K J Somaiya Institute of Engineering and Information Technology, Sion, Mumbai

An Autonomous Institute under University of Mumbai

Autonomy Syllabus Scheme-I (2021-22)

Bachelor of Technology

in

Electronics Engineering (ETRX)

(Last Year-Semester-VII)

(With Effect from AY 2021-22)

From the Principal's Desk:

The academic reforms recently recommended by the AICTE and UGC have effectually strengthened the higher education system in India. To adhere to the status quo and enhance the academic standards and quality of engineering education further, it is essential to assimilate innovation and recurrent revision in curriculum, teaching-learning methodology, examination, and assessment system.

In congruence with it, the University of Mumbai has adapted Outcome-Based Education (OBE) system and has revised the engineering curriculum thrice in the last decade as Rev 2012, Rev 2016, and the recent Rev 2019, 'C' scheme focusing on cutting-edge technology courses.

K. J. Somaiya Institute of Engineering and Information Technology, being an autonomous institute possesses more flexibility in adapting newer approaches to reach higher levels of excellence in engineering education. This first syllabus scheme under the autonomy comprises state-of-the-art courses and laboratory sessions on emerging areas of technology. The syllabus is designed with an objective to foster the students for developing innovative solutions to real-world issues of the society and/or industry through the acquired knowledge. The induction program for the students is deliberated as per guidelines of AICTE and shall be executed over the entire First Year.

With an ideology that the root of innovation is 'interest', the curriculum offers a wide range of elective courses - grouped into core and inter-disciplinary domains. At par with international engineering education, the students can choose to study courses concerning areas of their interests.

The curriculum introduces Skill-Based Learning (SBL), Activity-Based Learning (ABL), and Technology-Based Learning (TBL) as eXposure (SAT) courses - that assure X factor in all the students of the institute. The SAT courses shall be practiced across the first three years of engineering, focusing on graduate attributes like work ethics, responsibilities towards society, problem-solving ability, communication skills, motivation for life-long learning, leadership and teamwork, etc. that may not be copiously imbibed through regular engineering courses. The proficiencies acquired herein shall open huge employment and entrepreneurial opportunities for the students.

Students of the institute are already provided exposure to the work culture and trends in industries through live / collaborative projects / product developments, etc. Under autonomy too, through the component of Project-Based Learning included in the syllabus, the students shall develop Mini, Minor, and Major projects in Second, Third, and Last Year respectively concerning healthcare, agriculture, societal / industrial need-based problems, etc. as well as pursue internships at the end of each semester / year - making them industry-ready engineers. The blend of all these learning components in the curriculum shall strengthen the research and innovation ecosystem in the institute — for best benefits of the students.

This first syllabus shall be effective from Academic Year 2021-22 to all four years at once. It comprises 165 credits, follows the AICTE model curriculum, focuses on learner-centric approach as well as continuous evaluation, and shall offer the ideal learning experience for the students of the institute.

In the coming years, the institute shall also offer an Honours degree for students who are desirous of pursuing their special interest areas in industry-relevant tracks like Artificial Intelligence, Internet of Things, Cyber Security, etc. Through joint efforts of all stakeholders, strategic planning, and efficient execution of neoteric educational practices with hi-tech wizardry, we shall strive to become a role model for all autonomous institutes across the nation.

Dr. Suresh Ukarande
Principal and Chairman - Academic Council

Member Secretary, Academic Council's Preamble:

We, Board of Studies in Computer Engineering (CE), Information Technology (IT), Artificial Intelligence and Data Science (AI-DS), Electronics and Telecommunication (ET) and Electronics Engineering (EX) are very happy to present 4 years of undergraduate and 2 years of post-graduation in Artificial Intelligence (AI), Engineering technology syllabus effective from the Academic Year 2021-22 under the autonomy status granted to our institute, K J Somaiya Institute of Engineering and Information Technology (KJSIEIT). We are sure you will find this syllabus interesting, challenging and meeting the needs of Industry 4.0.

