# UNIVERSITY OF MUMBAI

# Scheme

### for

## Bachelor of Engineering

### in

## Electronics & Computer Science

**Second Year with Effect from AY 2020-21**
**Third Year with Effect from AY 2021-22**
**Final Year with Effect from AY 2022-23**

**(REV- 2019 'C' Scheme) from Academic Year 2019 – 20**
**Under**

# FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

**Program Structure for Third Year Electronics and Computer Science**

# UNIVERSITY OF MUMBAI
**(With Effect from 2021-2022)**

## UNIVERSITY OF MUMBAI

| Sr. No. | Heading | Particulars |
|---|---|---|
| 1 | Title of the Course | Final Year of B.E in Electronics & Computer Science (ECS) |
| 2 | Eligibility for Admission | **After Passing Third Year Engineering as per the Ordinance 0.6242** |
| 3 | Passing Marks | **40%** |
| 4 | Ordinances / Regulations ( if any) | **Ordinance 0.6242** |
| 5 | No. of Years / Semesters | **4 Years / 8 Semesters** |
| 6 | Level | ~~P.G.~~/ **U.G.**/ ~~Diploma / Certificate~~ (Strike out which ~~is applicable)~~ |
| 7 | Pattern | ~~Yearly~~/ **Semester** (Strike out which is not applicable ) |
| 8 | Status | ~~New~~/ Revised **REV- 2019 'C'** |
| 9 | To be implemented from Academic Year | **With effect from Academic Year: 2022-2023** |

Date:

**Dr. S. K. Ukarande**
Associate Dean
Faculty of Science and Technology
University of Mumbai

**Dr. Anuradha Majumdar**
Dean
Faculty of Science and Technology
University of Mumbai

**Program Structure for Third Year Electronics and Computer Science**
# UNIVERSITY OF MUMBAI
**(With Effect from 2021-2022)**

# Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering)of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc. There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 170, wherein focus is not only on providing knowledge but also on building skills, attitude and self-learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self-learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

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# Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self-learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of 'C'scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme 'A' and 'B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self-learning to learner. Learners are now getting sufficient time for self-learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD's/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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**Program Structure for Third Year Electronics and Computer Science**
# UNIVERSITY OF MUMBAI
**(With Effect from 2021-2022)**

# Preface

Technical education in the country is undergoing a paradigm shift in current days. Think tank at national level are deliberating on the issues, which are of utmost importance and posed challenge to all the spheres of technical education. Eventually, impact of these developments was visible and as well adopted on bigger scale by almost all universities across the country. These are primarily an adoption of CBCS (Choice base Credit System) and OBE (Outcome based Education) with student centric and learning centric approach. Education sector in the country, as well, facing critical challenges, such as, the quality of graduates, employability, basic skills, ability to take challenges, work ability in the fields, adoption to the situation, leadership qualities, communication skills and ethical behaviour. On other hand, the aspirants for admission to engineering programs are on decline over the years. An overall admission status across the country is almost 50%; posing threat with more than half the vacancies in various colleges and make their survival difficult. In light of these, an All India Council for Technical Education (AICTE), the national regulator, took initiatives and enforced certain policies for betterment, in timely manner. Few of them are highlighted here, these are design of model curriculum for all prevailing streams, mandatory induction program for new entrants, introduction of skill based and inter/cross discipline courses, mandatory industry internships, creation of digital contents, mandate for use of ICT in teaching learning, virtual laboratory and so on.

To keep the pace with these developments in technical education, it is mandatory for the Institutes & Universities to adopt these initiatives in phased manner, either partially or in toto. Hence, the ongoing curriculum revision process has a crucial role to play. The BoS of Electronics Engineering under the faculty of Science & Technology, under the gamut of Mumbai University has initiated a step towards adoption of these initiatives. We, the members of Electronics Engineering Board of Studies of Mumbai University feel privileged to present the revised version of curriculum for Electronics Engineering program to be implemented from academic year 2020-21. Some of the highlights of the revision are;

   i.   Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.

   ii.   New skill-based courses have been incorporated in curriculum keeping in view AICTE model curriculum.

   iii.   Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students

   iv.   Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.

   v.   An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self-learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

Thus, this revision of curriculum aimed at creating deep impact on the teaching learning methodology to be adopted by affiliated Institutes, thereby nurturing the student fraternity in multifaceted directions and create competent technical manpower with legitimate skills. In times to come, these graduates shall shoulder the responsibilities of proliferation of future technologies and support in a big way for 'Make in India' initiative, a reality. In the process,

BoS, Electronics Engineering got whole hearted support from all stakeholders including faculty, Heads of department of affiliating institutes, experts faculty who detailed out the course contents, alumni, industry experts and university official providing all procedural support time to time. We put on record their involvement and sincerely thank one and all for contribution and support extended for this noble cause.

**Boards of Studies in Electronics Engineering**

| Sr. No. | Name | Designation | Sr. No. | Name | Designation |
|---------|------|-------------|---------|------|-------------|
| 1 | Dr. R. N. Awale | Chairman | 5 | Dr. Rajani Mangala | Member |
| 2 | Dr. Jyothi Digge | Member | 6 | Dr. Vikas Gupta | Member |
| 3 | Dr. V. A. Vyawahare | Member | 7 | Dr. D. J. Pete | Member |
| 4 | Dr. Srija Unnikrishnan | Member | 8 | Dr. Vivek Agarwal | Member |

**Program Structure for Final Year Electronics and Computer Science**
# UNIVERSITY OF MUMBAI
**(With Effect from 2022-2023)**

# Semester VIII

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | TH | PR | Tut | TH | Pract | Tut | Total |
| ECC 801 | Robotics | 3 | - | - | 3 | - | - | 3 |
| ECC DO801 | Department Level Optional Course -V | 3 | - | - | 3 | - | - | 3 |
| ECC DO802 | Department Level Optional Course -VI | 3 | - | - | 3 | - | - | 3 |
| ECC IO801 | Institute Level Optional Course - II | 3 | - | - | 3 | - | - | 3 |
| ECL 801 | Robotics Lab | - | 2 | - | - | 1 | - | 1 |
| ECL 802 | Department Level Optional Course - V Lab | - | 2 | - | - | 1 | - | 1 |
| ECP 801 | Major Project II | - | 12 | - | - | 6 | - | 6 |
| | Total | 12 | 16 | - | 12 | 8 | - | 20 |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Internal Assessment | | | End Sem Exam | Exam Duration (in Hrs) | TW | Pract/ Oral | Total |
| | | Test 1 | Test 2 | Av | | | | | |
| ECC 801 | Robotics | 20 | 20 | 20 | 80 | 03 | - | - | 100 |
| ECC DO801 | Department Level Optional Course -V | 20 | 20 | 20 | 80 | 03 | - | - | 100 |
| ECC DO802 | Department Level Optional Course -VI | 20 | 20 | 20 | 80 | 03 | - | - | 100 |
| ECC IO801 | Institute Level Optional Course - II | 20 | 20 | 20 | 80 | 03 | - | - | 100 |
| ECL 801 | Robotics Lab | - | - | - | - | 03 | 25 | 25 | 50 |
| ECL 802 | Department Level Optional Course - V Lab | - | - | - | - | - | 25 | 25 | 50 |
| ECP 801 | Major Project II | - | - | - | - | - | 50 | 100 | 150 |
| | Total | | | 80 | 320 | - | 100 | 150 | 650 |

**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 |

**Note:**

1. Students group and load of faculty per week.

   **Mini Project 1 and 2:**
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   *Faculty Load:* 1 hour per week per four groups

   **Major Project 1 and 2:**
   Students can form groups with minimum 2 (Two) and not more than 4 (Four)
   *Faculty Load:* In Semester VII– ½ hour per week per project group
   In Semester VIII – 1 hour per week per project group

2. Out of 4 hours/week allotted for the mini-projects 1-A and 1-B, an expert lecture of at least one hour per week from industry/institute or a field visit to nearby domain specific industry should be arranged.

