice Hall.
2. Christopher D. Manning & Hinrich Schutze, Foundations of Statistical Natural Language Processing, MIT Press.
3. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
4. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), The Handbook of Computational Linguistics and Natural Language Processing

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL 802 | 3D printing and Design Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course outcomes | CO1 | Demonstrate the use of 3d Modelling software. |
| | CO2 | Explain the Workflow between the modelling software and 3d printer |
| | CO3 | Explain the working of reverse engineering Technologies |
| | CO4 | Analyze the different file formats used for file sharing |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Study of Specifications & Processes for 3d Printing Machines | [1],[2] |
| 2 | 2D Modeling Using CAD Software | [1],[2],[3] |
| 3 | Assembly Modeling Involving 2 or 3 Components | [1],[2],[3] |
| 4 | Creation of STL Files and Slicing Files as Preprocessing for 3D printing | [1],[2],[3] |
| 5 | Study of Meshing and its Influence on the accuracy of component | [1],[2] |
| 6 | Reverse Engineering using a 3 D scanner / CMM | [1],[2] |
| 7 | Design of Supports For Thin Section / Overhang Features of a Component | [1],[2] |
| 8 | Study workflow, Material Requirements, Design Considerations, Post Processing of Fused Deposition Modeling FDM 3D printer | [1],[2],[3] |
| 9 | Design for additive Manufacturing : one or Two experiments | [2],[3] |
| 10 | Mini Project on New Product Design | [3] |

**Laboratory Assessment:**

**ISE:**

**1. ISE-1** will be conducted for five experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2** will be conducted for Four experiments and mini project. Continuous pre-defined rubrics-based evaluation for 30 Marks

**Recommended Books:**

1. Fundamentals of Digital Manufacturing science, Zude Zhou, Shane (Shengquan) Xie, Dejun Chen, Springer 2012
3. Additive Manufacturing Technologies, Ian Gibson, David Rosen, Brent Stucker, Spinger
4. Understanding Additive Manufacturing, Andreas Gebhardt, Hanser Publication, ISBN-13:978-1-56990-507-4
5. Rapid Manufacturing: An Industrial Revolution fo the digital Age, N. Hopkins, R.J.M. Hague and P.M. Dickens (Eds.), John Wiley and Sons, 2006
6. Rapid Proto-typing Principles and Applications, Chua C. K., Leong K. F., and Lim C.S. , 2nd edition , World Scientific, 2003
7. Rapid Proto-typing Theory and Practice, Ali Kamrani and EmadAbouel Nasr (Eds.), Springer, 2006

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ECL 802 | Advanced Algorithms Lab | L | T | P | L | T | P | Total |
| | | -- | -- | 2 | -- | -- | 1 | 1 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | -- | 50 | |

| Pre-requisite Course Codes | | |
|---|---|---|
| At the end of the laboratory course, students will be able to: | | |
| Course outcomes | CO1 | Understand the methods of designing and analyzing algorithms. |
| | CO2 | Design and implement efficient algorithms for a specified application. |
| | CO3 | Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem. |
| | CO4 | Analyze worst-case running time of algorithms and understand fundamental algorithmic problems. |

| Experiment No. | Title | Ref. |
|---|---|---|
| 1 | Implementation of Merge and Quick sort using divide and conquer approach | [1] |
| 2 | Implementation of Fractional Knapsack | [1],[2] |
| 3 | Implementation of Djikstras's algorithms | [1],[2] |
| 4 | Implementation of 0/1 Knapsack using dynamic programming | [1],[2],[3] |
| 5 | Implementation of Longest Common Subsequence | [1],[2],[3] |
| 6 | Implementation of Floyd's Warshall's algorithm | [1],[2],[3] |
| 7 | Implementation of Ford Fulkerson algorithm | [2],[3] |
| 8 | Implementation of Maximum Bipartite matching algorithm | [2],[3] |
| 9 | Implementation of n-queen using backtracking | [1],[2],[3] |
| 10 | Implementation of sum of subsets algorithm | [1],[2],[3] |
| 11 | Implementation of 15 puzzle problem | [3] |
| 12 | Implementation of Travelling salesman's problem. | [3] |

