AC No: 2/2022, 11th July 2022
Item No.: 6.33 (R)

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	B.E in Electronics & Computer Science (ECS)
2	Eligibility for Admission	**After Passing Third Year Engineering as per the Ordinance 0.6244**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6244**
5	No. of Years / Semesters	**4 Years / 8 Semesters**
6	Level	~~P.G.~~ / **U.G.**/ ~~Diploma / Certificate~~ (Strike out which is not 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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Programme Structure for Bachelor of Engineering (B.E.) Electronics and Computer Science

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 VII

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		TH	PR	Tut	TH	Pract	Tut	Total
ECC 701	VLSI Design	3	-	-	3	-	-	**3**
ECC 702	Internet of Things	3	-	-	3	-	-	**3**
ECC DO701	Department Level Optional Course - III	3	-	-	3	-	-	**3**
ECC DO702	Department Level Optional Course - IV	3	-	-	3	-	-	**3**
ECC IO701	Institute Level Optional Course - I	3	-	-	3	-	-	**3**
ECL701	VLSI Design Lab	-	2			1		**1**
ECL702	Internet of Things Lab	-	2	-	-	1	-	**1**
ECL703	Department Level Optional Course - III Lab	-	2	-	-	1	-	**1**
ECP701	Major Project - I	-	6	-	-	3	-	**3**
Total		**15**	**12**	**-**	**15**	**6**	**-**	**21**

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 701	VLSI Design	20	20	20	80	03	-	-	**100**
ECC 702	Internet of Things	20	20	20	80	03	-	-	**100**
ECC DO701	Department Level Optional Course - III	20	20	20	80	03	-	-	**100**
ECC DO702	Department Level Optional Course - IV	20	20	20	80	03	-	-	**100**
ECC IO701	Institute Level Optional Course - I	20	20	20	80	03	-	-	**100**
ECL701	VLSI Design Lab	-	-	-	-	-	25	25	**50**
ECL702	Internet of Things Lab	-	-	-	-	-	25	25	**50**
ECL703	Department Level Optional Course - III Lab	-	-	-	-	-	25	25	**50**
ECP701	Major Project - I	-	-	-	-	-	50	-	**50**
Total				**100**	**400**	**-**	**125**	**75**	**700**

Department Level Optional Courses:

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

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 701	VLSI 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 701	VLSI Design	20	20	20	80	03	25	25	--	150

Course Pre-requisite: Electronic Devices (ECC 302)
                  Electronic Circuits (ECC402)
                  Digital Electronics (ECC 303)

Course Objectives:

1. To understand VLSI Design flow and technology trends.
2. To realise MOS based circuits using different design styles.
3. To study semiconductor memories using MOS logic.
4. To study adder, multiplier and shifter circuits for realizing data path design.
5. Understand the Backend flow of the IC Fabrication

Course Outcomes:

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

1. Demonstrate a clear understanding of VLSI Design flow, technology trends, scaling and MOSFET models.
2. Design and analyse MOS based inverters.
3. Realise MOS based circuits using different design styles.
4. Realise semiconductor memories, adder, multiplier and shifter circuits using CMOS logic.
5. Understand the flow of IC Fabrication

Module No.	Unit No.	Contents	Hrs.
1		**VLSI Design flow and Technology Trends**	05
	1.1	VLSI Design Flow: Full custom and Semicustom IC design flow	
	1.2	Semiconductor Manufacturing: Semiconductor technology trend,clean rooms, Wafer cleaning and Gettering. Fabrication flowchart for steps in IC fabrication	
	1.3	Scaling: Types of scaling, comparison of MOSFET Model levels	
	1.4	Technology Comparison: Comparison of BJT and MOS technologies, long channel and short channel MOS devices	
2		**MOSFET Inverters**	08
	2.1	Introduction to MOS inverters: Active and passive load nMOS inverters, CMOS inverter and their comparison	
	2.2	Circuit Analysis of MOS InvertersStatic Analysis of Resistive nMOS and CMOS Inverters: Calculation of critical voltages and noise margins	
	2.3	Design of symmetric CMOS inverter	
	2.4	Analysis of CMOS inverter: Calculation of rise time, fall time and propagation delay	
	2.5	Various components of power dissipation in CMOS circuits	
3		**MOS Circuit Design Styles**	07
	3.1	Static CMOS	
	3.2	Pseudo NMOS design styles	
	3.3	Pass transistor, Transmission gate	
	3.4	Dynamic: C^2MOS	
	3.5	Significance of Stick diagram and Design rules, Layout of CMOS NAND, CMOS NOR	
4		**Combinational and Sequential Circuit Realization**	07
	4.1	Analysis and design of 2-I/P NAND, 2-I/P NOR and complex Boolean function realization using equivalent CMOS inverter for simultaneous switching, Complex Boolean function realization using various design stylesand Basic gates and MUX realization using pass transistor and transmission gate logic	
	4.2	SR Latch, JK FF, D FF, 1 Bit Shift Register realization using CMOS logic	
5		**Semiconductor Memories**	06
	5.1	SRAM: 6T SRAM operation, design strategy, read/write circuits, sense amplifier,	
	5.2	DRAM: 1TDRAM, operation modes, leakage currents, refresh operation, physical design	
	5.3	ROM Array: NAND and NOR based ROM array	
	5.4	Flash memory: F-N tunnelling	
6		**Data Path Design**	06
	6.1	Adder: CLA adder, MODL, Manchester carry chain, High-speed adders: carry skip, carry select and carry save	
	6.2	Multipliers and shifter: Array multiplier and barrel shifter	
		Total	**39**

Text Books:

1. CMOS Digital Integrated Circuits Analysis and Design, Sung-Mo Kang and Yusuf Leblebici, Tata McGraw Hill, Revised 4thEdition.
2. Introduction to VLSI Circuits and Systems, John P. Uyemura, Wiley India Pvt. Ltd.
3. Sorab K. Gandhi, "VLSI Fabrication Principles", Wiley, Student Edition.

Reference Books:

1. Digital Integrated Circuits: A Design Perspective, Jan M. Rabaey, Anantha ChandrakasanBorivoje Nikolic, Pearson Education, 2nd Edition
2. Basic VLSI Design, Douglas A Pucknell, Kamran Eshraghian, Prentice Hall of India Private Ltd.
3. Logical Effort: Designing Fast CMOS Circuits, Ivan Sutherlan and Bob Sproull
4. Basics of CMOS Cell Design, Etienne Sicard and Sonia Delmas Bendhia, Tata McGraw Hill
5. CMOS VLSI Design: A Circuits and Systems Perspective, Neil H. E. Weste, David Harris and Ayan Banerjee, Pearson Education
6. Analysis and Design of Digital Integrated Circuits, David Hodges, Horace Jackson, Resve Saleh, McGraw-Hill, Inc.
7. Advanced Semiconductor Memories: Architectures, Designs, and Applications, Ashok K. Sharma, Wiley Publication
8. Magnetic Memory Technology: Spin- Transfer- Torque MRAM and Beyond, Denny D.Tang, Chi-Feng Pai, Wiley online Library
9. Resistive Switching: From Fundamentals of Nanoionic Redox Processes to Memristive Device Applications, Daniele Ielmini , Rainer Waser, Wiley online Library

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 702	Internet of Things	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 702	Internet of Things	20	20	20	80	03	25	-----	25	150

Course Pre-requisite: Computer Networks, Embedded Systems, Web Technologies

Course Objectives:

1. To understand the basic building blocks of IoT
2. To understand various IoT protocols.
3. To introduce data handling in IoT
4. To understand the Design Methodology in IoT through case studies.

Course Outcomes:

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

1. Understand concepts, functional blocks and communication methodology relevant to IoT.
2. Identify various components of IoT
3. Compare various communication protocols for IoT.
4. Understand various methods for data handling in IoT-based systems.
5. Design basic applications based on IoT using specific components.
6. Introduce various security issues in IoT

Module No.	Unit No.	Contents	Hrs.
1		**Introduction to IoT**	5
	1.1	Definition and Characteristics of IoT	
	1.2	IoT Protocols	
	1.3	IoT Functional Blocks	
	1.4	IoT Communication Models	
	1.5	IoT Communication APIs :- REST and WebSockets	
	1.6	IoT Enabling Technologies	
	1.7	Introduction to M2M and Difference between IoT and M2M	
2		**Components(Things) in IoT**	5
	2.1	Sensor Technology, Examples of Sensors	
	2.2	Actuators	
	2.3	Applications of RFID and WSN in IoT	
	2.4	Exemplary Device: - R–Pi and its Interfaces, PCDuino, BeagleBone	
3		**Data Handling in IoT**	9
	3.1	Data Acquiring and Storage, Organizing the Data, Transactions and Business Processes, Analytics	
	3.2	Data Collection, Storage and Computing Using Cloud Platform,	
		Introduction to Cloud Computing, Virtualization, Cloud Models	
		Cloud Services	
		IoT Cloud-based Data Collection, Storage, Computing using Xively	
4		**Design Principles for Web Connectivity**	10
	4.1	Communication Technologies – A comparison	
	4.2	Web Communication Protocols for connected devices:- CoRE Environment, CoAP, LWM2M, MQTT, XMPP, HTTP, SOAP Protocols	
	4.3	LPWAN Fundamentals: LORA and NBIoT	
5		**IoT Design Methodology**	6
	5.1	Defining Specifications About**: -** Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device and Component Integration: - Case Studies of Home automation, Weather Monitoring	
	5.2	IoT Levels and Deployment Templates	
	5.3	Supply Chain Management	
6		**IoT Security and Vulnerabilities Solutions**	4
	6.1	Iot Security Tomography and Layered Attacker Model	
	6.2	Identity Management, Establishment, Access Control and Secure Message Communication	
	6.3	Security Protocols	
		Total	**39**

Text Books:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach, Universities Press.