3. Mini-projects 2-A and 2-B should be based on DLOs.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECC 801 | Robotics | 03 | 02 | -- | 03 | -- | -- | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Prac tical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECC 801 | Robotics | 20 | 20 | 20 | 80 | 03 | -- | -- | -- | 100 |

**Course Pre-requisite:** Applied Mathematics III, Applied Mathematics IV, Controls and Instrumentation

**Course Objectives:**

1. To get acquainted with the basics of robotics
2. To familiarize students with kinematics & dynamics of robots
3. To familiarize students with Trajectory & task planning of robots.
4. To familiarize students with robot vision

**Course Outcomes:**

**After successful completion of the course students will be able to:**

1. Describe the basics of Robotics
2. Describe and derive kinematics and dynamics of stationary and mobile robots.
3. Apply trajectory planning algorithms
4. Describe concepts of robot motion planning algorithms
5. Apply image processing in robotic vision
6. Identify suitable Robot language based on applications

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| **1** | | **Fundamentals of Robotics** | 04 |
| | **1.1** | Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Specification Notations, Applications. | |
| **2** | | **Direct Kinematics** | 08 |
| | **2.1** | Dot and Cross Products, Co-ordinate frames, Rotations, Homogeneous Co-ordinates, Link Co-ordinates, Arm Equation (3 axis and 4 axis Robots) | |
| **3** | | **Inverse Kinematics and Work Space Analysis** | 07 |
| | **3.1** | General properties of solutions, Tool Configuration, Inverse kinematics of 3 axis, 4 axis and 5 axis Robots, Work Space Analysis of 3 axis and 4 axis Robots, Work Envelope. | |
| **4** | | **Trajectory planning** | 04 |
| | **4.1** | Basics of Trajectory planning , Joint-space trajectory planning, Pick and place operations, Continuous path motion, Interpolated motion,  Straight line motion | |
| **5** | | **Task Planning** | 07 |
| | **5.1** | Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, BUG 1, BUG 2 and Tangent Bug Algorithms | |
| **6** | | **Robot Vision and Robot Languages** | 09 |
| | 6.1 | Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform. | |
| | 6.2 | Robot language, Classification of Robot languages, Computer control and Robot software, Variable Assembly Language system and language | |
| | | | |
| | | **Total** | **39** |

**Text 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

**Reference Books:**

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

**Internal Assessment (IA):**
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

**End Semester Examination:**
1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the module

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECC DO801 | MEMS Technology | 03 | 02 | -- | 03 | 01 | -- | 04 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Prac tical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECC DO801 | MEMS Technology | 20 | 20 | 20 | 80 | 03 | 25 | 25 | -- | 150 |

**Course Pre-requisite:** 1. Controls and Instrumentation
2. Embedded Systems and RTOS

**Course Objectives:**

1. To provide knowledge of MEMS fabrication steps.
2. To provide knowledge of MEMS Materials with respect to applications.
3. To demonstrate the use of semiconductor-based fabrication processes for sensors and actuators
4. To provide an understanding of basic design and operation of MEMS sensors, actuators and passive structures.

**Course Outcomes:**

**After successful completion of the course students will be able to:**

1. Understand the different MEMS devices, working principles, materials and their properties.
2. Design and simulate MEMS devices using standard simulation tools.
3. Develop different concepts of MEMS sensors and actuators for real-world applications.
4. Understand the rudiments of Micro-fabrication techniques.

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **Introduction to MEMS** | 04 |
| | 1.1 | Introduction to MEMS and Micro Electronics Technologies. | |
| | 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. | |
| 2 | | **MEMS Materials and Their Properties** | 07 |
| | 2.1 | Use of Si, $SiO_2$, SiN, SiC, Cr, Au, Al, Ti, SU8, PMMA, Pt in building MEMS applications. | |
| | 2.2 | Material properties such as Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Thermoelectricity. | |
| 3 | | **MEMS Sensors and Actuators** | 08 |
| | 3.1 | Types MEMS Sensing (Capacitive, Piezo electric Piezo resistive) | |
| | 3.2 | Micro Actuation Techniques (Thermal, Piezo electric, Electro static), Shape Memory Alloys, Micro Grippers, Micro Gears, Micro Motors, Micro Valves, Micro Pumps. | |
| 4 | | **MEMS Fabrication Processes** | 08 |
| | 4.1 | MEMS Processes & Process parameters: Bulk & Surface Micromachining, High Aspect Ratio MEMS (LIGA) . | |
| | 4.2 | X-Ray Lithography, Photolithography, PVD, Wet etching, Dry etching, Plasma etching, DRIE, Etch Stop Techniques, Die, Wire & Wafer Bonding, Dicing, Packaging. | |
| 5 | | **MEMS Devices** | 09 |
| | 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. | |
| 6 | | **MEMS Reliability** | 03 |
| | 6.1 | Reliability and various failure mechanisms for MEMS. | |
| | 6.2 | Reliability curve. | |
| | | **Total** | 39 |

## Text 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

## Reference Books:

1. Fundamentals of Micro-fabrication - by M. Madou; Publisher: CRC Press; $2^{nd}$ edition.

2. Micro machined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

## Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

## End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECCDLO 8012 | Natural Language Processing | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | Exam Duration (Hrs.) | Term Work | Practical and Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ECCDLO 8012 | Natural Language Processing | 20 | 20 | 20 | 80 | 03 | -- | -- | 100 |

**Course Pre-requisite:**

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**Course Objectives:**

1. To understand natural language processing and to learn how to apply basic algorithms in this field.
2. To get acquainted with the basic concepts and algorithmic description of the main language levels:morphology, syntax, semantics, and pragmatics.
3. To design and implement applications based on natural language processing

**Course Outcomes:**

After successful completion of the course student will be able to:

1. Have a broad understanding of the field of natural language processing.
2. Understand the mathematical and linguistic preliminaries necessary for various processes in NLP
3. Be able to Design, implement and test algorithms for NLP problems
4. Perform Word-Level, Syntax-Level and Semantic-Level Analysis
5. Develop basic understanding of Pragmatics in NLP
6. Be able to apply NLP techniques to design real world NLP applications