**Laboratory Assessment:**

**ISE:**
**1.ISE-1** will be conducted for six experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.

**2. ISE-2**
a. Six experiments. Continuous pre-defined rubrics-based evaluation for 20 marks.
b. Activity: Mini- Project (10 marks)

**Recommended Books:**

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", Third Edition, The MIT Press, 2009.
2. Michael T Goodrich and Roberto Tamassia, "Algorithm Design: Foundations, Analysis and Internet Examples", John Wiley and Sons, 2002.
3. Sanjoy Dasgupta, Christos Papadimitriou and Umesh Vazirani, "Algorithms", Tata McGraw-Hill, 2009
4. R.K. Ahuja, TL Magnanti and JB Orlin, "Network flows: Theory, Algorithms, and Applications", Prentice Hall Englewood Cliffs, NJ 1993.
5. M.R. Garey and D.S. Johnson, Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, 1979.
6. E. Horowitz and S. Sahni, Fundamentals of Computer Algorithms, Computer Science Press,1978.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO8021 | Project Management | L | T | P | L | T | P | Total |
| | | 03 | -- | | 03 | -- | | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| | | |
|---|---|---|
| **Pre-requisite Course Codes** | Data structure concepts, Discrete structures | |
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| **Course Outcomes** | CO1 | Apply selection criteria and select an appropriate project from different options. |
| | CO2 | Write work break down structure for a project and develop a schedule based on it. |
| | CO3 | Identify opportunities and threats to the project and decide an approach to deal with them strategically. |
| | CO4 | Use Earned value technique and determine & predict status of the project. |
| | CO5 | Capture lessons learned during project phases and document them for future reference |

| Module No. | Unit No. | Topics | Ref. | Hrs |
|---|---|---|---|---|
| **1. Project Management Foundation:** | 1.1 | Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI). | [1], [2], [4], [5] | 5 |
| **2. Initiating Projects:** | 2.1 | How to get a project started, Selecting project strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics | [1] | 6 |
| **3. Project Planning and Scheduling** | 3.1 | GANTT chart. Introduction to Project Management Information System (PMIS). | [1] | 8 |

| | | | | |
|---|---|---|---|---|
| **4. Planning Projects** | 4.1 | Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.<br>Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks | [1] | 6 |
| **5.** | 5.1 | Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. | [1] | 8 |
| | 5.2 | Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit | | |
| | 5.3 | Project procurement management, contracting and outsourcing | | |
| **6.** | 6.1 | Introduction to project leadership, ethics in projects. Multicultural and virtual projects | [1] | 6 |
| | 6.2 | Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study. | | |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus
**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7thEd.
2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA
3. Gido Clements, Project Management, Cengage Learning.
4. Gopalan, Project Management, , Wiley India
5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO8022 | Finance Management | L | T | P | L | T | P | Total |
| | | 03 | -- | | 03 | -- | | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand Indian finance system and corporate finance |
| | CO2 | Take investment, finance as well as dividend decisions |

| Module No. | Unit No. | Topics | Ref. | Hrs |
|---|---|---|---|---|
| 1. | 1.1 | **Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System. | [1], [2,], [4], [5] | 6 |
| | 1.2 | **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills | [1] | |
| | | **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market | [1] | |
| | | **Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges | [1] | |
| 2. | 2.1 | **Concepts of Returns and Risks:** Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio. | [1] | 6 |
| | 2.2 | **Time Value of Money:** Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting | [1] | |
| 3. | 3.1 | **Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision. | [1] | 9 |

| | | | | |
|---|---|---|---|---|
| | 3.2 | **Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis | [1] | |
| **4.** | 4.1 | **Capital Budgeting:** Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value(NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate of Return (MIRR) | [1] | 10 |
| | 4.2 | **Working Capital Management:** Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities | [1] | |
| **5.** | 5.1 | **Sources of Finance:** Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance. | [1] | 5 |
| | | Capital Structure: Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure | | |
| **6.** | 6.1 | Dividend Policy: Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches— Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach | [1] | 3 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Fundamentals of Financial Management, 13th Edition (2015) by Eugene F. Brigham and Joel F. Houston; Publisher: Cengage Publications, New Delhi.
2. Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi.
3. Indian Financial System, 9th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi.
4. Financial Management, 11th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO8023 | Entrepreneurship Development and Management | L | T | P | L | T | P | Total |
| | | 03 | -- | | 03 | -- | | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | Computer Networks | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand the concept of business plan and ownerships |
| | CO2 | Interpret key regulations and legal aspects of entrepreneurship in India |
| | CO3 | Understand government policies for entrepreneurs |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. | 1.1 | **Overview Of Entrepreneurship:** Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership | [1], [2,],[4] ,[5] | 4 |
| | 1.2 | Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship | [1] | |
| 2. | 2.1 | **Business Plans And Importance Of Capital To Entrepreneurship:** Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and | [1] | 9 |