2. Raj Kamal, " Internet of Things: Architecture and Design Principles", McGraw Hill Education ,First edition

3. David Hanes ,Gonzalo salgueiro"IoT Fundamentals Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, Kindle 2017 Edition

4. Andrew Minteer ,"Analytics for the Internet of Things(IoT)", Kindle Edition

Reference Books:

1. Adrian McEwen, Hakim Cassimally, : Designing the Internet of Things", Paperback, First Edition

2. Yashavant Kanetkar, Shrirang Korde: Paperback "21 Internet of Things (IOT) Experiments", BPB Publications

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 DO701	Department Level Optional Course - III (Deep Learning)	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 DO701	Department Level Optional Course - III (Deep Learning)	20	20	20	80	03	25	25	--	150

Course Prerequisite: Basic Mathematics, Linear Algebra, Machine Learning

Course Objectives:

1. To develop mathematical concepts required for Deep Learning algorithms
2. To gain an in-depth understanding of training Deep Neural Networks.
3. To acquire knowledge of advanced concepts of Convolution Neural Networks, Autoencoders and Recurrent Neural Networks
4. To get familiarised with the recent trends in Deep Learning.

Course Outcomes:

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

1. Understand the basic knowledge of Neural Networks
2. Explain the process of training, optimization and Regularization of Deep Neural Networks
3. Design supervised models for DNN
4. Design unsupervised model for DNN
5. Select suitable DNN model for a given application

Module No.	Unit No.	Contents	Hrs.
1		**Introduction**	5
	1.1	Biological neuron, Mc-Culloch Pitts Neuron, Perceptron, Perceptron Learning, Delta learning, Multilayer Perceptron: Linearly separable, linearly non-separable classes.	
	1.2	Deep Networks: Fundamentals, Brief History, Three Classes of Deep Learning Basic Terminologies of Deep Learning	
2		**Training, Optimization and Regularization of Deep Neural Network**	
	2.1	**Training Feedforward DNN** Multi Layered Feed Forward Neural Network, Learning Factors, Activation functions: Tanh, Logistic, Linear, Softmax, ReLU, Leaky ReLU, Loss functions: Squared Error loss, Cross Entropy, Choosing output function and loss function	6
	2.2	**Optimization** Learning with backpropagation, Learning Parameters: Gradient Descent (GD), Stochastic and Mini Batch GD, Momentum Based GD, Nesterov Accelerated GD, AdaGrad, Adam, RMSProp	
	2.3	**Regularization** Overview of Overfitting, Types of biases, Bias Variance Tradeoff Regularization Methods: L1, L2 regularization, Parameter sharing, Dropout, Weight Decay, Batch normalization, Early stopping, Data Augmentation, Adding noise to input and output.	
3		**Convolutional Neural Networks (CNN): Supervised Learning**	
	3.1	Convolution Operation, Motivation, Basic structure of a convolutional neural network: Padding, strides, pooling, fully connected layers, interleaving between layers	
	3.2	Training a convolutional network: Backpropagation through convolution, Backpropagation as convolution with inverted filter, Convolution/backpropagation as matrix multiplication	
	3.3	Modern Deep Learning Architectures: LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet	
4		**Recurrent Neural Networks (RNN)**	
	4.1	Sequence Learning Problem, Unfolding Computational graphs, Recurrent Neural Network, Bidirectional RNN, Back propagation Through Time (BTT), Vanishing and Exploding Gradients, Truncated BTT	
	4.2	Long Short Term Memory: Selective Read, Selective write, Selective Forget, Gated Recurrent Unit	

5		**Autoencoders: Unsupervised Learning**	
	5.1	Introduction, Linear Autoencoder, Undercomplete Autoencoder, Overcomplete Autoencoders, Regularization in Autoencoders	
	5.2	Denoising Autoencoders, Sparse Autoencoders, Contractive Autoencoders	
6		**Recent Trends and Applications**	
	6.1	Generative Adversarial Network (GAN): Architecture	
	6.2	Applications: Image Compression, Brain Tumour Detection, Fraud Detection, Expression identification	
		Total	**39**

Text Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville. Deep Learning. An MIT Press book. 2016.
2. Li Deng and Dong Yu, "Deep Learning Methods and Applications", now publishers Inc (30 June 2014)
3. Satish Kumar "Neural Networks A Classroom Approach" Tata McGraw-Hill.
4. J M Zurada "Introduction to Artificial Neural Systems", Jaico Publishing House
5. M. J. Kochenderfer, Tim A. Wheeler. "Algorithms for Optimization", MIt Press.

Reference Books:

1. Jon Krohn, Grant Beyleveld, Aglae Bassens, "Deep Learning Illustrated: A Visual, Interactive Guide to Artificial Intelligence", Pearson Education.
2. Buduma, N. and Locascio, N., "Fundamentals of deep learning: Designing next-generation machine intelligence algorithms" 2017. O'Reilly Media, Inc.".
3. François Chollet, "Deep Learning with Python", Manning Publications, 2018.
4. Douwe Osinga. "Deep Learning Cookbook", O'REILLY, SPD Publishers, Delhi.
5. Simon Haykin, Neural Network- A Comprehensive Foundation- Prentice Hall International, Inc

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the 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.

Online References:

Sr. No.	Website Links
1	https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3	https://nptel.ac.in/courses/106/106/106106184/
4	https://www.deeplearningbook.org/
5	http://introtodeeplearning.com/
6	http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDO701	Image Processing	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					
ECCDO 701	Image Processing	20	20	20	80	03	25	25	150

Course Pre-requisite: Engineering Mathematics, Digital Signal Processing

Course Objectives:

1. To learn the fundamental concepts of image processing for image enhancement.
2. To learn image compression, segmentation techniques with practical applications.
3. To provide basic concepts of computer vision and its applications.

Course Outcomes:

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

1. Represent image in its numerical and graphical form.
2. Perform different image enhancement approaches for improving image quality.
3. Elucidate the mathematical modelling of image segmentation and morphology.
4. Apply the concept of image compression.
5. Understand computer vision system elements.
6. Develop a computer vision system based on requirement.

Module No.	Unit No.	Contents	Hrs.
1		**Fundamentals of Digital Image Processing**	
	1.1.	Introduction: Background, Representation of a Digital Image, Fundamental steps in Image Processing, Elements of a Digital Image Processing System.	4
	1.2.	Digital Image Fundamentals: Elements of Visual Perception, A Simple Image Model, Two-dimensional Sampling and Quantization, Tonal and Spatial Resolutions, Introduction to ColorModel(RGB, CMYK, YIQ, HSI).	
2		**Enhancement in Spatial and Frequency domain**	10
	2.1.	Enhancement in the spatial domain: Intensity Transformations, Histogram Processing, Arithmetic and logical operations.	
	2.2.	Spatial domain filters: Smoothing Filters, Sharpening Filters, High boost Filter.	
	2.3.	Image Transforms: 2D-DFT, FFT, DCT and Haar Transform. Frequency domain enhancement, Homomorphic filtering.	
3		**Image Segmentation and Morphology**	6
	3.1.	Image Segmentation: Detection of discontinuities, Edge linking and Boundary detection, Thresholding, Region based segmentation.	
	3.2	Image Morphology: Dilation, Erosion, Opening, Closing, Hit-Or-Miss Transformation, Boundary Detection, Thinning, Thickening.	
4		**Image Compression**	6
	4.1	Need of compression, Redundancy, Objective and subjective fidelity criteria. Lossless compression: Run Length Coding, VLC (Huffman coding), Arithmetic coding, LZW Coding, Vector Quantization. Lossy compression: Bit plane coding, Predictive Coding, Transform Coding, JPEG Compression standard.	
5		**Computer Vision Basics**	9
	5.1	Introduction, definition, Computer vision components, Boundary Pre-processing: Chain code, Boundary approximation, Signatures, Skeletonization.	
	5.2	Image Feature Extraction: Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, Gabor Filters and DWT. Boundary feature descriptors: Basic descriptors, Shape descriptor, Fourier descriptors, Statistical moments. Region feature descriptors: color, intensity and texture.	
6		**Computer Vision Applications**	4
	6.1	Computer Vision applications: Visual inspection of equipments, object detection like locating pedestrians, face detection and recognition, counting vehicles, content-based image retrieval, applications of computer vision in agriculture, health care, industry, sports etc.	
		Total	**39**

Text Books:

1. Rafael C. Gonzalez and Richard E.Woods, "Digital Image Processing," Pearson Education, edition 4, 2018.
2. Anil K.Jain, "Fundamentals of Digital Image Processing," Pearson Education, 2010.
3. S. Jayaraman, T. Veerakumar, A. Esakkirajan, "Digital Image Processing," First Edition, McGraw Hill Education, 2017
4. Robert J. Schallkoff , "Digital Image Processing and Computer Vision", John Wiley and Sons, 1989.
5. J. R. Parker , "Algorithms for Image Processing and Computer Vision" John Wiley and Sons, 1997.