| Module No. | Unit No. | Topics | Hrs. |
|---|---|---|---|
| **1.0** | | **Introduction to Natural Language Processing** | **06** |
| | **1.1** | The need of NLP. Generic NLP system, Levels of NLP | 02 |
| | **1.2** | Stages in building a Natural Language Processing System. Challenges and ambiguities in NLP Design | 04 |
| **2.0** | | **Mathematical and Linguistic Preliminaries** | **06** |
| | **2.1** | Probability Theory, Conditional Probability and Independence, Bayes Rule, Random Variables, Probability Distributions, Statistics, Counting, Frequency, Mean and Variance | 04 |
| | **2.2** | English Grammar, Parts of Speech, Phrase Structures | 02 |
| **3.0** | | **Word Level Analysis** | **06** |
| | **3.1** | Tokenization, Segmentation, Lemmatization, Edit Distance, Collocations, Porter Stemmer, N-gram Language Model | 04 |
| | **3.2** | Morphological Analysis, Derivational and Reflectional Morphology | 02 |
| **4.0** | | **Syntax-Analysis** | **08** |
| | **4.1** | Tag set for English, Penn Tree bank,  Introduction to Parts of Speech Tagging (POST) | 02 |
| | **4.2** | Markov Processes, Hidden Markov Models (HMM) | 02 |
| | **4.2** | Parts of Speech Tagging using Hidden Markov Models, Viterbi Algorithm | 04 |
| **5.0** | | **Semantic Analysis** | **08** |
| | **4.1** | Lexical Semantics, ambiguous words, word senses, Relations between senses: synonym, antonym, reversives, hyponym, hypernym, meronym, structured polysemy, metonymy, zeugma | 04 |
| | **4.2** | Introduction to WordNet, gloss, synset, sense relations in WordNet. Cosine distance between documents. Word sense disambiguation. | 04 |
| **6.0** | | **Pragmatics and applications of NLP** | **05** |
| | **6.1** | Reference resolution: Discourse model, Reference Phenomenon, Syntactic and Semantic Constraints on co reference | 03 |
| | **6.2** | Applications of NLP: Categorization, Summarization, Sentiment Analysis, Named Entity Recognition, Machine Translation, Information Retrieval, Question Answer System | 02 |
| | | **Total** | **39** |

**Text 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.

**Reference Books:**

1. Steven Bird, Ewan Klein, Natural Language Processing with Python, O'Reilly
2. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin (Editor), The Handbook of Computational Linguisticsand 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
   https://onlinecourses.nptel.ac.in/noc20_cs87/preview

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**Internal Assessment (20-Marks):**

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

**End Semester Examination (80-Marks):**

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questionswill be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECC DO801 | 3D Printing and Design | 03 | 02 | -- | 03 | 01 | -- | 04 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECC DO801 | 3D Printing and Design | 20 | 20 | 20 | 80 | 03 | 25 | 25 | -- | 150 |

**Course Pre-requisite: None**

**Course Objectives:**

1. To Understand the concept of Additive Manufacturing
2. To Classify the Various different AM Processes
3. To Demonstrate the concept of Direct Digital Manufacturing
4. To Implement the Concept of Design for Additive Manufacturing
5. To Understand RE Technologies

**Course Outcomes:**

**After successful completion of the course students will be able to:**

1. Repeat  the concept of Additive Manufacturing
2.  Describe the Various different AM Processes
3. Demonstrate the concept of Direct Digital Manufacturing
4. Demonstrate the Concept of Design for Additive Manufacturing
5. Implement RE Technologies

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **Introduction** | 5 |
| | | 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 <br> Applications of AM : Engineering, Planning, Aerospace, Automotive, Jewellery, Architecture, Arts, Medical, Bio Engineering | |
| 2 | | **Additive Manufacturing systems** | 10 |
| | | Vat Polymerisation, Powder Bed Fusion Based AM, Material Extrusion based, Material Jetting Based, Binder Jetting Based, Sheet Lamination based, Direct Energy Deposition based | |
| 3 | | **Direct Digital Manufacturing** | 6 |
| | | 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 | |
| 4 | | **Design for Additive Manufacturing** | 6 |
| | | Design for Additive Manufacturing <br> AM unique Capabilities : Shape Complexity, Heirarchical Complexity, Functional Complexity and Material Complexity. <br> Core DFAM Concepts and Objective : Complex Geometry, Integrated Assemblies, Customised Geometry, Multi-functional Design, Eliminnaaton of Conventional Design for Manufacturing Constraints | |
| 5 | | **Rapid Proto-typing** | 6 |
| | | Rapid Prototyping Data Formats : STL, File Format Problems and Limitations, Consequence of Building valid and Invalid Tessellated model, STL File repair, Newly Proposed File Formats. RapidProto-typing software Features of various Software. | |
| 6 | | **Reverse Engineering** | 6 |
| | | 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 <br> Other Related technologies: Reverse Engineering , Computer Aided Engineering, Haptic Feedback Based CAD | |
| | | **Total** | **39** |

**Text Books:**

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, Spinger

**Reference Books:**

1. Understanding Additive Manufacturing, Andreas Gebhardt, Hanser Publication, ISBN-13:978-1-56990-507-4
2. 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
3. Rapid Proto-typing Principles and Applications, Chua C. K., Leong K. F., and Lim C.S. , $2^{nd}$ edition , World Scientific, 2003
4. Rapid Proto-typing Theory and Practice, Ali Kamrani and EmadAbouel Nasr (Eds.), Springer, 2006

**Internal Assessment (IA):**

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

**End Semester Examination:**

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECC DO801 | Advanced Algorithms | 03 | 02 | -- | 03 | 01 | -- | 04 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Prac tical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECC DO801 | Advanced Algorithms | 20 | 20 | 20 | 80 | 03 | 25 | 25 | -- | 150 |

**Course Pre-requisite:** Data structure concepts, Discrete structures

**Course Objectives:**

1. To provide mathematical approaches for Analysis of Algorithms
2. To understand and solve problems using various algorithmic approaches
3. To analyse algorithms using various methods

**Course Outcomes:**

**At the end of the course learner will be able to**

1. Analyze the running time and space complexity of algorithms.
2. Describe, apply and analyze the complexity of divide and conquer, greedy and dynamic programming strategy.
3. Identify appropriate data structures and design techniques for different problems
4. Differentiate polynomial and non-deterministic polynomial algorithms.
5. Analyze various algorithms.

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| 1 | | **Introduction to analysis of algorithm** | 08 |
| | 1.1 | Mathematical background for algorithm analysis, Growth of function – Big – Oh, Omega, Theta notation, Complexity derivations, | |
| | 1.2 | Solving recurrences using Substitution Method, Recursion tree method and Master method | |
| | 1.3 | Complexity Classes: P, NP, NP Hard, NP Complete | |
| | 1.4 | Amortised Analysis -Aggregate Method, Accounting Method, Potential Method | |
| 2 | | **Divide and Conquer approach** | 04 |
| | 2.1 | General method,Binary Search, Merge Sort, Quick Sort, Randomized quick sort, and Min-max algorithm | |
| 3 | | **Greedy Algorithms** | 06 |
| | 3.1 | General Method, Knapsack Problem, Huffman's Codes , Minimum Spanning Tree, Kruskal's Algorithm , Prim's Algorithm , Dijkstra's Algorithm. | |
| 4 | | **Dynamic Programming Approach** | 08 |
| | 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 | |
| 5 | | **Maximum Flow** | 07 |
| | 5.1 | Flow networks, Ford Fulkerson method, Max bipartite matching , Push relabel algorithm , The relabel to front algorithm | |
| 6 | | **Classical Problems in Algorithms** | 06 |
| | 6.1 | Travelling Salesman problem, Subset Sum Problem, Matrix Multiplication, 15 puzzle , N-queens problem | |
| | | **Total** | **39** |

## Text 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.

## Reference Books:

1. M.R. Garey and D.S. Johnson, Computers and Intractability: A Guide to the Theory of NP-Completeness, Freeman, 1979.
2. 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

## Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

## End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECC DO8021 | Advanced Networking Technologies | 03 | - | -- | 03 | - | -- | 04 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | | Term Work | Practical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | | |
| ECC DO8021 | Advanced Networking Technologies | 20 | 20 | 20 | 80 | 03 | | - | -- | - | 100 |

**Course Pre-requisite:** Computer Networks

**Course Objectives:**

1. Understand the characteristic features of Various Wireless networks.
2. Understand the characteristic features of Various Wireless networks.
3. Introduce the need for network security and safeguards

**Course Outcomes:**

**After successful completion of the course students will be able to:**

1. Appreciate the need for Wireless networks and study the IEEE 802.11 Standards
2. Comprehend the significance of Asynchronous Transfer Mode(ATM).
3. Analyze the importance of Optical networking
4. Demonstrate knowledge of network design and security and management
5. Understand the concept of multimedia networks..