| | | | | |
|---|---|---|---|---|
| | | Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur | | |
| | 2.2 | Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations. | [1] | |
| **3.** | 3.1 | Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises. | [1] | 5 |
| **4.** | 4.1 | Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organizations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc.,5 | [1] | 8 |
| | 4.2 | Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc | [1][2] | |
| **5.** | 5.1 | **Effective Management of Business:** Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing | [1] | 8 |
| **6.** | 6.1 | **Achieving Success In The Small Business:** Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business | | 5 |
| | | | | |
| | | | Total | 39 |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz of 10 marks for a 1 hour duration

**ISE-2:**

Student seminars based on case study application in practical, real-life domains for 20 marks, 1 hour duration

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson
2. Education Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr TN Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr CN Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. Maddhurima Lall, Shikah Sahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO8024 | Human Resource Management | L | T | P | L | T | P | Total |
| | | 03 | -- | | 03 | -- | | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand the concepts, aspects, techniques and practices of the human resource management. |
| | CO2 | Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective. |
| | CO3 | Gain knowledge about the latest developments and trends in HRM. |
| | CO4 | Apply the knowledge of behavioral skills learnt and integrate it with in inter personal and intergroup environment emerging as future stable engineers and managers |

| Module No. | Unit No. | Topics | Ref. | Hrs |
|---|---|---|---|---|
| 1. Introduction to HR | 1.1 | Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. | [1], [2], [4], [5] | 5 |
| | 1.2 | Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. | [1] | |
| 2. Organizational Behavior (OB) | 2.1 | Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues | [1] | 7 |
| | 2.2 | Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness Perception: Attitude and Value, Effect of perception on Individual Decision making, Attitude and Behavior. | [1] | |
| | 2.3 | Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor); | [1] | |

| | | | | |
|---|---|---|---|---|
| | 2.4 | Group Behavior and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team.<br>Case study | [1] | |
| **3. Organizational Structure & Design** | 3.1 | Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.<br>Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.<br>Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies | [1] | 6 |
| **4. Human resource Planning** | 4.1 | Recruitment and Selection process, Job enrichment, Empowerment- Job- Satisfaction, employee morale.<br>Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning.<br>Training & Development: Identification of Training Needs, Training Methods | [1] | 5 |
| **5. Emerging Trends in HR** | 5.1 | Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment. | [1] | 6 |
| | 5.2 | Cross Cultural Leadership and Decision Making**:** Cross Cultural Communication and diversity at work**,** Causes of diversity, managing diversity. With special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation | [1]<br>[2] | |
| **6.**<br><br>**HR & MIS Strategic HRM** | 6.1 | Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries. | [1] | 10 |
| | 6.2 | Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals | [1]<br>[2] | |
| | 6.3 | Labor Laws & Industrial Relations:<br>Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act | [1] | |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Stephen Robbins, Organizational Behavior, 16th Ed, 2013
2. V S P Rao, Human Resource Management, 3rd Ed, 2010, Excel publishing
3. Aswathapa, Human resource management: Text & cases, 6th edition, 2011
4. C. B. Mamoria and S V Gankar, Dynamics of Industrial Relations in India, 15th Ed, 2015, Himalaya Publishing, 15thedition, 2015
5. P. Subba Rao, Essentials of Human Resource management and Industrial relations, 5th Ed, 2013, Himalaya Publishing
6. Laurie Mullins, Management & Organizational Behavior, Latest Ed, 2016, Pearson Publications