Reference Books:

1. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003
2. B.Chanda and D.Dutta Majumder, "Digital Image Processing and Analysis," Prentice Hall of India, 2002
3. William K. Pratt, "Digital Image Processing," John Wiley & Sons, 2nd edition, 2004
4. Alan C. Bovik, "Handbook of Image and Video Processing," Elsevier Science Publishing Co Inc, 2009
5. Richard Szeliski, "Computer Vision: Algorithms and Applications," 2nd edition, The University of Washington, 2022
6. Kenneth R. Castleman, "Digital Image Processing," Pearson Education, 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

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECCDLO 7014	Big Data Analytics	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 7014	Big Data Analytics	20	20	20	80	03	--	--	100

Course Prerequisite:

Basic knowledge of Database Management System

Course Objectives:

1. To Provide an Overview of an exciting growing field of Big Data Analytics.
2. To introduce the tools required to manage and analyze big data like Hadoop, NoSql, Map Reduce.
3. To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability

Course Outcomes:

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

1. Understand the key issues in big data management and its associated applications in intelligent business andscientific computing.
2. Acquire fundamental enabling techniques and scalable algorithms like Hadoop, MapReduce & NoSQL in big data analytics.
3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Achieve adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.
5. Develop applications for Big Data analysis using Hadoop and NoSQL etc.

Module No.	Unit No.	Topics	Hrs
1		**Introduction to Big Data Analytics**	03
	1.1	Introduction to Big Data, Big Data characteristics, Types of Big Data, Traditional vs. Big Data a business approach	
	1.2	Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.	
2		**Hadoop**	05
	2.1	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem-Apache HBase, Hive, HCatalog, Pig, Mahout, Oozie, Zookeeper, Sqoop, Physical Architecture, Hadoop limitations.	
3		**NoSQL**	06
	3.1	Introduction to NoSQL, NoSQL business drivers, NoSQL database case studies.	
	3.2	NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns	
	3.3	Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems, Managing MongoDB database with CRUD operations.	
4		**MapReduce**	06
	4.1	MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization.	
	4.2	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures	
	4.3	Algorithms Using MapReduce: MapReduce WordCount Program, Matrix-Vector Multiplication by MapReduce , Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix Multiplication by MapReduce.	
5		**Techniques in Big Data Analytics**	13
	5.1	Finding Similar Item: Nearest Neighbor Search, Similarity of Documents, Distance Measures: Euclidean, Jaccard , Cosine , Edit and Hamming Distance with its Examples	
	5.2	Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis Filtering streams: The Blooms filter.	
	5.3	Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a	

		search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce	
	5.4	Frequent Itemset Mining: Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	
6		**Big Data Analytics Applications**	**06**
	6.1	Recommendation Systems: Introduction, A Model for Recommendation Systems: Collaborative-Filtering System, Content based system and its Examples.	
	6.2	Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using MapReduce.	
		Total	**39**

Textbooks:
1. Radha Shankarmani and M Vijayalakshmi ―Big Data Analytics‖, Wiley
2. Alex Holmes ―Hadoop in Practice‖, Manning Press, Dreamtech Press.
3. Dan McCreary and Ann Kelly ―Making Sense of NoSQL – A guide for managers and the rest of us,Manning Press.

Reference Books:
1. Bill Franks, ―Taming The Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics‖, Wiley
2. Chuck Lam, ―Hadoop in Action‖, Dreamtech Press

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

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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-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 DO701	Advanced Database Management Systems	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 duratio n Hours				
		Te st 1	Test 2	Avg of Test 1 and Test 2						
ECC DO 701	**Advanced Database Management Systems**	20	20	20	80	03	25	–	25	125

Course Prerequisite: Database Management System.

Course Objectives:

1. To impart knowledge related to query processing and query optimizer phases of a database management system
2. To introduce concepts of advanced access control techniques like role based and discretionary methods
3. To impart knowledge related to indexing in database management system
4. To introduce advanced database models like parallel and distributed databases
5. To impart an overview of emerging data models like temporal, mobile and spatial databases.
6. To introduce concepts of Big data

Course Outcomes:

After successful completion of the course students will be able to

1. Measure query costs and design alternate efficient paths for query execution.
2. Apply sophisticated access protocols to control access to the database.
3. Implement alternate models like Parallel and Distributed databases and Design applications using advanced models like mobile, spatial databases
4. Apply indexing techniques on large data in database
5. Apply Big data concepts in real world applications

Module No.	Unit No.	Contents	Hrs.
1		**Query Processing and Optimization**	6
	1.1	Query Optimization Overview, Measures of Query Cost Selection Operation	
	1.2	Sorting, Join Operation, Other Operations, Evaluation of Expressions	
	1.3	Transformation of Relational Expressions Estimating Statistics of Expression Results, Choice of Evaluation Plans	
2		**Advanced Data Management Techniques**	6
	2.1	Advanced Database Access protocols: Discretionary Access Control Based on Granting and Revoking Privileges;	
	2.2	Mandatory Access Control and Role- Based Access Control.	
	2.3	Overview of Advanced Database models like Mobile databases, Temporal databases, Spatial databases.	
3		**Indexing**	7
	3.1	Indexed Sequential Access Method (ISAM) B+ Trees: A Dynamic Index Structure, Format of a Node	
	3.2	Search, insert, delete operations in B+ Tree	
	3.3	Hashing Techniques; Types of Indexes: Single Level Ordered Indexes; Multilevel Indexes; Overview of B-Trees and B+-Trees	
4		**Parallel Databases**	6
	4.1	Architectures for Parallel Databases, Parallel Query Evaluation and Optimization,	
	4.2	Data Partitioning, Parallelizing Sequential Operator Evaluation Code	
	4.3	Parallelizing Individual Operations: Bulk Loading and Scanning, sorting, joins	
5		**Distributed Databases**	6
	5.1	Introduction: Distributed Data Processing, What is a Distributed Database System?	
	5.2	Design Issues, Distributed DBMS Architecture.	
	5.3	Distributed Database Design: Top-Down Design Process, Distribution Design Issues, Fragmentation, Allocation.	
	5.4	Overview of Query Processing: Query Processing Problem, Objectives of Query Processing	
	5.5	Characterization of Query Processors, Layers of Query Processing, Query Optimization in Distributed Databases;	
6		**Introduction to Big Data**	8
	5.1	Sources and Uses of Big Data, Querying Big Data	
	6.2	Big Data Storage Systems: Distributed File Systems, Key-Value Storage Systems	
	6.3	The MapReduce Paradigm: MapReduce in Hadoop with the example of word count	
	6.4	Streaming Data: Querying Streaming Data Introduction to Graph Databases	
		Total	**39**

Text Books:

1. Korth, Slberchatz,Sudarshan, :"Database System Concepts", 6th Edition, McGraw – Hill
2. Elmasri and Navathe, "Fundamentals of Database Systems", 6th Edition, PEARSON Education.
3. Raghu Ramakrishnan and Johannes Gehrke, "Database Management Systems" 3rd Edition McGraw Hill

Reference Books:

1. Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom "Database System Implementation", Pearson Ltd. 1/e
2. Thomas M. Connolly Carolyn Begg, Database Systems: A Practical Approach to Design Implementation and Management, 4/e, Pearson Ltd.

Internal Assessment (IA):

Two tests must be conducted which should cover at least 80% of the 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
ECCDO702	Cloud Computing	03	--	--	03	--	--	03

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						
ECCDO702	Cloud Computing	20	20	20	80	03	--	--	--	100

Course Pre-requisites: Computer networks, Basics of operating system (O.S.)

Course Objectives:
1. To provide an overview of cloud computing fundamentals.
2. To make students familiar with thekey concepts of virtualization.
3. To explore various cloud computing services.
4. To create an opensource cloud.
5. To identify risks and provide cloud security.
6. To analyze several cloud applications and recent trends in cloud computing.

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

1. Define cloud computing and understand different cloud services and deployment models.
2. Implement different types of virtualization.
3. Use several cloud computing services.
4. Design of opensource cloud.
5. Identification of threats and cloud-based risks for cloud security.
6. Understand cloud applications and recent trends.

Module No.	Unit No.	Contents	Hrs.
0		**Pre-requisites:** Basics of operating system (O.S.), ISO-OSI model and its layers	2
1		**Introduction to Cloud Computing**	4
	1.1	Definitionofcloudcomputing and cloud data centre, NIST model and cloud cube model, andcharacteristics of cloud computing.	
	1.2	Cloud deployment models (private, public, hybrid, and community) and service models (SaaS, PaaS, and IaaS).	
	1.3	Impact of cloud computing on business,key drivers for cloud computing.	
	1.4	Advantages and disadvantages of cloud computing.	
		Self-learning topics: Comparison between cloud service providers with traditional IT service providers.	
2		**Virtualization**	8
	2.1	Introduction and benefits of virtualization, implementation levels of virtualization, VMM.	
	2.2	Virtualization at O.S.level, middleware support for virtualization, virtualization structure/tools and mechanisms, hypervisor and xen architecture, binary translation with full virtualization, para virtualization with compiler support.	
	2.3	CPU virtualization, memory virtualization and I/O virtualization, virtualization in multicore processors,demonstration of virtualization usingtype II hypervisor.	
		Self-learning topics: Comparison between virtualization and containerization (docker).	
3		**Cloud Computing Services**	5
	3.1	Exploring different cloud computingservices: Software-as-a-Service (SaaS) (e.g., Dropbox, Google Workspace, Salesforce, etc.), Platform-as-a-Service(PaaS) (e.g., AWS Elastic Beanstalk, Windows Azure, Heroku, Google App Engine, etc.), Infrastructure-as-a-Service (IaaS) (e.g., DigitalOcean, AWS, Microsoft Azure, Google Compute Engine (GCE), etc.).	
	3.2	Anything-as-a-Service or Everything-as-a-Service (XaaS), Security-as-a-Service, Identity Management-as-a-Service, and Database-as-a-Service.	
	3.3	Storage-as-a-Service, Collaboration-as-a-Service, Compliance-as-a-Service,Monitoring-as-a-Service, Communication-as-a-Service,Network-as-a-Service Disaster Recovery-as-a-Service, Analytics-as-a-Service, and Backup-as-a-Service	
		Self-learning topics: Explore any 10 services offered by AWS/Microsoft Azure.	
4		**Open Source Cloud Implementation of OpenStack and Eucalyptus**	7
	4.1	OpenStack Cloud Architecture, Features of OpenStack, Components of OpenStack, Mode of Operations of OpenStack	
	4.2	Eucalyptus Architecture, Features of Eucalyptus, Components of Eucalyptus, Mode of Operations of Eucalyptus	
	4.3	Installation and configuration process of OpenStack and Eucalyptus	
		Self-learning topics: Exploreopen source cloud and edge computing platform for an enterprise: OpenNebula.	
5		**Cloud Security**	7
	5.1	Security overview, cloud security challenges and risks, SaaS security, cloud computing security architecture, architectural considerations.	
	5.2	General issues in securing cloud, securing data, application, and virtual machine security.	
	5.3	AAA model, automatic security establishing trusted cloud computing, secure execution environments and communications, access control, disaster recovery in clouds.	