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| **1** | | **Wireless LAN and WAN Technologies** | **08** |
| | **1.1** | Introduction to Wireless networks : Infrastructure networks, Ad-hoc networks | |
| | **1.2** | IEEE 802.11 architecture and services | |
| | **1.3** | Medium Access Control sub-layers | |
| | **1.4** | CSMA/CA, Physical Layer, 802.11 Security considerations | |
| | **1.5** | Asynchronous Transfer Mode (ATM): Architecture, ATM logical connections, ATM cells , ATM Functional Layers, Congestion control and Quality of service | |
| **2** | | **Optical Networking** | **06** |
| | **2.1** | SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks | |
| | **2.2** | WDM, DWDM: Frame format, DWDM architecture ,Optical Amplifier , Optical cross connect Performance and design considerations. | |
| **3** | | **Routing in the Internet** | **08** |
| | **3.1** | Intra and inter domain Routing, Unicast Routing Protocols: RIP, OSPF, BGP | |
| | **3.2** | Multicast Routing Protocols ,Drawbacks of traditional Routing methods | |
| **4** | | **Network Security** | **08** |
| | **4.1** | Security goal, Security threats, security safeguards, firewall types and design, IPTABLES | |
| | **4.2** | Internet Security: Network Layer Security, Transport Layer Security, Application Layer Security | |
| **5** | | **Multimedia Information and Networking** | **06** |
| | **5.1** | Compression Fundamentals, Digital Representation, Compression techniques | |
| | **5.2** | Multimedia Communication across networks, RTP, RTSP, SIP,H..323 | |
| **6** | | **Network Design** | **03** |
| | **6.1** | 3 tier Network design layers: Application layer, Access layer | |
| | **6.2** | Backbone layers, Ubiquitous computing and Hierarchical computing | |
| | | **Total** | **39** |

## Text Books:

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

## Reference Books:

1. K. R. Rao et al: Multimedia Communication Systems, Prentice-Hall of India,.
2. Deven Shah , Ambavade, "Advanced Communication Networking"
3. Beherouz A Forouzan , "TCP /IP Protocol Suite" , Tata McGraw Hill Education ,4th edition

## Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

## End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECC DO802 | Multimedia System and Virtual reality | 03 | - | -- | 03 | - | -- | 03 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Prac tical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECC DO802 | Multimedia System and Virtual reality | 20 | 20 | 20 | 80 | 03 | - | - | -- | 100 |

**Course Pre-requisites:** Computer Fundamentals, Graphics, Communication Theory, ISO-OSI Model, Java Classes

**Course Objectives:**

1. To introduce students about basic fundamentals and key aspects of the multimedia system.
2. To provide knowledge of compression techniques of different multimedia components.
3. To discuss the multimedia authoring tools and security in multimedia systems.
4. To comprehend and analyse the fundamentals of virtual reality system.
5. To learn different pipeline and modelling techniques in virtual reality.
6. To understand various programming languages in virtual reality.

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

1. Understand the basics of multimedia and multimedia system architecture.
2. Analyse file formats and compression algorithms for different multimedia components.
3. Understand multimedia authoring system and apply different security techniques in multimedia environment.
4. Define the fundamentals of virtual reality and its related technologies.
5. Understand typical rendering pipeline and modelling techniques.
6. Design an application with the principles of virtual reality.

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| | | **Pre-requisites** | |
| 0 | | Computer Fundamentals, Graphics, Communication Theory, ISO-OSI Model, Java Class | 2 |
| 1 | | **Introduction to Multimedia** | 5 |
| | 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. | |
| | 1.2 | 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. | |
| 2 | | **Multimedia Types, File Formats and Compression Techniques** | 10 |
| | 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 | |
| | 2.2 | **Digital Audio:** Computer representation of sound, File Formats – WAV, MPEG Audio, Compression: PCM, DM, DPCM | |
| | 2.3 | **Digital Video**: Digitization of Video, types of video signals (component, composite and S-video), File Formats: MPEG Video, H.261, Compression: MPEG | |
| 3 | | **Multimedia Authoring and Security** | 6 |
| | 3.1 | **Authoring System**: Overview, Introduction to Authoring Tools, Features of Authoring Tools, Design Issue of Multimedia Authoring, Types of Authoring Systems. | |
| | 3.2 | **Digital Watermarking**: Concept, Visible and Invisible Watermarks, Watermarking Classification (Spatial Domain, Transform Domain, Feature Domain), Digital Watermarking Applications | |
| | 3.2 | **Steganography**: Concept and Types | |
| | 3.3 | **Image Authentication**: Issues and Digital Signature Based Image Authentication | |
| 4 | | **Introduction to Virtual Reality** | 4 |
| | 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 | |

| 5 | | **VR Rendering Pipeline and Modelling** | 6 |
|---|---|---|---|
| | 5.1 | Graphical Rendering Pipeline, Haptic Rendering Pipeline, OpenGL Rendering Pipeline, Geometric Modelling, Kinematic Modelling, Physical Modelling, BehaviourModelling | |
| 6 | | **VR Programming** | 6 |
| | 6.1 | VRML, Extensible 3D (X3D), Java 3D, OpenGL | |
| | | | |
| | | **Total** | 39 |

## Text Books:

1. Prabhat K. Andleigh&KiranThakrar, "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.

## Reference Books:

1. Steinmetz Ralf and NahrstedtKlara, "Multimedia: Computing, Communications and Applications", Pearson, 2008
2. AtulPuri, "Multimedia Systems, Standards, and Networks", 1st Edition, CRC Press, 2000.
3. Frank Y. Shih, "Multimedia Security: Watermarking, Steganography and Forensics", CRC Press, 2013.
4. Grigore C. Burdea, Philippe Coiffet, "Virtual Reality Technology", 2nd Edition, Wiley, 2003.
5. 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

**Internal Assessment (IA):**
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

**End Semester Examination:**
1. Question paper will comprise 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on the entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

| Course Code | Course Name | Teaching Scheme (Contact Hours) | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECCDLO 7025 | Quantum Computing | 03 | -- | -- | 03 | -- | -- | 03 |

| Course Code | Course Name | Examination Scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | Exam Duration (Hrs.) | Term Work | Practical and Oral | Total |
| | | Internal Assessment | | | End Sem. Exam. | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ECCDLO 7025 | Quantum Computing | 20 | 20 | 20 | 80 | 03 | -- | -- | 100 |

**Course pre-requisite:**

ECC303- Digital System Design
ECC301-Engineering Mathematics-III
ECCDLO5014- Data Structures and Algorithm
ECL404-Skill Lab: Python Programming

**Course Objectives:**
1. To understand basics of quantum computing
2. To understand mathematics required for quantum computing.
3. To understand building blocks of quantum computing.
4. To understand quantum algorithms.
5. To understand quantum hardware principles.
6. To understand tools for quantum computing.