UGC states the benefits of granting academic autonomy to higher education institutes as the freedom to modernize curricula, making it globally competent, locally relevant and skill oriented to promote employability'. Thus exercising academic freedom by eligible and capable institutes is the need for developing the intellectual climate of our country and bringing and promoting academic excellence in higher education system. KJSIEIT under its first autonomous syllabus scheme (KJSIEIT-Scheme I) is keen in providing globally required exposure to its learners focusing sound theoretical background supported by practical experiences in the relevant areas of engineering and technology.

Besides engineering and technology foundation, Industry 4.0 demands modern, industry-oriented education, up-to-date knowledge of analysis, interpretation, designing, implementation, validation, and documentation of not only computer software and systems but also electronics and communication systems, hardware devices and tools, trained professional, ability to work in teams on multidisciplinary projects, etc. Thus KJSIEITs autonomy Scheme-I syllabus has been designed for the learners to successfully acquaint with the demands of the industry worldwide, life-long experiential learning, professional ethics with universal human values and training for needed skillsets and in line with the objectives of higher and technical education, AICTE, UGC and various accreditation and ranking agencies by keeping an eye on the technological developments, innovations, and industry requirements.

The salient features of KJSIEITs autonomy Scheme-I syllabus are:

1. Total 165 credits ensuring extra time for students' experiential learning through extracurricular activities, innovations, and research.
2. Introduction of Skill Based, Activity Based, Technology based and Project Based learning to showcase learners' creativity, interest and talent by developing additional skillsets, social involvement and contributions through activities, case studies, field visits, internships, creative learning, innovative mini, minor and major project developments, strengthen their profile and increasing the chances of employability.
3. Value addition learning through MOOCs platforms such as IBM-ICE, Coursera, NPTEL, SWAYAM, Spoken Tutorial etc.
4. Emerging areas of technology learning in Artificial Intelligence, Machine learning, Data Science, Internet of things, Cyber Security, Block chain, augmented and Virtual reality.

We would like to place on record our gratefulness to the faculty, alumni, students, industry experts and stakeholders for having helped us in the formulation of this syllabus.

Dr. Sunita R Patil

Member Secretary, Academic Council and Vice Principal, KJSIEIT, Sion

Preface by Board of Studies in Electronics Engineering:

We, the members of Board of Studies of B.Tech in Electronics Engineering are very happy to present a syllabus of Third and Last Year of B. Tech in Electronics Engineering with effect from the Academic Year 2021-22. We are assured that you will discover this syllabus interesting and challenging.

There are nine emerging technology thrust areas declared by AICTE, as an Electronics Engineer he/she should have knowledge about all the emerging technologies which will rules the industries in future so we have touched almost every emerging areas while deciding the courses and contents there in. The syllabus focuses on providing a sound theoretical background as well as good practical exposure to students in the relevant areas. Program Educational Objectives are considered while deciding different courses. It is envisioned to deliver a modern, industry-oriented education in Electronics Engineering. It aims at creating skilled engineers who can successfully acquaint with the demands of the industry worldwide. They obtain skills and experience in up-to-date knowledge to analysis, design, employ, technologies, software and systems.

At the beginning of every course we have added two theory lectures for prerequisites and course outline and at the end one theory lecture added for coverage of course conclusion which includes recap of modules, outcomes, applications, and summarization. We have mapped Course outcomes, PBL outcomes, Skills outcomes, Activity outcomes and TBL outcomes module wise throughout the syllabus. Faculty in this program adopted collaborative, co-operative and online teaching learning techniques during coverage of the course; this will help students to understand each course in depth. The designed syllabus promises to achieve the objectives of affiliating University, AICTE, UGC, and various accreditation agencies by keeping an eye on the technological developments, innovations, and industry requirements.

We would like to show our appreciation to the faculties, students, industry experts and stakeholders assisting us in the design of this syllabus.