		Self-learning topics: Cloud security in AWS/Microsoft Azure/Google Cloud Platform.	
6		**Cloud Applications and Recent Trends**	
	6.1	**Cloud Applications:**	**6**
		Scientific Applications: **Healthcare:** ECG analysis in cloud **IoT-enabled Cloud Applications:** Smart Agriculture	
		Business and Consumer Applications: CRM and ERP, Productivity, networking, media applications, multiplayer online gaming.	
	6.2	**Recent Trends:**	
		Mobile cloud computing, autonomic cloud computing, multimedia cloud, energy aware cloud computing.	
		Self-learning topics: Jungle computing, Fog computing, Quantum computing	
			39

Text Books:

1) Mastering Cloud Computing by Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, McGraw Hill Education
2) Cloud Computing and Services by Arup Vithal, Bhushan Jadhav, StarEdu Solutions, SYBGEN Learning India Pvt. Ltd.
3) Cloud Computing: A Practical Approach forLearning and Implementation by A. Srinivasan, J.Suresh, Pearson.
4) Cloud Security: A Comprehensive Guide to Secure Cloud Computing by Ronald L. Krutz,Russell Dean Vines, Wiley & Sons.
5) Cloud Computing Bible by Barrie Sosinsky, Wiley Publishing.

Reference Books:
1) Cloud Computing Black Book by Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Deven Shah, Dreamtech Press.
2) Amazon Web Services in Action by Michael Wittig, Andreas Wittig, Manning Publisher.
3) To the cloud: cloud powering an Enterprise, Arora Pankaj, Tata Mc Graw Hill Education.
4) Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Kai Hwang, Morgan Kaufmann.

Useful Digital Links:

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

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 DO702	Mobile Communication	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 DO702	Mobile Communication	20	20	20	80	03	--	--	--	100

Course Pre-requisite:
1. Analog and Digital Communication
2. Communication Networks
3. Digital Electronics

Course Objectives:
1. To introduce the concepts and design fundamentals of Cellular communication systems.
2. To understand the architecture and services of 2G cellular technologies.
3. To study the evolution of cellular technology from 2G to 5G.
4. To understand the services provided by network, transport and application layer in mobile communication.

Course Outcomes:

After successful completion of the course students will be able to:
1. Analyse the design parameters of cellular communication system
2. Examine various multiple access techniques and design PN-sequence generator.
3. Describe and compare GSM and IS-95 CDMA technologies.
4. Summarize the underlying fundamentals of cellular technologies from 2G to 4G.
5. Explain services provided by network, transport and application layer in mobile communication

Module No.	Unit No.	Contents	Hrs.
1		**Concept of Cellular Communication**	**07**
	1.1	Introduction to cellular communications, basic propagation mechanisms and multipath fading	
	1.2	**Cellular System design fundamentals :** Cluster, frequency reuse, Call setup, Handoff strategies, interference and system capacity, cluster size and system capacity and Channel assignment strategies	
	1.3	**Traffic Theory:** Trunking and Grade of service, Improving Coverage and capacity	
2		**Multiple Access Techniques**	**06**
	2.1	Multiplexing and Multiple Access: Time Division Multiple Access, Frequency Division Multiple Access, Space division multiple access technique	
	2.2	Spread spectrum Multiple Access: Need for and concept of spread spectrum (SS) modulation, PN-sequence generation, properties of PN-sequence, Gold-sequence generation, Direct-sequence SS, Frequency-hopping SS	
3		**2G Technologies**	**10**
	3.1	**GSM:** Services and features, GSM air specifications, GSM network architecture, Physical andLogical Channels, Frame structure, Identifiers, Authentication and security, call procedure, Hand-off procedure	
	3.2	**IS-95 (CDMA):** Air specifications of IS-95, Forward and Reverse CDMA channels, Forward and Reverse CDMA channel modulation process block diagram, power control subchannel, Handoffs in IS 95 CDMA and RAKE receiver.	
4		**Evolution from 2G to 5G**	**06**
	4.1	GPRS, EDGE technologies, W-CDMA (UMTS), CDMA2000: features and network architectures	
	4.2	**LTE:** LTE System Overview, Evolution from UMTS to LTE, LTE/SAE Requirements, SAE Architecture, EPS: Evolved Packet System, E-UTRAN, Voice over LTE (VoLTE), Introduction to 5G	
5		**Mobile Network Layer**	**05**
	5.1	**Mobile IP**: IP Packet Delivery, Agent Advertisement and Discovery, Registration, Tunneling and Encapsulation	
	5.2	**Mobility Management:** Introduction, IP Mobility, Optimization, IPv6, Micro Mobility: CellularIP	
6		**Mobile Transport and Application Layer**	**05**
	6.1	Mobile TCP: Traditional TCP, Classical TCP Improvements like Indirect TCP, Snooping TCP & Mobile TCP, Selective Retransmission	
	6.2	WAP: Architecture, WDP, WTLS, WTP, WSP, WAE, WML	
		Total	**39**

Text Books:

1. Theodore Rappaport, "Wireless Communications: Principles and Practice, 2nd Edition, Pearson Publication
2. Jochen Schiller, "Mobile Communications", 3e, Pearson Publication.
3. William Stallings, "Wireless Communication and Networking", PHI Publication.
4. Vijay Garg, "IS-95 CDMA and CDMA 2000: Cellular/PCS System Implementation", Pearson Publication.

Reference Books:

1. T.L Singal, "Wireless Communication", Tata McGraw Hill ,2010.
2. Upena Dalal, "Wireless Communication", Oxford University Press, 2009.
3. Andreas F Molisch, "Wireless Communication", John Wiley, India 2006.
4. Vijay Garg, "Wireless communication and Networking", Pearson Publication.
5. Christopher Cox, "An Introduction to LTE: LTE, LTE-Advanced, SAE and 4G Mobile Communications", Wiley publications.

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 DO702	Cyber Security	03	--	--	03	--	--	03

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						
		20	20	20	80	03	----	--	--	100

Course Prerequisite:

Course Objectives:

1. To understand the need for Cyber Security Awareness.
2. To understand the flow and methodology of an attack
3. To learn and explore various static and web vulnerability analysis tools.
4. To understand the various IPR, privacy and security compliances.

Course Outcomes:

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

1. Understand the need of Cyber Security and its aspects.
2. Illustrate the various tools and techniques used by attackers to launch their attacks.
3. Identify cyber attacks and its countermeasures.
4. Identify various web application and Network vulnerability scanning techniques and defence methodologies.
5. Describe the various Privacy and standard compliances with the help of real world application.

Module No.	Unit No.	Contents	Hrs.	CO
0		**Prerequisite**	2	
		Computer Networks		
1		**Introduction to Cyber space**	8	
	1	**Cyber Crime:** Cybercrime definition, Types of Cybercrime. Classifications of cybercrime, Cyber Hygiene, Types of Hackers - Hackersand Crackers - Cyber-Attacks and Vulnerabilities - Malware threats -Sniffing - Gaining Access - Escalating Privileges - Executing Applications - Hiding Files - Covering Tracks - Worms - Trojans - Viruses - Backdoors		CO 1
	2	**Cyber Attacks:**Cyber attack Lifecycle,social engineering, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Attacks on Wireless and mobile Networks.		
2		**Cyber crime Attacks and Techniques**	8	
	3.	**Attacks Techniques:**Password Cracking, Key loggers and Spywares Steganography,Identity Theft (ID Theft),, Banner Grabbing Techniques, ransom wares,Crypto wares		CO 2
		network information gathering, vulnerability scanning, Virtual Private Networks (VPN), Open Port Identification, Social engineering, Types of social engineering, How cyber criminal works?, Prevention from being victim of social engineering.		
3		**Cyber Attacks and Preventions**	6	
	4	attacks on WIFI and prevention, traditional techniques, theft of internet hours, Wi-Fi measures		CO 3
		attacks on Mobile phone and prevention, mobile phone theft,mobile virus ,mishing,vishing,smishing,hacking bluetooth		
4		**Web and Network Security**	8	
	5	Web Security:OWASP, Web Security Considerations, Management, Cookies, Privacy on Web, Web Browser Attacks,Web Bugs, Clickjacking, Session Hijacking and Management, Phishing and Pharming Techniques, Web Service Security		CO 4
	6.	Network security:Syn-DOS:,DDOS,defences against Denial of Service Attacks.Virtual Private Networks(VPN)		
5		**Cyber Laws**	4	
	7.	Information Security Privacy and Standard Compliances (WR) HIPPA,FISMA, PCI DSS, GDPR, Intellectual Property Aspect of Cyber Law, Creative Commons Library, Data Protection Laws in India.		CO 5
6		**Cyber Security Initiatives-(case studies)**	3	
	8.	Online Banking, Mobile Banking Security , Security of Debit and Credit Card,UPI Security		CO 5
		Role of AI/ML in Cyber Security		
		Total	**39**	