**Course Outcome:**
After successful completion of the course student will be able to :-
1. Explain basic concepts of quantum computing
2. Explain mathematical fundamentals required for quantum computing.
3. Explain building blocks of quantum computing through architecture and programming models.
4. Explain quantum algorithms.
5. Explain quantum hardware building principles.
6. Explain usage of tools for quantum computing.

| Module No. | Unit No. | Topics | Hrs. |
|---|---|---|---|
| **1.0** | | Introduction to Quantum Computing | **07** |
| | 1.1 | Motivation for studying Quantum Computing | |
| | 1.2 | Origin of Quantum Computing | |
| | 1.3 | Quantum Computer vs. Classical Computer | |
| | 1.4 | Introduction to Quantum mechanics | |
| | 1.5 | Overview of major concepts in Quantum Computing<br>Qubits and multi-qubits states<br>Bloch Sphere representation<br>Quantum Superposition<br>Quantum Entanglement | |
| | 1.6 | Major players in the industry (IBM, Microsoft, Rigetti, D-Wave etc.) | |
| **2.0** | | Mathematical Foundations for Quantum Computing | **05** |
| | 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. | |
| **3.0** | | Building Blocks for Quantum Program | **08** |
| | 3.1 | Architecture of a Quantum Computing platform | |
| | 3.2 | Details of q-bit system of information representation:<br>Block Sphere<br>Multi-qubpits Stateys Quantum -superposAition of qpubits (vralid aind linvalid superposition)<br>Quantum Entanglement<br>Useful states from quantum algorithmic perceptive e.g. Bell State Operation on qubits: Measuring and transforming using gates.<br>Quantum Logic gates and Circuit<br>No Cloning Theorem and Teleportation | |
| | 3.3 | Programming model for a Quantum Computing Program<br>Steps performed on classical computer<br>Steps performed on Quantum Computer<br>Moving data between bits and qubits. | |
| **4.0** | | Quantum Algorithms and Error correction | **06** |
| | 4.1 | Quantum Algorithms<br>Shor's Algorithm<br>Grover's Algorithm<br>Deutsch's Algorithm<br>Deutsch -Jozsa Algorithm | |
| | 4.2 | Quantum error correction using repetition codes<br>3 qubit codes<br>Shor's 9 qubit error correction Code | |
| **5.0** | | Quantum Hardware | **10** |
| | 5.1 | Ion Trap Qubits<br>The DiVincenzo Criteria<br>Lagrangian and Hamiltonian Dynamics in a Nutshell: Dynamics of a Translating Rotor | |
| | 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 .. | |
|---|---|---|---|
| | 5.3 | Cavity Quantum Electrodynamics (cQED): Eigenstates of the Jaynes-Cummings Hamiltonian<br>Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits | |
| | 5.4 | Quantum computing with spins:<br>Quantum inverter realized with two exchange coupled spins in quantum dots, A 2-qubit spintronic universal quantum gate. | |
| **6.0** | | OSS Toolkits for implementing Quantum program | **03** |
| | 6.1 | IBM quantum experience | |
| | 6.2 | Microsoft Q<br>Rigetti PyQuil (QPU/QVM) | |
| | | **Total** | **39** |

**Text books:**

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.

**Reference books:**

1. The Second Quantum Revolution: From Entanglement to Quantum Computing and OtherSuper-Technologies, Lars Jaeger
2. La Guardia, Giuliano Gladioli "Quantum Error correction codes" Springer,2021

**Internal Assessment (20-Marks):**

Internal Assessment (IA) consists of two class tests of 20 marks each. IA-1 is to be conducted on approximately 40% of the syllabus and IA-2 will be based on remaining contents (approximately 40% syllabus but excluding contents covered in IA-I). Duration of each test shall be one hour. Average of the two tests will be considered as IA marks.

**End Semester Examination (80-Marks):**

Weightage to each of the modules in end-semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of **total 06** questions, each carrying **20 marks**.
2. **Question No: 01** will be **compulsory** and based on entire syllabus wherein 4 to 5 sub-questions will be asked.
3. Remaining questions will be mixed in nature and randomly selected from all the modules.
4. **Total 04 questions** need to be attempted.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECC DO802 | System Security | 03 | 02 | -- | 03 | | -- | 3 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Prac tical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECC DO802 | System Security | 20 | 20 | 20 | 80 | 03 | | | -- | 100 |

**Course Pre-requisite:** Computer Networks

**Course Objectives:**

1. To understand the fundamentals of system security.

2. To explore the working principles and utilities of various crypto algorithms including Secret key Cryptography and public key algorithms

3. To understand the various controls available for protection against internet attacks, including integrity check, firewalls, intruder detection systems.

4. To understand, and evaluate different attacks on Open Web Applications and Web services

5. To describe the mechanisms used to provide security in different infrastructure and networks.

6. To perform Security Auditing and Analysis

**Course Outcomes:**

**After successful completion of the course students will be able to:**

1. Understand the concept of vulnerabilities, attacks and protection mechanisms.

2. Understand theworkingof various crypto algorithms.

3. Analyzevarious controls available for protection against internet attacks.

4. Evaluate different attacks on Open Web Applications and Web services

5. Analyze mechanisms used to provide security in different infrastructure and networks

6. Perform security monitoring and testing of system

| Module No. | Unit No. | Contents | Hrs. |
|---|---|---|---|
| **1** | | **The Need for System Security** | 4 |
| | 1.1 | Risks, Threats, and Vulnerabilities,**Tenets of Information Systems Security (**Confidentiality,Integrity ,Availability ) | |
| | 1.2 | **Malicious Attack** <br><br> Birthday Attacks ,Brute-Force Password Attacks , <br><br> Dictionary Password Attacks, IP Address Spoofing <br><br> Hijacking ,Replay Attacks ,Man-in-the-Middle Attacks <br><br> Masquerading ,Eavesdropping ,Social Engineering, Phreaking ,Phishing ,Pharming . | |
| **2** | | **Cryptography** | 6 |
| | **2.1** | Cryptography : Overview of Cryptography : What is cryptography , encryption and decryption techniques ,Symmetric and asymmetric key cryptography : AES, DES, RSA, Knapsack cryptosystem. | |
| **3** | | Network Security | 9 |
| | 3.1 | Firewall: Need of Firewall, types of firewall- Packet Filters, Stateful Packet Filters, Application Gateways, Circuit gateways. Firewall Policies, Configuration, limitations, DMZ, VPN. | |
| | 3.2 | Intrusion Detection System Vulnerability Assessment, Misuse detection, Anomaly Detection, Network Based IDS, Host-Based IDS, Honeypots | |
| | 3.3 | Kerberos: Working, AS, TGS, SS | |
| | 3.4 | IP Security- Overview, Protocols- AH, ESP, Modes- transport and Tunnel. | |
| | 3.5 | Public key infrastructure Introduction, Certificates, (PKI): Certificate Authority, authority, Registration | |
| | 3.6 | X.509/PKIX certificate format. | |
| | 3.7 | Basic concepts of SNMP, SNMPv1 Community facility and SNMPv3 | |
| **4** | | **Web Security** | 7 |
| | 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. | |

| 5 | | **Infrastructure Security** | 9 |
|---|---|---|---|
| | 5.1 | **Physical Security**: Managerial, Technical And Physical Controls, Environmental Exposures And Controls, Physical Access Controls | |
| | 5.2 | **Wireless network Security:** IEEE 802.11xWireless LAN Security, Wireless Intrusion Detection System (WIDS) | |
| | 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 | |
| | 5.4 | **IOT Security:** IoT Concepts, IoT Attacks, IoT Hacking Methodology, IoT Hacking Tools, IoT Countermeasures | |
| | | | |
| 6 | | **Security Auditing and Analysis** | 4 |
| | 6.1 | How to define your audit plan? <br><br> What auditing benchmarks are ? <br><br> How to collect audit data? <br><br> Which post-audit activities you need to perform? <br><br> How to perform security monitoring? <br><br> Which types of log information you should capture? <br><br> How to verify security controls ? <br><br> • How to monitor and test your security systems? | |
| | | | |
| | | **Total** | **39** |