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | L | T | P | Total |
| | | 03 | -- | | 03 | -- | | 03 |
| | | Examination Scheme | | | | | | |
| ILO8025 | Professional Ethics and Corporate Social Responsibility (CSR) | | ISE 1 | MSE | ISE 2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand rights and duties of business |
| | CO2 | Distinguish different aspects of corporate social responsibility |
| | CO3 | Demonstrate professional ethics |
| | CO4 | Understand legal aspects of corporate social responsibility |

| Module No. | Unit No. | Topics | Ref. | Hrs |
|---|---|---|---|---|
| **1.** | 1.1 | The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business | [1], [2], [4], [5] | 4 |
| **2.** | 2.1 | **Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy | [1] | 8 |
| | 2.2 | **Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources | [1] | |
| **3.** | 3.1 | **Professional Ethics of Consumer Protection:** Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy<br>**Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs | [1] | 6 |
| **4.** | 4.1 | **Introduction to Corporate Social Responsibility:** Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection.<br>Trajectory of Corporate Social Responsibility in India | [1] | 5 |
| **5.** | 5.1 | Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India | [1] | 8 |
| **6.** | 6.1 | **Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of | [1] | 8 |

| | | | | |
|---|---|---|---|---|
| | | India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013 | | |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.
2. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge.
3. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi.
4. Corporate Social Responsibility in India (2015) by BidyutChakrabarty, Routledge, New Delhi

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO8026 | Research Methodology | L | T | P | L | T | P | Total |
| | | 03 | -- | | 03 | -- | | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | | Total |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | | 100 |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Prepare a preliminary research design for projects in their subject matter areas |
| | CO2 | Accurately collect, analyze and report data |
| | CO3 | Present complex data or situations clearly |
| | CO4 | Review and analyze research findings |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction and Basic Research Concepts | 1.1 | Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology | [1], [2],[4],[5 ] | 9 |
| | 1.2 | Need of Research in Business and Social Sciences | [1] | |
| | 1.3 | Objectives of Research | [1] | |
| | 1.4 | **Issues** and Problems in Research | [1] | |
| | 1.5 | Characteristics of Research:Systematic, Valid, Verifiable, Empirical and Critical | [1] | |
| 2. Types of Research | 2.1 | Basic Research | [1] | 7 |
| | 2.2 | Applied Research | [1] | |
| | 2.3 | Descriptive Research | [1] | |
| | 2.4 | Analytical Research | [1] | |
| | 2.5 | Empirical Research | [1] | |
| | 2.6 | Qualitative and Quantitative Approaches | [1] | |
| 3. Research Design and Sample Design | 3.1 | Research Design – Meaning, Types and Significance | [1] | 7 |
| | 3.2 | Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors | | |
| 4. Research | 4.1 | Meaning of Research Methodology | [1] | 8 |

| | | | | |
|---|---|---|---|---|
| **Methodology** | 4.2 | Stages in Scientific Research Process:<br>**a.** Identification and Selection of Research Problem<br>**b.** Formulation of Research Problem<br>**c.** Review of Literature<br>**d.** Formulation of Hypothesis<br>**e.** Formulation of research Design<br>**f.** Sample Design<br>**g.** Data Collection<br>**h.** Data Analysis<br>**i.** Hypothesis testing and Interpretation of Data<br>Preparation of Research Report | | |
| **5. Formulating Research Problem** | 5.1 | Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis | [1] | 4 |
| **6. Outcome of Research** | 6.1 | Preparation of the report on conclusion reached | [1] | 4 |
| | 6.2 | Validity Testing & Ethical Issues | [1] | |
| | 6.3 | Suggestions and Recommendation | [1] | |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R.,1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nded), Singapore, Pearson Education

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO8027 | IPR and Patenting | L | T | P | L | T | P | Total |
| | | 3 | -- | | 3 | -- | | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | understand Intellectual Property assets |
| | CO2 | assist individuals and organizations in capacity building |
| | CO3 | work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. | 1.1 | **Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks,Copyrights, Industrial Designs, Plant variety protection, Geographical indications,Transfer of technology etc. | [1], [2],[4],[5] | 5 |
| | 1.2 | **Importance of IPR in Modern Global Economic Environment:** Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development | [1] | |
| 2. | 2.1 | **Enforcement of Intellectual Property Rights:** Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) activein IPR enforcement | [1] | 7 |
| | 2.2 | **Indian Scenario of IPR:**Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc. | [1] | |
| 3. | | **Emerging Issues in IPR:**Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc. | [1] | 5 |