Text Books:

1. Nina Godbole,Sunit Belapure, "Cyber Security-Understanding Cyber Crimes,Computer Forensics and Legal Perspective",Wiley-India,2011.
2. The Complete Cyber Security Course -Volume 1- Nathan House
3. Network Security Bible, Eric Cole, Second Edition, Wiley

Reference Books:

1. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi
2. James Graham,Richard Howard ,Ryan Olson. " Cyber Security Essentials,CRC Press,2018 print.
3. Build your own Security Lab, Michael Gregg, Wiley India
4. Computer Security, Dieter Gollman, Third Edition, Wiley

Web References:

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

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 DO702	Blockchain Technology	03	02	---	03	---	---	03

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 & Test 2						
ECC DO702	Blockchain Technology	20	20	20	80	03	---	---	---	100

Course Prerequisite: Computer Network, Operating System, Cryptography

Course Objectives:

1. To learn the fundamentals of Blockchain
2. To obtain knowledge about technologies of Blockchain
3. To incorporate the models of Blockchain- Ethereum
4. To learn the models of Hyperledger Fabric
5. To explore various applications of Blockchain.

Course Outcomes:

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

1. Describe the primitives of the cryptography related to blockchain.
2. Understand and explore the working of Blockchain technology
3. Illustrate the concepts of Bitcoin and their usage.
4. Implement Ethereum block chain contract.
5. Explore Hyperledger Fabric and its working.
6. Investigate security features in blockchain technologies

Module No.	Unit No.	Contents	Hrs.
1		**Introduction of Cryptography**	4
	1.1	Basic Cryptographic primitives used in Blockchain - Public Key cryptosystem, Cryptographic Hash functions: Properties of Hash, MD5, SHA 256, Hash Pointers and Data Structures, Digital Signatures: ECDSA, Public Keys as Identities, Cryptocurrencies: Goofycoin	
2		**Introduction to Blockchain**	7
	2.1	Centralization vs. Decentralization, What is Blockchain, History of Blockchain, Blockchain defined- peer to peer, Distributed Ledger, Cryptographically Secure, Append-only, Updatable via consensus, How Blockchain Works, Benefits and Limitations of Blockchain, Types of Blockchain, The Structure of a Block, Block header, Genesis block, Mining , Rewards, Consensus, Types of ConsensusMechanisms, Consensus in Blockchain.	
3		**Bitcoin and Cryptocurrency**	6
	3.1	What is Bitcoin, Private keys in Bitcoin, Public Keys in Bitcoin, Addresses in Bitcoin, Transactions, The Bitcoin Network,Bitcoin Wallets, Scripting language in Bitcoin, Bitcoin Mining- task of Bitcoin miners, Mining Hardware, Crypto Currencies, Anonymity and Pseudonymity in Bitcoin	
	3.2	Self Study - Alt Coins	
4		**Introduction to Ethereum**	10
	4.1	Introduction to Ethereum, Ethereum's Consensus Mechanisms, MetaMask Setup,Ethereum Accounts, Ethers, Gas, Introduction to Smart Contracts, Remix IDE, Writing smart contracts using Solidity	
	4.2	Self Study- Geth, Ganache-Creating Wallets	
5		**Introduction to Hyperledger**	6
	5.1	What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer, Transaction Flow.	
	5.2	Self study: Case Study of Supply Chain Management using Hyperledger	
6		**Privacy, Security issues in Blockchain**	6
	6.1	Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains (Sybil attacks, selfish mining, 51% attacks), prevention of attacks	

	6.2	Self Study: Corda, Ripple, Quorum platforms and its security	
		Total	**39**

Text Books:

1. A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016.
2. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, Decentralization and Smart Contracts Explained", Second Edition, Packt Publishing, 2018.

Reference Books:

1. Mastering Bitcoin: Unlocking Digital Cryptocurrencies, by Andreas M Antonopoulos 2018
2. D. Drescher, Blockchain Basics. Apress, 2017.
3. Merunas Grinčelaitis, "Mastering Ethereum: Implement Advanced Blockchain Applications Using Ethereum-supported Tools, Services, and Protocols", Packt Publishing.
4. Blockchain with Hyperledger Fabric,Luc Desrosiers, Nitin Gaur, Salman A. Baset, Venkatraman Ramakrishna, Packt Publishing.

OTHER ONLINE REFERENCES

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

Internal Assessment (IA):

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

End Semester Examination:

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

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
ECL701	VLSI Design 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						
ECL701	VLSI Design Lab	--	--	--	--	--	25	25	--	50

Laboratory Outcomes:

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

1. Demonstrate transfer, dynamic characteristics of various digital circuits.
2. Understand the circuit design using various simulation tools
3. Demonstrate layouts for various circuits and doing simulations.
4. Understand the variation in the behaviour after extraction.

Term Work:

At least 10 experiments covering entire syllabus of VLSI **Design ECC 701** 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	Plot Transfer and output characteristics of NMOS and PMOS
2	For NMOS as well as PMOS devices use the ITRS technology node 32nm, 45nm, 65nm and 90nm. Simulate the device and download the customized nominal model cards
3	Design CMOS inverter. Carry out static as well as transient simulation with different aspect ratio of pull up and pull-down devices
4	Comparative analysis of the NMOS Inverter with different types of loads.
5	Find the equivalent CMOS inverter for the given 2-input NAND and NOR gates
6	Implement the given equation using various logic design style
7	Implementation of any Flip- Flop using various logic design styles
8	Simulate Minimum Sized CMOS INVERTER circuit to calculate τ_{PHL} and τ_{PLH}
9	Design and Simulate 4:1 multiplexer using NMOS pass transistor
10	Design and simulate 4-bit adder/subtractor
11	Design CMOS transmission gate and perform all the analysis to verify its Characteristics.
12	Design and Simulate 4-bit multiplier
13	Simulate and carry out comparative analysis for 6T SRAM cell with a) $\beta= 1.5$ and $\alpha=1$, and b) $\beta= 1$ and $\alpha=1$
14	Draw the CMOS schematic and Layout of the inverter circuit, simulate layout
15	Extraction of CMOS layout and simulation of the extracted Inverter
16	Draw and simulate layout for CMOS NAND and CMOS NOR gate

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 702	Internet of Things	--	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 702	Internet of Things	--	--	--	--	--	25	25	50

Prerequisites: 1. Programming Using Arduino IDE
2. Python programming

Laboratory Outcomes:

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

1.   Interface various sensors to any IoT device and push data onto cloud.

2.   Remotely control various devices using Blynk App and Node-red environment.

3.   Implement IoT protocols to control devices remotely.

4.   Implement services like Google Assistance, Adafruit I/O, IFTTT, Firebase etc in IoT.

5.   Configure AWS Cloud and its Application in IoT

Term Work:

At least 10 experiments covering entire syllabus of **Internet of Things ECC702** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempt should be made tomake 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	Interfacing Various Sensors like LDR, ultrasonic, DHT etc (data collection) and pushing data on to Thingspeak Cloud
2	Controlling IoT devices/sensors remotely using Node-red and rpi.
3	Application of MQTT in node red
4	Control a LED Remotely & Monitor Temperature values with a Raspberry Pi using Node-RED
5	Controlling IoT devices using Blynk App.
6	Temperature and Humidity monitor using Blynk
7	ESP8266 Voice Control with Google Assistant and Adafruit IO and IFTTT.
8	Implementing Publish-Subscribe model using MQTT protocol and DHT11 sensor
9	Google Firebase: - controlling LED using Android App
10	Publishing sensor data from ESP32 to AWS IoT Cloud.
11	Device controlling over cloud on android mobile app :- Monitoring sensor and different data on mobile phone
12	Creating an emergency push button to upload status on Facebook
13	To send Push notification to IoT device (R-pi to smart phone)
14	Google Assistant Controlled Switch Using NodeMCU
15	AWS and SNS service

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 703	Department Level Optional Course - III Lab (Deep Learning)	--	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						
ECL703	Department Level Optional Course – III Lab (Deep Learning)	--	--	--	--	--	25	25	--	50

Course Pre-requisite: Python Programming, Engineering Mathematics

Laboratory Outcomes:

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

1. Implement basic neural network models to learn logic functions.
2. Design and train feed-forward neural networks using various learning algorithms.
3. Build and train deep learning models such as Auto-encoders, CNNs, RNN, LSTM etc.

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.