## Text Books:

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

## Reference Books:

1. Web Application Hackers Handbook by Wiley.
2. Information Security The Complete Reference, 2nd Edition ,**Mark Rhodes-Ousley,**McGraw Hill Education
3. Computer Security, Dieter Gollman, Third Edition, Wiley
4. CCNA Security Study Guide, Tim Boyle, Wiley
5. Introduction to Computer Security, Matt Bishop, Pearson.
6. Cloud Security and Privacy, Tim Mather, Subra Kumaraswamy, Shahed Latif ,O'Reilly

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## Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered as final IA marks

## End Semester Examination:

1. Question paper will comprise of 6 questions, each of 20 marks.
2. Total 4 questions need to be solved.
3. Question No.1 will be compulsory and based on entire syllabus wherein sub questions of 2 to 5 marks will be asked.
4. Remaining questions will be selected from all the modules.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECL 801 | Robotics lab | -- | 02 | -- | -- | 01 | -- | 01 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Pract ical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECL 801 | Robotics lab | -- | -- | -- | -- | -- | 25 | -- | 25 | 50 |

**Laboratory outcomes:**

**After successful completion of the laboratory, students will be able to:**

1. Use the acquired knowledge in solving direct and inverse kinematics problems
2. Select and Implement suitable task and trajectory planning algorithms.
3. Develop suitable programming tools for Robotic applications
4. Construct Robots/Robotic arms for automation applications

## Term Work:

Term work consists of performing minimum 6 experiments covering entire syllabus of Robotics, one mini project and two assignments. The experiments should be student centric and attempt should be made to make experiments more meaningful and interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and/or Oral exam will be based on the entire syllabus.

## Suggested List of Experiments

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

**Note:** Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECL 802 | MEMS Technology | -- | 02 | -- | -- | 01 | -- | 01 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECL 802 | MEMS Technology | -- | -- | -- | -- | -- | 25 | 25 | -- | 50 |

**Laboratory outcomes:**

**After completing laboratory sessions, students will be able to**

1. Determine various parameters for MEMS devices.
2. Plot characteristics of MEMS devices.
3. Select particular device for specific application.
4. Observe effect of device parameters variation on its performance.

**Term Work:**

At least 10 experiments covering entire syllabus of **MEMS Technology ECC DO801** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Case study experiment can be given to cover advance development in the subject. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

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

**Note:** Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECL 802 | Natural Language processing | -- | 02 | -- | -- | 01 | -- | 01 |

| Subject Code | Subject Name | Theory Marks | | | | | Term Work | Practical/ Oral | Total |
|---|---|---|---|---|---|---|---|---|---|
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | |
| ECL 802 | Natural Language processing | -- | -- | -- | -- | -- | 25 | 25 | 50 |

**Laboratory outcomes:**

**After successful completion of the laboratory, students will be able to:**

1. Design, implement and test algorithms for NLP problems.
2. Understand the mathematical and linguistic foundations underlying approaches to the various areas in NLP.
3. Apply NLP techniques to design real world NLP applications such as machine translation, text categorization, text summarization, information extraction...etc.

**Term Work:**

At least 8 experiments covering entire syllabus of **Natural Language processing ECC DO801** should be set to have well predefined inference and conclusion. Additionally, **a Case Study/ Mini Project** based on any Application is mandatory. The experiments should be student centric and attempt should be made to make experiments more meaningful and interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

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

**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.

**Note:** Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECL 802 | 3D printing and Design Lab | -- | 02 | -- | -- | 01 | -- | 01 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Pract ical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Te st 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECL 802 | 3D Printing and Design Lab | -- | -- | -- | -- | -- | 25 | 25 | -- | 50 |

**Term Work:**

At least 10 experiments covering entire syllabus of **3D Printing and Design ECC DO801** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

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

**Note:** Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

| Subject Code | Subject Name | Teaching Scheme | | | Credits Assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Practical | Tutorial | Theory | Practical | Tutorial | Total |
| ECL 802 | Advanced Algorithms Lab | -- | 02 | -- | -- | 01 | -- | 01 |

| Subject Code | Subject Name | Examination Scheme | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory Marks | | | | | Term Work | Practical | Oral | Total |
| | | Internal assessment | | | End Sem. Exam | Exam duration Hours | | | | |
| | | Test 1 | Test 2 | Avg of Test 1 and Test 2 | | | | | | |
| ECL 802 | Advanced Algorithms Lab | 20 | 20 | 20 | 80 | 3 | 25 | 25 | -- | 50 |

**Laboratory Outcomes:**

**After completing laboratory sessions, students will be able to**

1. Understand the methods of designing and analyzing algorithms.
2. Design and implement efficient algorithms for a specified application.
3. Strengthen the ability to identify and apply the suitable algorithm for the given real-world problem.
4. Analyze worst-case running time of algorithms and understand fundamental algorithmic problems.

**Term Work:**

At least 10 experiments covering entire syllabus should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiment must be graded from time to time. The grades should be converted into marks as per the Credit and Grading System manual and should be added and averaged. The grading and term work assessment should be done based on this scheme. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. Practical and Oral exam will be based on the entire syllabus.

Suggested List of Experiments

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

**Note:** Suggested List of Experiments is indicative. However, flexibilities lie with individual course instructor to design and introduce new, innovative and challenging experiments, (limited to maximum 30% variation to the suggested list) from within the curriculum, so that, the fundamentals and applications can be explored to give greater clarity to the students and they can be motivated to think differently.

| e Code | Course Name | Credits |
|--------|-------------|---------|
| **ILO8021** | **Project Management** | **03** |

**Objectives:**

1. To familiarize the students with the use of a structured methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.
2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.

**Outcomes:** Learner will be able to…

1. Apply selection criteria and select an appropriate project from different options.
2. Write work break down structure for a project and develop a schedule based on it.
3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.
4. Use Earned value technique and determine & predict status of the project.
5. Capture lessons learned during project phases and document them for future reference

| Module | Detailed Contents | Hrs |
|--------|-------------------|-----|
| **01** | **Project Management Foundation:**<br><br>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). | 5 |
| **02** | **Initiating Projects:**<br><br>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. | 6 |
| **03** | **Project Planning and Scheduling:**<br><br>Work Breakdown structure (WBS) and linear responsibility chart, Interface<br><br>Co-ordination and concurrent engineering, Project cost estimation and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, | 8 |

| | | |
|---|---|---|
| | GANTT chart. Introduction to Project Management Information System (PMIS). | |
| 04 | **Planning Projects:**<br><br>Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan.<br><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 | 6 |
| 05 | **5.1 Executing Projects:**<br><br>Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects.<br><br>Team management, communication and project meetings.<br><br>**5.2 Monitoring and Controlling Projects:**<br><br>Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.<br><br>**5.3 Project Contracting**<br><br>Project procurement management, contracting and outsourcing, | 8 |
| 06 | **6.1 Project Leadership and Ethics:**<br><br>Introduction to project leadership, ethics in projects.<br><br>Multicultural and virtual projects.<br><br>**6.2 Closing the Project:**<br><br>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. | 6 |

**Assessment:**

**Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**REFERENCES:**

1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7$^{th}$Ed.