| | | | | |
|---|---|---|---|---|
| | | Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors | | |
| **4. Research Methodology** | 4.1 | **Basics of Patents:**Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method | [1] | 7 |
| **5. Formulating Research Problem** | 5.1 | **Patent Rules:** Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.) | [1] | 8 |
| **6. Outcome of Research** | 6.1 | **Procedure for Filing a Patent (National and International):** Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publicationetc, Time frame and cost, Patent Licensing, Patent Infringement<br>**Patent databases:** Important websites, Searching international databases | [1] | 7 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India
2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws
3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International
4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press
5. Cornish, William Rodolph & Llewelyn, David. 2010, Intellectual Property: Patents, Copyrights, Trade Marks and Allied Right, 7th Edition, Sweet & Maxwell

6. Lous Harns, 2012, The enforcement of Intellactual Property Rights: A Case Book, 3rd Edition, WIPO
7. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH
8. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books
9. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications
10. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications
11. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights,
12. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company
13. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting,Interpretation of Patent Specifications and Claims, New India Publishing Agency
14. Vivien Irish, 2005, Intellectual Property Rights for Engineers,IET
15. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley-IEEE Press

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO8028 | Digital Business Management | L | T | P | L | T | P | Total |
| | | 03 | -- | | 03 | -- | | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Identify drivers of digital business |
| | CO2 | Illustrate various approaches and techniques for E-business and management |
| | CO3 | Prepare E-business plan |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. Introduction to Digital Business- | 1.1 | Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy,<br>Opportunities and Challenges in Digital Business, | [1], [2],[4], [5] | 9 |
| | 1.2 | **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) | [1] | |
| 2. Overview of E-Commerce | 2.1 | **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement<br>B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals | [1] | 6 |
| | 2.2 | Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing<br>EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC | [1] | |

| | | | | |
|---|---|---|---|---|
| **3. Digital Business Support services** | | ERP as e –business backbone, knowledge Tope Apps, Information and referral system | [1] | 6 |
| | | **Application Development:** Building Digital business Applications and Infrastructure | | |
| **4. Managing E-Business** | 4.1 | Managing Knowledge, Management skills for e-business, Managing Risks in e –business<br>Security Threats to e-business -Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications | [1] | 6 |
| **5. E-Business Strategy** | 5.1 | E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy,<br>E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation) | [1] | 4 |
| **6. Materializing e-business** | 6.1 | **From Idea to Realization-Business plan preparation**<br><br>**Case Studies and presentations** | [1] | 8 |
| | | | **Total** | **39** |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. A textbook on E-commerce, Er Arunrajan Mishra, Dr W K Sarwade,Neha Publishers & Distributors, 2011
2. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002

3. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014
4. Introduction to E-business-Management and Strategy, Colin Combe, ELSVIER, 2006
5. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson
6. Trend and Challenges in Digital Business Innovation, VinocenzoMorabito, Springer
7. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan
8. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
9. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5
10. Measuring Digital Economy-A new perspective - DOI:10.1787/9789264221796-enOECD Publishing

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| ILO8029 | Environmental Management | L | T | P | L | T | P | Total |
| | | 03 | -- | | 03 | -- | | 03 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE 2 | ESE | Total | |
| | | Theory | 20 | 30 | 20 | 100(30% weightage) | 100 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Understand the concept of environmental management |
| | CO2 | Understand ecosystem and interdependence, food chain etc. |
| | CO3 | Understand and interpret environment related legislations |

| Module No. | Unit No. | Topics | Ref. | Hrs. |
|---|---|---|---|---|
| 1. | 1.1 | Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. Environmental issues relevant to India, Sustainable Development, The Energy scenario. | [1], [2], [4], [5] | 10 |
| 2. | 2.1 | Global Environmental concerns : Global Warming, Acid Rain, Ozone Depletion, Hazardous Wastes, Endangered life-species, Loss of Biodiversity, Industrial/Man- made disasters, Atomic/Biomedical hazards, etc. | [1] | 6 |
| 3. | 3.1 | Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc. | [1] | 5 |
| 4. | 4.1 | Scope of Environment Management, Role & functions of Government as a planning and regulating agency. Environment Quality Management and Corporate Environmental Responsibility | [1] | 10 |
| 5. | 5.1 | Total Quality Environmental Management, ISO-14000, EMS certification | [1] | 5 |
| 6. | 6.1 | General overview of major legislations like Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act, etc. | [1] | 3 |
| | | | Total | 39 |