Suggested List of Experiments

Sr.No.	Experiment Name
1	**Based on Module 1 (Any two) using Virtual Lab**
	Implement Mc-Culloch Pitts model for binary logic functions.
	Implement Perceptron algorithm to simulate any logic gate.
	Implement Multilayer Perceptron algorithm to simulate XOR gate.
	To explore python libraries for deep learning e.g. Theano, TensorFlow etc.
2	**Module 2 (Any Two)**

	Apply any of the following learning algorithms to learn the parameters of the supervised single layer feed-forward neural network.
	    a. Stochastic Gradient Descent
	    b. Mini Batch Gradient Descent
	    c. Momentum GD
	    d. Nestorev GD
	    e. Adagrad GD
	Adam Learning GD

3	**Module 3 (Any One)**
	Implement a back-propagation algorithm to train a DNN with at least 2 hidden layers.
	Design and implement a fully connected deep neural network with at least 2 hidden layers for a classification application. Use appropriate Learning Algorithm, output function and loss function
4	**Module 4 (Any One)**
	Design and implement a CNN model for digit recognition application.
	Design and implement a CNN model for image classification.
5	**Module 5 (Any One)**
	Design the architecture and implement the auto-encoder model for Image Compression.
	Design the architecture and implement the auto-encoder model for Image denoising.
6	**Module 6 (Any One)**
	Design and implement LSTM for Text / Image / Audio / Video / etc.
	Design and implement GRU for Text / Image / Audio / Video / etc.
	Design and implement RNN for Text / Image / Audio / Video / etc.

Online References:

Sr. No.	Website Links
1	https://nptel.ac. https://deeplearning.cs.cmu.edu/S21/index.html
2	http://www.cse.iitm.ac.in/~miteshk/CS6910.html
3	https://nptel.ac.in/courses/106/106/106106184/
4	https://www.deeplearningbook.org/
5	http://introtodeeplearning.com/
6	http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php

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
ECL703	Image Processing 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					
ECL703	Image Processing Lab	--	--	--	--	--	25	25 --	50

Laboratory Outcomes;

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

1. Enhance the quality of image in spatial and frequency domain.
2. Apply lossless or lossy compression techniques to reduce the size of an image.
3. Segment image components based on discontinuity and similarity criteria.
4. Extract various features from the scene for specified computer vision application.

Term Work:

At least **8** experiments covering entire syllabus of 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. Experiments must be graded from time to time. One presentation on a **case-study or mini project** based on the topic in Digital Image Processing need to be submitted. 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 basedon the entire syllabus. The Term work assessment can be carried out based on the different tools and the rubrics decided by the concerned faculty members and need to be conveyed to the students well in advanced.

Suggested List of Experiments

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

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 703	Big Data Analytics	--	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 703	Big Data Analytics	--	--	--	--	--	25	25	50

Laboratory outcomes:

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

1. Develop problem solving and critical thinking skills in fundamental enabling techniques like Hadoop, Mapreduce and NoSQL in big data analytics.
 2. Collect, manage, store, query and analyze various forms of Big Data.
 3. Interpret business models and scientific computing paradigms, and apply software tools for big data analytics.
4. Adapt adequate perspectives of big data analytics in various applications like recommender systems, social media applications etc.

Term Work:

At least 8 experiments covering entire syllabus of **Big Data Analytics (ECC DO701)** should be set to have well predefined inference and conclusion. Additionally, a Mini Project on a real-life large data application to be implemented (Use standard Datasets available on the web). 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	Hadoop HDFS Practical: -HDFS Basics, Hadoop Ecosystem Tools Overview. -Installing Hadoop. -Copying File to Hadoop. -Copy from Hadoop File system and deleting file. -Moving and displaying files in HDFS.
2	To install and configure MongoDB/ Cassandra/ HBase/ Hypertable to execute NoSQL commands.
3	Implementing simple algorithms in Map-Reduce: Matrix multiplication, Aggregates, Joins, Sorting, Searching, etc.
4	Write a program to implement word count program using MapReduce.
5	Implement PageRank using Map-Reduce.
6	Implementing any one Clustering algorithm (K-Means/CURE) using Map-Reduce.
7	Implement Bloom Filter using any programming language
8	Perform CRUD operations in MongoDB
9	To demonstrate use of recommendation system for movie rating prediction
10	To find common friends in social network graph using Map-Reduce.

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 703	Advanced Database Management Systems 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 703	Advanced Database Management Systems Lab	--	--	--	--	--	25	--	25	50

Prerequisite: Database Management System

Laboratory Outcomes:

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

1. Build index on database.
2. Analyze time series data using open source tools.
3. Perform partitioning tasks on the database.
4. Write codes using map-reduce technique.

Term Work:

At least 10 experiments covering entire syllabus of **Advanced Database Systems (ECL 703)** should be set to have well predefined inference and conclusion. The experiments should be student centric and attempts should be made to make experiments more meaningful, interesting. Simulation experiments are also encouraged. Experiments 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	Create an index on the given tables, observe execution time of queries and record your observations.
2	Demonstrate use of grant and revoke access
3	Find the cost of queries using DBMS tools (Postgresql, MySQL, Oracle etc)
4	Data distribution and partitioning using Apache Ignite
5	Collocating computations with data using Apache Ignite
6	Time series data analysis using Temporal database like TimescaleDB
7	Count number of words in a large file using map reduce
8	Compare the cost required for query execution and obtain the optimized query
9	Develop a distributed database application. (FileServer Implementation using RMI)
10	Create a node and relationships using neo4j
11	Select and display data using neo4j
12	Create index and add constraints using neo4j

References:

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

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.

Course Code	Course Name	Credits
ILO7011	**Product Life Cycle Management**	**03**

Objectives:

1. To familiarize the students with the need, benefits and components of PLM
2. To acquaint students with Product Data Management & PLM strategies
3. To give insights into new product development program and guidelines for designing and developing a product
4. To familiarize the students with Virtual Product Development

Outcomes: Learner will be able to…

1. Gain knowledge about phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.
2. Illustrate various approaches and techniques for designing and developing products.
3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.
4. Acquire knowledge in applying virtual product development tools for components, machining and manufacturing plant

Module	Detailed Contents	Hrs
01	**Introduction to Product Lifecycle Management (PLM):**Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:**Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	10
02	**ProductDesign:**Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	09

03	**Product Data Management (PDM):**Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation	05
04	**Virtual Product Development Tools:**For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	05
05	**Integration of Environmental Aspects in Product Design:**Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	05
06	**Life Cycle Assessment and Life Cycle Cost Analysis:**Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle CostAnalysis	05

Assessment:

Internal:

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End Semester Theory Examination:

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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. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking",   TataMcGrawHill,2006,ISBN:0070636265

Course Code	Course Name	Credits
ILO7012	**Reliability Engineering**	**03**

Objectives:

1. To familiarize the students with various aspects of probability theory
2. To acquaint the students with reliability and its concepts
3. To introduce the students to methods of estimating the system reliability of simple and complex systems
4. To understand the various aspects of Maintainability, Availability and FMEA procedure

Outcomes: Learner will be able to…

1. Understand and apply the concept of Probability to engineering problems
2. Apply various reliability concepts to calculate different reliability parameters
3. Estimate the system reliability of simple and complex systems
4. Carry out a Failure Mode Effect and Criticality Analysis

Module	Detailed Contents	Hrs
01	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem. **Probability Distributions:** Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	08
02	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis:** Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models:** Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	08
03	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	05
04	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	08

	System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	
05	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	05
06	**Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis	05

<u>Assessment</u>**:**

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4. Only Four question need to be solved.

REFERENCES:

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

Course Code	Course Name	Credits
ILO7013	**Management Information System**	**03**

Objectives:

1. The course is blend of Management and Technical field.
2. Discuss the roles played by information technology in today's business and define various technology architectures on which information systems are built
3. Define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage
4. Identify the basic steps in systems development

Outcomes: Learner will be able to…

1. Explain how information systems Transform Business
2. Identify the impact information systems have on an organization
3. Describe IT infrastructure and its components and its current trends
4. Understand the principal tools and technologies for accessing information from databases to improve business performance and decision making
5. Identify the types of systems used for enterprise-wide knowledge management and how they provide value for businesses

Module	Detailed Contents	Hrs
01	Introduction To Information Systems (IS): Computer Based Information Systems, Impact of IT on organizations, Imporance of IS to Society. Organizational Strategy, Competitive Advantages and IS.	4
02	Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management. Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results	7
03	Ethical issues and Privacy: Information Security. Threat to IS, and Security Controls	7
04	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing, Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	7
05	Computer Networks Wired and Wireless technology, Pervasive computing, Cloud	6

	computing model.	
06	Information System within Organization: Transaction Processing Systems, Functional Area Information System, ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models.	8

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4. Only Four question need to be solved.

REFERENCES:

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

Course Code	Course Name	Credits
ILO7014	**Design of Experiments**	**03**

Objectives:

1. To understand the issues and principles of Design of Experiments (DOE)
2. To list the guidelines for designing experiments
3. To become familiar with methodologies that can be used in conjunction with experimental designs for robustness and optimization

Outcomes: Learner will be able to…

1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action
2. Apply the methods taught to real life situations
3. Plan, analyze, and interpret the results of experiments

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Strategy of Experimentation 1.2 Typical Applications of Experimental Design 1.3 Guidelines for Designing Experiments 1.4 Response Surface Methodology	06
02	**Fitting Regression Models** 2.1 Linear Regression Models 2.2 Estimation of the Parameters in Linear Regression Models 2.3 Hypothesis Testing in Multiple Regression 2.4 Confidence Intervals in Multiple Regression 2.5 Prediction of new response observation 2.6 Regression model diagnostics 2.7 Testing for lack of fit	08

03	**Two-Level Factorial Designs and Analysis** 3.1 The 2^2 Design 3.2 The 2^3 Design 3.3 The General 2^k Design 3.4 A Single Replicate of the 2^k Design 3.5 The Addition of Center Points to the 2^k Design, 3.6 Blocking in the 2^k Factorial Design 3.7 Split-Plot Designs	07
04	**Two-Level Fractional Factorial Designs and Analysis** 4.1 The One-Half Fraction of the 2^k Design 4.2 The One-Quarter Fraction of the 2^k Design 4.3 The General 2^{k-p} Fractional Factorial Design 4.4 Resolution III Designs 4.5 Resolution IV and V Designs 4.6 Fractional Factorial Split-Plot Designs	07
05	**Conducting Tests** 5.1 Testing Logistics 5.2 Statistical aspects of conducting tests 5.3 Characteristics of good and bad data sets 5.4 Example experiments 5.5 Attribute Vs Variable data sets	07
06	**Taguchi Approach** 6.1 Crossed Array Designs and Signal-to-Noise Ratios 6.2 Analysis Methods 6.3 Robust design examples	04

Assessment:

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End Semester Theory Examination:

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4. Only Four question need to be solved.