2. A Guide to the Project Management Body of Knowledge (PMBOK$^{\circledR}$ Guide), 5$^{th}$ 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 | Credits |
|---|---|---|
| **ILO8022** | **Finance Management** | **03** |

**Objectives:**

1. Overview of Indian financial system, instruments and market
2. Basic concepts of value of money, returns and risks, corporate finance, working capital and its management
3. Knowledge about sources of finance, capital structure, dividend policy

**Outcomes:** Learner will be able to…

1. Understand Indian finance system and corporate finance
2. Take investment, finance as well as dividend decisions

| Module | Detailed Contents | Hrs |
|---|---|---|
| **01** | **Overview of Indian Financial System:** Characteristics, Components and Functions of Financial System.<br><br>**Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.<br><br>**Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market<br><br>**Financial Institutions:** Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges | 06 |
| **02** | **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.<br><br>**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. | 06 |
| **03** | **Overview of Corporate Finance:** Objectives of Corporate Finance; Functions of Corporate Finance—Investment Decision, Financing Decision, and Dividend Decision.<br><br>**Financial Ratio Analysis:** Overview of Financial Statements—Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; | 09 |

| | | |
|---|---|---|
| | Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis. | |
| 04 | **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)<br><br>**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. | 10 |
| 05 | **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.<br><br>**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 | 05 |
| 06 | **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 | 03 |

## Assessment:

**Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**REFERENCES:**

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 | Credits |
|---|---|---|
| ILO8023 | Enterpreneurship Development and Management | 03 |

**Objectives:**

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

**Outcomes:** Learner will be able to…

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

| Module | Detailed Contents | Hrs |
|---|---|---|
| 01 | **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<br><br>Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship | 04 |
| 02 | **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 Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur<br><br>**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 | 09 |
| 03 | Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises | 05 |
| 04 | **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 organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., | 08 |

| | | |
|---|---|---|
| | Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc | |
| **05** | **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 | 08 |
| **06** | **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 | 05 |

## Assessment:
**Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**REFERENCES:**

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 | Credits |
|---|---|---|
| **ILO8024** | **Human Resource Management** | **03** |

**Objectives:**

1. To introduce the students with basic concepts, techniques and practices of the human resource management.
2. To provide opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations.
3. To familiarize the students about the latest developments, trends & different aspects of HRM.
4. To acquaint the student with the importance of inter-personal & inter-group behavioral skills in an organizational setting required for future stable engineers, leaders and managers.

**Outcomes:** Learner will be able to…

1. Understand the concepts, aspects, techniques and practices of the human resource management.
2. Understand the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.
3. Gain knowledge about the latest developments and trends in HRM.
4. 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 | Detailed Contents | Hrs |
|---|---|---|
| **01** | **Introduction to HR**<br><br>• Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.<br><br>• Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues. | 5 |
| **02** | **Organizational Behavior (OB)**<br><br>• Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues<br>• Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness<br><br>• Perception: Attitude and Value, Effect of perception on Individual Decision- | 7 |

| | | |
|---|---|---|
| | making, Attitude and Behavior.<br><br>• Motivation: Theories of Motivation and their Applications for Behavioral Change (Maslow, Herzberg, McGregor);<br><br>• 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><br>• Case study | |
| 03 | **Organizational Structure &Design**<br><br>• Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.<br><br>• Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.<br><br>• Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies. | 6 |
| 04 | **Human resource Planning**<br><br>• Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.<br><br>• Performance Appraisal Systems: Traditional & modern methods, Performance Counseling, Career Planning.<br><br>• Training & Development: Identification of Training Needs, Training Methods | 5 |
| 05 | **Emerging Trends in HR**<br><br>• Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development , managing processes & transformation in HR. Organizational Change, Culture, Environment<br><br>• 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. | 6 |
| 06 | **HR & MIS**<br><br>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<br><br>**Strategic HRM**<br><br>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 | 10 |

| | **Labor Laws & Industrial Relations**<br><br>Evolution of IR, IR issues in organizations, Overview of Labor Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act | |

## Assessment:

**Internal:**

Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**REFERENCES:**

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

| Course Code | Course Name | Credits |
|---|---|---|
| ILO8025 | **Professional Ethics and Corporat Social Responsibility (CSR)** | **03** |

**Objectives:**

1. To understand professional ethics in business
2. To recognized corporate social responsibility

**Outcomes:** Learner will be able to…

1. Understand rights and duties of business
2. Distinguish different aspects of corporate social responsibility
3. Demonstrate professional ethics
4. Understand legal aspects of corporate social responsibility

| Module | Detailed Contents | Hrs |
|---|---|---|
| 01 | **Professional Ethics and Business:** The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business | 04 |
| 02 | **Professional Ethics in the Marketplace:** Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy<br><br>**Professional Ethics and the Environment:** Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources | 08 |
| 03 | **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><br>**Professional Ethics of Job Discrimination:** Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs. | 06 |
| 04 | **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><br>Trajectory of Corporate Social Responsibility in India | 05 |
| 05 | **Corporate Social Responsibility:** Articulation of Gandhian Trusteeship | 08 |

| | Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India | |
|---|---|---|
| **06** | **Corporate Social Responsibility in Globalizing India:** Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013. | 08 |

## Assessment:

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Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or assignment on live problems or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**REFERENCES:**

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 | Credits |
|---|---|---|
| **ILO8026** | **Research Methodology** | **03** |

**Objectives:**

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation

**Outcomes:** Learner will be able to…

1. Prepare a preliminary research design for projects in their subject matter  areas
2. Accurately collect, analyze and report data
3. Present complex data or situations clearly
4. Review and analyze research findings

| Module | Detailed Contents | Hrs |
|---|---|---|
| **01** | **Introduction and Basic Research Concepts**<br><br>**1.1**  Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology<br><br>**1.2** Need of Research in Business and Social Sciences<br><br>**1.3** Objectives of Research<br><br>**1.4 Issues** and Problems in Research<br><br>**1.5** Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical | **09** |
| **02** | **Types of Research**<br><br>**2.1.** Basic Research<br><br>**2.2.** Applied Research<br><br>**2.3.** Descriptive Research<br><br>**2.4.** Analytical    Research<br><br>**2.5.** Empirical Research<br><br>**2.6** Qualitative and Quantitative Approaches | **07** |

| | | |
|---|---|---|
| 03 | **Research Design and Sample Design**<br><br>**3.1** Research Design – Meaning, Types and Significance<br><br>**3.2** Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors | 07 |
| 04 | **Research   Methodology**<br><br>**4.1** Meaning of Research Methodology<br><br>**4.2**. Stages in Scientific Research Process:<br><br>**a.** Identification and Selection of Research Problem<br><br>**b.** Formulation of Research Problem<br><br>**c.** Review of Literature<br><br>**d.** Formulation of Hypothesis<br><br>**e.** Formulation of research Design<br><br>**f.** Sample Design<br><br>**g.** Data Collection<br><br>**h.** Data Analysis<br><br>**i.** Hypothesis testing and Interpretation of Data<br><br>**j.** Preparation of Research Report | 08 |
| 05 | **Formulating Research Problem**<br><br>**5.1** Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis | 04 |
| 06 | **Outcome of Research**<br><br>**6.1** Preparation of the report on conclusion reached<br><br>**6.2** Validity Testing & Ethical Issues<br><br>**6.3** Suggestions and Recommendation | 04 |