**Course Assessment:**

**ISE-1:**
Assignments for 10 marks
Multiple choice questions (MCQ) quiz for 10 marks [1 hour duration]

**ISE-2:**
Seminars based on Case study/Application in practical, real-life domain for 20 marks

**MSE:** 30 Marks written examination based on 50% syllabus

**ESE:** Three hours 100 Marks written examination (with 30% weightage) based on entire syllabus

**Recommended Books:**

1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999
2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing
3. Environmental Management,T V Ramachandra and Vijay Kulkarni, TERI Press
4. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005
5. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Maclillan India, 2000
6. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC Press
7. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015

| Course Code | Course Name | Teaching Scheme (Hrs/week) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| ISP801 | Major Project – II | L | T | P | L | T | P | Total |
| | | | -- | 12 | | -- | 3 | 3 |
| | | Examination Scheme | | | | | | |
| | | | ISE1 | MSE | ISE2 | ESE | Total | |
| | | Lab | 20 | -- | 30 | 100 | 150 | |

| Pre-requisite Course Codes | -- | |
|---|---|---|
| Course Outcomes (CO): | At the End of the course students will be able to : | |
| Course Outcomes | CO1 | Identify problems based on societal /research needs. |
| | CO2 | Apply Knowledge and skill to solve societal problems in a group. |
| | CO3 | Develop interpersonal skills to work as a member of a group or leader. |
| | CO4 | Draw the proper inferences from available results through theoretical/ experimental/simulations. |
| | CO5 | Analyze the impact of solutions in societal and environmental context for sustainable development. |
| | CO6 | Use standard norms of engineering practices |
| | CO7 | Excel in written and oral communication. |
| | CO8 | Demonstrate capabilities of self-learning in a group, which leads to lifelong learning |
| | CO9 | Demonstrate project management principles during project work |

**Guidelines for Major Project**

- Students should form groups with minimum 2(two) and not more than 4 (four)
- Students should do surveys and identify needs, which shall be converted into problem statements for major projects in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students shall submit implementation plans in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major projects.
- A log book to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisors may give inputs to students during major project activity; however, focus shall be on self-learning.
- Students in a group shall understand problems effectively, propose multiple solutions and select the best possible solution in consultation with the guide/ supervisor.
- Students shall convert the best solution into a working model using various components of their domain areas and demonstrate.

- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

**Review/progress monitoring committee may consider following points for assessment.**

In VIII semester expected work shall be procurement of component's/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
First review is based on readiness of building working prototypes to be conducted.
Second review shall be based on poster presentation cum demonstration of working model in the last month of the said semester.

**Assessment criteria of Major Project-II**

Major Project-II shall be assessed based on following criteria;

1. Cost effectiveness and Societal impact
2. Full functioning of working model as per stated requirements
3. Effective use of skill sets
4. Effective use of standard engineering norms
5. Contribution of an individual's as member or leader
6. Clarity in written and oral communication

**Guidelines for Assessment of Major Project Practical/Oral Examination:**

Report should be prepared as per the guidelines issued by the University of Mumbai.
Major Project shall be assessed through a presentation and demonstration of working model by the
student project group to a panel of Internal and External Examiners preferably from industry or research
organizations having experience of more than five years approved by the head of Institution.
Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

**Major Project shall be assessed based on following points:**

1. Quality of problem and Clarity
2. Innovativeness in solutions
3 .Cost effectiveness and Societal impact
4 .Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individuals as member or leader
8. Clarity in written and oral communication

**Course Assessment:**

**ISE: Final ISE marks will be average of ISE1 and ISE 2**

1. **ISE-1** will be conducted in mid semester for 50 marks
2. **ISE-2** will be conducted by the end of the semester for 50 marks.

**ESE: Final Oral/Presentation 50 Marks**