UNIVERSITY OF MUMBAI

Scheme

for

Bachelor of Engineering

in

Electronics & Computer Science

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

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

FACULTY OF SCIENCE & TECHNOLOGY

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

Program Structure for Third Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

UNIVERSITY OF MUMBAI

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

Date:

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

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

Program Structure for Third Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Preamble

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

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

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

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Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

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

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

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

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Program Structure for Third Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2021-2022)

Preface

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

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

i. Curriculum has been framed with reduced credits and weekly contact hours, thereby providing free slots to the students to brain storm, debate, explore and apply the engineering principles. The leisure provided through this revision shall favour to inculcate innovation and research attitude amongst the students.
ii. New skill-based courses have been incorporated in curriculum keeping in view AICTE model curriculum.
iii. Skill based Lab courses have been introduced, which shall change the thought process and enhance the programming skills and logical thinking of the students
iv. Mini-project with assigned credits shall provide an opportunity to work in a group, balancing the group dynamics, develop leadership qualities, facilitate decision making and enhance problem solving ability with focus towards socio-economic development of the country. In addition, it shall be direct application of theoretical knowledge in practice, thereby, nurture learners to become industry ready and enlighten students for Research, Innovation and Entrepreneurship thereby to nurture start-up ecosystem with better means.
v. An usage of ICT through NPTEL/SWAYAM and other Digital initiatives of Govt. of India shall be encouraged, facilitating the students for self-learning and achieve the Graduate Attribute (GA) specified by National Board of accreditation (NBA) i.e. lifelong learning.

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

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

Boards of Studies in Electronics Engineering

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

Program Structure for Final Year Electronics and Computer Science

UNIVERSITY OF MUMBAI

(With Effect from 2022-2023)

Semester 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

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

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	Practical	Oral	Total
		Internal assessment			End Sem. Exam	Exam duration Hours				
		Test 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**
	6.1	**Cloud Applications:**	
		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	Practical	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 - Hackers and 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	Block Chain Technologies	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 and Test 2						
ECC DO702	Block Chain Technologies	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
		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
		Centralization vs. Decentralization, What is Blockchain, History of Blockchain, Blockchain defined- peer to peer, Distributed Ledger, Cryptographically Secure, Append-only, Updatable via consensus, How Blockchain Works, Benefits and Limitations of Blockchain, Types of Blockchain, The Structure of a Block, Block header, Genesis block, Mining , Rewards, Consensus, Types of Consensus Mechanisms, Consensus in Blockchain.	
3		**Bitcoin and Cryptocurrency**	6
		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	
		Self Study - Alt Coins	
4		**Introduction to Ethereum**	10
		Introduction to Ethereum, Ethereum's Consensus Mechanisms, MetaMask Setup, Ethereum Accounts, Ethers, Gas, Introduction to Smart Contracts, Remix IDE, Writing smart contracts using Solidity	
		Self Study- Geth, Ganache-Creating Wallets	
5		**Introduction to Hyperledger**	6
		What is Hyperledger? Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer, Transaction Flow.	
		Self study: Case Study of Supply Chain Management using Hyperledger	
6		**Privacy, Security issues in Blockchain**	6
		Pseudo-anonymity vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on Blockchains (Sybil attacks, selfish mining, 51% attacks), prevention of attacks	

		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) β= 1.5 and α=1, and b) β= 1 and α=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 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	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 based on 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 Manageme-nt 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 Cost Analysis	05

Assessment:

Internal:

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

End Semester Theory Examination:

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

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

REFERENCES:

1. 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

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. 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

Assessment:

Internal:

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End Semester Theory Examination:

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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 General2^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:

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:

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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. 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:

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
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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. 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

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.

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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 the past 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

Assessment:

Internal:

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End Semester Theory Examination:

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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 on investment (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
ISP701	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.					
ISP701	Major Project – I	--	--	--	--	50	--	50	100

Subject Code	Subject Name	Credits
ISP701	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