REFERENCES:

1. Raymond H. Mayers, Douglas C. Montgomery, Christine M. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, 3rd edition, John Wiley & Sons, New York, 2001
2. D.C. Montgomery, Design and Analysis of Experiments, 5th edition, John Wiley & Sons, New York, 2001
3. George E P Box, J Stuart Hunter, William G Hunter, Statics for Experimenters: Design, Innovation and Discovery, 2nd Ed. Wiley
4. W J Dimond, Peactical Experiment Designs for Engineers and Scintists, John Wiley and Sons Inc. ISBN: 0-471-39054-2
5. Design and Analysis of Experiments (Springer text in Statistics), Springer by A.M. Dean, and D. T.Voss
6. Phillip J Ross, "Taguchi Technique for Quality Engineering," McGrawHill
7. Madhav S Phadke, " Quality Engineering using Robust Design," Prentice Hall

Course Code	Course Name	Credits
ILO7015	**Operations Research**	**03**

Objectives:

1. Formulate a real-world problem as a mathematical programming model.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.

Outcomes: Learner will be able to…

1. Understand the theoretical workings of the simplex method, the relationship between a linear program and its dual, including strong duality and complementary slackness.
2. Perform sensitivity analysis to determine the direction and magnitude of change of a model's optimal solution as the data change.
3. Solve specialized linear programming problems like the transportation and assignment problems, solve network models like the shortest path, minimum spanning tree, and maximum flow problems.
4. Understand the applications of integer programming and a queuing model and compute important performance measures

Module	Detailed Contents	Hrs
01	**Introduction to Operations Research**: Introduction, , Structure of the Mathematical Model, Limitations of Operations Research **Linear Programming**: Introduction, Linear Programming Problem, Requirements of LPP, Mathematical Formulation of LPP, Graphical method, Simplex Method Penalty Cost Method or Big M-method, Two Phase Method, Revised simplex method, **Duality**, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis **Transportation Problem**: Formulation, solution, unbalanced Transportation problem. Finding basic feasible solutions – Northwest corner rule, least cost method and Vogel's approximation method. Optimality test: the stepping stone method and MODI method. **Assignment Problem**: Introduction, Mathematical Formulation of the Problem, Hungarian Method Algorithm, Processing of n Jobs Through Two Machines and m Machines, Graphical Method of Two Jobs m Machines Problem Routing Problem,	14

	Travelling Salesman Problem **Integer Programming Problem**: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.	
02	**Queuing models**: queuing systems and structures, single server and multi-server models, Poisson input, exponential service, constant rate service, finite and infinite population	05
03	**Simulation**: Introduction, Methodology of Simulation, Basic Concepts, Simulation Procedure, Application of Simulation Monte-Carlo Method: Introduction, Monte-Carlo Simulation, Applications of Simulation, Advantages of Simulation, Limitations of Simulation	05
04	**Dynamic programming**. Characteristics of dynamic programming. Dynamic programming approach for Priority Management employment smoothening, capital budgeting, Stage Coach/Shortest Path, cargo loading and Reliability problems.	05
05	**Game Theory**. Competitive games, rectangular game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy for 2 X 2 games.	05
06	**Inventory Models**: Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model,	05

Assessment:

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End Semester Theory Examination:

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4. Only Four question need to be solved.

REFERENCES:

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

Course Code	Course Name	Credits
ILO7016	**Cyber Security and Laws**	**03**

Objectives:

1. To understand and identify different types cybercrime and cyber law
2. To recognized Indian IT Act 2008 and its latest amendments
3. To learn various types of security standards compliances

Outcomes: Learner will be able to…

1. Understand the concept of cybercrime and its effect on outside world
2. Interpret and apply IT law in various legal issues
3. Distinguish different aspects of cyber law
4. Apply Information Security Standards compliance during software design and development

Module	Detailed Contents	Hrs
01	**Introduction to Cybercrime:** Cybercrime definition and origins of the world, Cybercrime andinformation security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	4
02	**Cyber offenses & Cybercrime:** How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation ofMobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed byMobile Devices, Registry Settings for Mobile Devices, AuthenticationService Security, Attacks on Mobile/Cell Phones, Mobile Devices:Security Implications for Organizations, Organizational Measures forHandling Mobile, Devices-Related Security Issues, OrganizationalSecurity Policies and Measures in Mobile Computing Era, Laptops	9
03	**Tools and Methods Used in Cyberline** Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer Over Flow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	6
04	**The Concept of Cyberspace** E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law	8

	,The Intellectual Property Aspect in Cyber Law , The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to Electronic Banking , The Need for an Indian Cyber Law	
05	**Indian IT Act.** Cyber Crime and Criminal Justice : Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	6
06	**Information Security Standard compliances** SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6

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4. Only Four question need to be solved.

REFERENCES:

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

8. Websites for more information is available on :   The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in
9. Website for more information , A Compliance Primer for IT professional   : https://www.sans.org/reading-room/whitepapers/compliance/compliance-primer-professionals-33538

Course Code	Course Name	Credits
ILO7017	**Disaster Management and Mitigation Measures**	**03**

Objectives:

1. To understand physics and various types of disaster occurring around the world
2. To identify extent and damaging capacity of a disaster
3. To study and understand the means of losses and methods to overcome /minimize it.
4. To understand role of individual and various organization during and after disaster
5. To understand application of GIS in the field of disaster management
6. To understand the emergency government response structures before, during and after disaster

Outcomes: Learner will be able to…

1. Get to know natural as well as manmade disaster and their extent and possible effects on the economy.
2. Plan of national importance structures based upon the previous history.
3. Get acquainted with government policies, acts and various organizational structure associated with an emergency.
4. Get to know the simple do's and don'ts in such extreme events and act accordingly.

Module	Detailed Contents	Hrs
01	**Introduction** 1.1 Definition of Disaster, hazard, global and Indian scenario, general perspective, importance of study in human life, Direct and indirect effects of disasters, long term effects of disasters. Introduction to global warming and climate change.	03
02	**Natural Disaster and Manmade disasters:** 2.1 Natural Disaster: Meaning and nature of natural disaster, Flood, Flash flood, drought, cloud burst, Earthquake, Landslides, Avalanches, Volcanic eruptions, Mudflow, Cyclone, Storm, Storm Surge, climate change, global warming, sea level rise, ozone depletion 2.2 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of growing population and subsequent industrialization, urbanization and changing lifestyle of human beings in frequent occurrences of manmade disasters.	09
03	**Disaster Management, Policy and Administration** 3.1 Disaster management: meaning, concept, importance, objective of disaster management policy, disaster risks in India, Paradigm shift in disaster management.	06

	3.2 Policy and administration: Importance and principles of disaster management policies, command and co-ordination of in disaster management, rescue operations-how to start with and how to proceed in due course of time, study of flowchart showing the entire process.	
04	**Institutional Framework for Disaster Management in India:** 4.1 Importance of public awareness, Preparation and execution of emergency management programme.Scope and responsibilities of National Institute of Disaster Management (NIDM) and National disaster management authority (NDMA) in India.Methods and measures to avoid disasters, Management of casualties, set up of emergency facilities, importance of effective communication amongst different agencies in such situations. 4.2 Use of Internet and softwares for effective disaster management. Applications of GIS, Remote sensing and GPS in this regard.	06
05	**Financing Relief Measures:** 5.1 Ways to raise finance for relief expenditure, role of government agencies and NGO's in this process, Legal aspects related to finance raising as well as overall management of disasters. Various NGO's and the works they have carried out in thepast on the occurrence of various disasters, Ways to approach these teams. 5.2 International relief aid agencies and their role in extreme events.	09
06	**Preventive and Mitigation Measures:** 6.1 Pre-disaster, during disaster and post-disaster measures in some events in general 6.2 Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication 6.3 Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. 6.4 Do's and don'ts in case of disasters and effective implementation of relief aids.	06

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4. Only Four question need to be solved.

REFERENCES:

1. 'Disaster Management' by Harsh K.Gupta, Universities Press Publications.
2. 'Disaster Management: An Appraisal of Institutional Mechanisms in India' by O.S.Dagur, published by Centre for land warfare studies, New Delhi, 2011.
3. 'Introduction to International Disaster Management' by Damon Copolla, Butterworth Heinemann Elseveir Publications.
4. 'Disaster Management Handbook' by Jack Pinkowski, CRC Press Taylor and Francis group.
5. 'Disaster management & rehabilitation' by Rajdeep Dasgupta, Mittal Publications, New Delhi.
6. 'Natural Hazards and Disaster Management, Vulnerability and Mitigation – R B Singh, Rawat Publications
7. Concepts and Techniques of GIS –C.P.Lo Albert, K.W. Yonng – Prentice Hall (India) Publications.