## <u>Assessment</u>:

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**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**REFERENCES:**

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 | Credits |
|:---:|:---:|:---:|
| **ILO8027** | **IPR and Patenting** | **03** |

**Objectives:**

1. To understand intellectual property rights protection system
2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures
3. To get acquaintance with Patent search and patent filing procedure and applications

**Outcomes:** Learner will be able to…

1. understand Intellectual Property assets
2. assist individuals and organizations in capacity building
3. work for development, promotion, protection, compliance, and enforcement of Intellectual Property and Patenting

| Module | Detailed Contents | Hr |
|:---:|:---|:---:|
| **01** | **Introduction to Intellectual Property Rights (IPR)**: Meaning of IPR, Different category of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plantvariety protection, Geographical indications, Transfer of technology etc.<br><br>**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 | 05 |
| **02** | **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<br><br>**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. | 07 |
| **03** | **Emerging Issues in IPR:** Challenges for IP in digital economy, e-commerce, human genome,biodiversity and traditional knowledge etc. | 05 |
| **04** | **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 | 07 |

| | | |
|---|---|---|
| | of getting a patent | |
| **05** | **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.) | 08 |
| **06** | **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><br> **Patent databases:** Important websites, Searching international databases | 07 |

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Assessment consists of two tests out of which; one should be compulsory class test and the other is either a class test or at least 6 assignments on complete syllabus or course project.

**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

**REFERENCE 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 | Credits |
|---|---|---|
| **ILO8028** | **Digital Business Management** | **03** |

**Objectives:**

1. To familiarize with digital business concept
2. To acquaint with E-commerce
3. To give insights into E-business and its strategies

**Outcomes:** The learner will be able to …..

1. Identify drivers of digital business
2. Illustrate various approaches and techniques for E-business and management
3. Prepare E-business plan

| Module | Detailed content | Hours |
|---|---|---|
| 1 | **Introduction to Digital Business-**<br><br>Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts<br><br>Difference between physical economy and digital economy,<br><br>**Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services)<br><br>Opportunities and Challenges in Digital Business, | 09 |
| 2 | **Overview of E-Commerce**<br><br>**E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement<br><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<br><br>Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing<br><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 | 06 |

| | | |
|---|---|---|
| 3 | **Digital Business Support services**: ERP as e –business backbone, knowledge Tope Apps, Information and referral system<br><br>**Application Development:** Building Digital business Applications and Infrastructure | 06 |
| 4 | **Managing E-Business**-Managing Knowledge, Management skills for e-business, Managing Risks in e –business<br><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 | 06 |
| 5 | **E-Business Strategy**-E-business Strategic formulation- Analysis of Company's Internal and external environment, Selection of strategy,<br><br>E-business strategy into Action, challenges and E-Transition<br><br>(Process of Digital Transformation) | 04 |
| 6 | **Materializing e-business: From Idea to Realization**-Business plan preparation<br><br>**Case Studies and presentations** | 08 |

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**End Semester Theory Examination:**

Some guidelines for setting up the question paper. Minimum 80% syllabus should be covered in question papers of end semester examination. **In question paper weightage of each module will be proportional to number of respective lecture hours as mention in the syllabus.**

1. Question paper will comprise of total six question
2. All question carry equal marks
3. Questions will be mixed in nature (for example supposed Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four question need to be solved.

## References:

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 | Credits |
|---|---|---|
| ILO8029 | **Environmental Management** | **03** |

**Objectives:**

1. Understand and identify environmental issues relevant to India and global concerns
2. Learn concepts of ecology
3. Familiarise environment related legislations

**Outcomes:** Learner will be able to…

1. Understand the concept of environmental management
2. Understand ecosystem and interdependence, food chain etc.
3. Understand and interpret environment related legislations

| Module | Detailed Contents | Hrs |
|---|---|---|
| **01** | Introduction and Definition of Environment: Significance of Environment Management for contemporary managers, Career opportunities. <br><br> Environmental issues relevant to India, Sustainable Development, The Energy scenario. | 10 |
| **02** | 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. | 06 |
| **03** | Concepts of Ecology: Ecosystems and interdependence between living organisms, habitats, limiting factors, carrying capacity, food chain, etc. | 05 |
| **04** | Scope of Environment Management, Role & functions of Government as a planning and regulating agency. <br><br> Environment Quality Management and Corporate Environmental Responsibility | 10 |
| **05** | Total Quality Environmental Management, ISO-14000, EMS certification. | 05 |
| **06** | 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. | 03 |

## Assessment:

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**End Semester Theory Examination:**

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4. Only Four question need to be solved.

**REFERENCES:**

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
Environment and Ecology, Majid Hussain, 3$^{rd}$ Ed. Access Publishing.2015

| Subject code | Subject Name | Teaching scheme | | | Credit assigned | | | |
|---|---|---|---|---|---|---|---|---|
| | | Theory | Pract. | Tut. | Theory | Pract. | Tut. | Total |
| ISP801 | Major Project – II | -- | 12# | -- | -- | 6 | -- | 6 |

# Indicates workload of Learner (Not Faculty)

| Sub Code | Subject Name | Examination scheme | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Theory (out of 100) | | | | Term work | Pract. and Oral | Oral | Total |
| | | Internal Assessment | | | End sem Exam | | | | |
| | | Test1 | Test2 | Avg. | | | | | |
| ISP801 | Major Project – II | -- | -- | -- | -- | 100 | -- | 50 | 150 |

| Subject Code | Subject Name | Credits |
|---|---|---|
| ISP801 | Major Project – II | 3 |
| **Course Objectives** | **The course is aimed**<br>1. To acquaint with the process of identifying the needs and converting it into the problem.<br>2. To familiarize the process of solving the problem in a group.<br>3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.<br>4. To inculcate the process of self-learning and research. | |
| **Course Outcomes** | **On successful completion of course learner/student will be able to:**<br>1  Identify problems based on societal /research needs.<br>2  Apply Knowledge and skill to solve societal problems in a group.<br>3  Develop interpersonal skills to work as member of a group or leader.<br>4  Draw the proper inferences from available results through theoretical/ experimental/simulations.<br>5  Analyze the impact of solutions in societal and environmental context for sustainable development.<br>6  Use standard norms of engineering practices<br>7  Excel in written and oral communication.<br>8  Demonstrate capabilities of self-learning in a group, which leads to lifelong learning.<br>9  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 statement for major project in consultation with faculty supervisor/head of department/internal committee of faculties.

- Student shall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of major project.

- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.

- Faculty supervisor may give inputs to students during major project activity; however, focus shall be on self-learning.

- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.

- Students shall convert the best solution into 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 the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the major Projects.

## Guidelines for Assessment of Major Project:
### Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of major project to be evaluated on continuous basis, minimum two reviews in the semester.

- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.

- Distribution of Term work marks for both semesters shall be as below;

  - Marks awarded by guide/supervisor based on log book     : 30
  - Marks awarded by review committee                       : 30
  - Quality of Project report                               : 40

## 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 prototype to be conducted.
- Second review shall be based on poster presentation cum demonstration of working model in 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 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

***************