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

Course Code	Course Name	Credits
ILO 7018	**Energy Audit and Management**	**03**

Objectives:

1. To understand the importance energy security for sustainable development and the fundamentals of energy conservation.
2. To introduce performance evaluation criteria of various electrical and thermal installations to facilitate the energy management
3. To relate the data collected during performance evaluation of systems for identification of energy saving opportunities.

Outcomes: Learner will be able to…

1. To identify and describe present state of energy security and its importance.
2. To identify and describe the basic principles and methodologies adopted in energy audit of an utility.
3. To describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities.
4. To describe the energy performance evaluation of some common thermal installations and identify the energy saving opportunities
5. To analyze the data collected during performance evaluation and recommend energy saving measures

Module	Detailed Contents	Hrs
01	**Energy Scenario:** Present Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy Security, Energy Conservation and its Importance, Energy Conservation Act-2001 and its Features. Basics of Energy and its various forms, Material and Energy balance	04
02	**Energy Audit Principles:** Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring& targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return oninvestment (ROI), Internal rate of return (IRR)	08
03	**Energy Management and Energy Conservation in Electrical System:** Electricity billing, Electrical load management and maximum demand Control;	10

	Power factor improvement, Energy efficient equipments and appliances, star ratings. **Energy efficiency measures in lighting system, Lighting control:** Occupancy sensors, daylight integration, and use of intelligent controllers. Energy conservation opportunities in: water pumps, industrial drives, induction motors, motor retrofitting, soft starters, variable speed drives.	
04	**Energy Management and Energy Conservation in Thermal Systems:** Review of different thermal loads; Energy conservation opportunities in: Steam distribution system, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system. General fuel economy measures in Boilers and furnaces, Waste heat recovery, use of insulation- types and application. HVAC system: Coefficient of performance, Capacity, factors affecting Refrigeration and Air Conditioning system performance and savings opportunities.	10
05	**Energy Performance Assessment:** On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method, Financial Analysis.	04
06	**Energy conservation in Buildings:** Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	03

Assessment:

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4. Only Four question need to be solved.

REFERENCES:

1. Handbook of Electrical Installation Practice, Geofry Stokes, Blackwell Science
2. Designing with light: Lighting Handbook, By Anil Valia, Lighting System
3. Energy Management Handbook, By W.C. Turner, John Wiley and Sons
4. Handbook on Energy Audits and Management, edited by A. K. Tyagi, Tata Energy Research Institute (TERI).
5. Energy Management Principles, C.B.Smith, Pergamon Press
6. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press
7. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press
8. www.energymanagertraining.com
9. www.bee-india.nic.in

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECP701	**Major Project – I**	--	6#	--	--	3	--	3

# 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.					
ECP701	**Major Project – I**	--	--	--	--	50	--	50	100

Subject Code	Subject Name	Credits
ECP701	**Major Project – I**	**3**
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1 Identify problems based on societal /research needs. 2 Apply Knowledge and skill to solve societal problems in a group. 3 Develop interpersonal skills to work as member of a group or leader. 4 Draw the proper inferences from available results through theoretical/ experimental/simulations. 5 Analyze the impact of solutions in societal and environmental context for sustainable development. 6 Use standard norms of engineering practices 7 Excel in written and oral communication. 8 Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 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. 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	: 15
Marks awarded by review committee	: 15
Quality of Project report	: 20

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

- In VII semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
   - First shall be for finalization of problem
   - Second shall be on finalization of proposed solution of problem.

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

1.   Quality of survey/ need identification

2.   Clarity of Problem definition based on need.

3.   Innovativeness in solutions

4.   Feasibility of proposed problem solutions and selection of best solution

5.   Cost effectiveness

6.   Societal impact

7.   Innovativeness

Guidelines for Assessment of Major Project Practical/Oral Examination:

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

•   Major Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organizations having experience of more than five years approved by head of Institution.

•   Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

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

1. Quality of problem and Clarity

2. Innovativeness in solutions

3. Cost effectiveness and Societal impact

4. Full functioning of working model as per stated requirements

5. Effective use of skill sets

6. Effective use of standard engineering norms

7. Contribution of an individual's as member or leader

8. Clarity in written and oral communication

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

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	Practical	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; 2nd 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
ECCDO 801	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.					
ECCDO 801	Natural Language Processing	20	20	20	80	03	--	--	100

Course Pre-requisite:

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

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	Prac tical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duratio n 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 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 AM unique Capabilities : Shape Complexity, Heirarchical Complexity, Functional Complexity and Material Complexity. 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 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. , 2nd 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	Practical	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 DO802	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 DO802	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**	
	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	08
	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 duratio n 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
ECCDO 802	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.					
ECCDO 802	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 Qubits and multi-qubits states Bloch Sphere representation Quantum Superposition 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: Block Sphere Multi-qubpits Stateys Quantum -superposAition of qpubits (vralid aind linvalid superposition) Quantum Entanglement Useful states from quantum algorithmic perceptive e.g. Bell State Operation on qubits: Measuring and transforming using gates. Quantum Logic gates and Circuit No Cloning Theorem and Teleportation	
	3.3	Programming model for a Quantum Computing Program Steps performed on classical computer Steps performed on Quantum Computer Moving data between bits and qubits.	
4.0		Quantum Algorithms and Error correction	**06**
	4.1	Quantum Algorithms Shor's Algorithm Grover's Algorithm Deutsch's Algorithm Deutsch -Jozsa Algorithm	
	4.2	Quantum error correction using repetition codes 3 qubit codes Shor's 9 qubit error correction Code	
5.0		Quantum Hardware	**10**
	5.1	Ion Trap Qubits The DiVincenzo Criteria 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 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 Circuit QED (cirQED): Quantum LC Circuits, Artificial Atoms, Superconducting Qubits	
	5.4	Quantum computing with spins: 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 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 duratio n 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** Birthday Attacks ,Brute-Force Password Attacks , Dictionary Password Attacks, IP Address Spoofing Hijacking ,Replay Attacks ,Man-in-the-Middle Attacks Masquerading ,Eavesdropping ,Social Engineering, Phreaking ,Phishing ,Pharming .	
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? What auditing benchmarks are ? How to collect audit data? Which post-audit activities you need to perform? How to perform security monitoring? Which types of log information you should capture? How to verify security controls ? • 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	Practical	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 fromtime to time. The grades should be converted into marks as per the Credit and Grading System manual and shouldbe 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	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 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.

Course 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:** 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:** 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:** Work Breakdown structure (WBS) and linear responsibility chart, Interface 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:** Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. 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:** Planning monitoring and controlling cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings. **5.2 Monitoring and Controlling Projects:** Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit. **5.3 Project Contracting** Project procurement management, contracting and outsourcing,	8
06	**6.1 Project Leadership and Ethics:** Introduction to project leadership, ethics in projects. Multicultural and virtual projects. **6.2 Closing the Project:** 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:

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End Semester Theory Examination:

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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, 7th Ed.

2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA

3. Gido Clements, Project Management, Cengage Learning.

4. Gopalan, Project Management, , Wiley India

5. Dennis Lock, Project Management, Gower Publishing England, 9 th Ed.

Course Code	Course Name	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. **Financial Instruments:** Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills. **Financial Markets:** Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign Currency Market **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. **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. **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) **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. **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:

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End Semester Theory Examination:

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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 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 **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:

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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** • Human Resource Management- Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions. • 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)** • Introduction to OB Origin, Nature and Scope of Organizational Behavior, Relevance to Organizational Effectiveness and Contemporary issues • Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness • Perception: Attitude and Value, Effect of perception on Individual Decision-	7

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

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End Semester Theory Examination:

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4. Only Four question need to be solved.

REFERENCES:

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

Course Code	Course Name	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 **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 **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. 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

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End Semester Theory Examination:

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

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

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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, Differentcategory of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plantvariety protection, Geographical indications, Transfer of technology etc. **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 **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 **Patent databases:** Important websites, Searching international databases	07

Assessment:

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End Semester Theory Examination:

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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-** Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy, **Drivers of digital business**- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things(digitally intelligent machines/services) Opportunities and Challenges in Digital Business,	09
2	**Overview of E-Commerce** **E-Commerce-** Meaning, Retailing in e-commerce-products and services, consumer behavior, market research and advertisement 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 Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile commerce and pervasive computing 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 **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 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, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation)	04
6	**Materializing e-business: From Idea to Realization**-Business plan preparation **Case Studies and presentations**	08

Assessment:

Internal:

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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. 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. 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:

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. 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, 3rd Ed. Access Publishing.2015

Subject code	Subject Name	Teaching scheme			Credit assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
ECP801	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.					
ECP801	Major Project – II	--	--	--	--	100	--	50	150

Subject Code	Subject Name	Credits
ECP801	Major Project – II	3
Course Objectives	**The course is aimed** 1. To acquaint with the process of identifying the needs and converting it into the problem. 2. To familiarize the process of solving the problem in a group. 3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems. 4. To inculcate the process of self-learning and research.	
Course Outcomes	**On successful completion of course learner/student will be able to:** 1 Identify problems based on societal /research needs. 2 Apply Knowledge and skill to solve societal problems in a group. 3 Develop interpersonal skills to work as member of a group or leader. 4 Draw the proper inferences from available results through theoretical/ experimental/simulations. 5 Analyze the impact of solutions in societal and environmental context for sustainable development. 6 Use standard norms of engineering practices 7 Excel in written and oral communication. 8 Demonstrate capabilities of self-learning in a group, which leads to lifelong learning. 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;

  o Marks awarded by guide/supervisor based on log book   : 30
  o Marks awarded by review committee   : 30
  o 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

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