Board of Studies in Electronics Engineering are,

Sr. No.	Name	Designation	Sr. No.	Name	Designation
1	Dr. Milind U. Nemade	Head of the Department concerned (Chairman)	9	Prof. Pankaj Deshmukh	Member
2	Dr. Sudhakar Mande	One expert to be nominated by the Vice-Chancellor	10	Prof. Sejal Shah	Member
3	Mr. Saurabh Srivastava	One Representative from Industry /Corporate Sector/ Allied area relating to Placement	11	Prof. Vidya Sagvekar	Member
4	Dr. Vaishali Wadhe	Member	12	Prof. Sheetal Jagtap	Member
5	Prof. Vrinda Ullas	Member	13	Prof. Sarika Mane	Member
6	Prof. Ganesh Wadmare	Member	14	Prof. G.R. Phadke	Member
7	Prof. Mandar Bivalkar	Member	15	Prof. Devanand Bathe	Member
8	Prof. Medha Asurlekar	Member			

Program Structure for Third and Last Year UG Technology with Credit and Examination Scheme
Program Structure for Last Year UG Technology (ET)

Semester- VII-Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.) (TH – P – TUT)	Total (Hrs.)	Credit Assigned (TH – P – TUT)	Total Credits	Course Category
1UETC701	Power Electronics	3–0–0	03	3–0–0	03	PC
1UETC702	Internet of Things	3–0–0	03	3–0–0	03	PC
1UETDLC703X	Department Level Elective-3	3–0–0	03	3–0–0	03	DLE
1UETDLC704X	Department Level Elective-4	3–0–0	03	3–0–0	03	DLE
1UILC705X	Institute Level Elective-1	3–0–0	03	3–0–0	03	ILE
1UETL702	Internet of Things Lab	0–2–0	02	0–1–0	01	PC
1UETDLL703X	Department Level Elective-3 Lab	0–2–0	02	0–1–0	01	DLE
1UETDLL704X	Department Level Elective-4 Lab	0–2–0	02	0–1–0	01	DLE
1UETPR75	Project Based Learning- Major Project Lab-A	0–6#–0	06*	0–3–0	03	PBL
Total		**15-12-0**	**27**	**15-6-0**	**21**	

PBL-PR-A- (Preparation for Conference paper, TPP, participation in competition as Term work)
*Load of learner, not the faculty

Semester- VII-Examination Scheme

Course Code	Course Name	Examination Scheme								
		Marks								
		CA			ESE	TW	O	P	P&O	Total
		T1	T2	IA						
1UETC701	Power Electronics	15	15	10	60	--	--	--	--	**100**
1UETC702	Internet of Things	15	15	10	60	--	--	--	--	**100**
1UETDLC703X	Department Level Elective-3	15	15	10	60	--	--	--	--	**100**
1UETDLC704X	Department Level Elective-4	15	15	10	60	--	--	--	--	**100**
1UILC705X	Institute Level Elective-1	15	15	10	60	--	--	--	--	**100**
1UETL702	Internet of Things Lab	--	--	--	--	25	25	--	--	**50**
1UETDLL703X	Department Level Elective-3 Lab	--	--	--	--	25	25	--	--	**50**
1UETDLL704X	Department Level Elective-4 Lab	--	--	--	--	25	25	--	--	**50**
1UETPR75	Project Based Learning- Major Project Lab-A	--	--	--	--	25	--	--	50	**75**
Total		**75**	**75**	**50**	**300**	**100**	**75**	--	**50**	**725**

Major Project A and B:

- Students can form groups with minimum 2 (Two) and not more than 3 (Three)
- Faculty Load : In Semester VII – ½ hour per week per project group
  In Semester VIII – 1 hour per week per project group

Department Level Elective-3			
Group A: Data Storage and Technology	**Group B: Electronics Core**	**Group C: Artificial Intelligence and Data Science**	**Group D: Computer Domain**
1UETDLC7032	1UETDLC7031	1UETDLC7033	1UETDLC7034
Graphic Processor and Parallel Computing	Mixed Signal VLSI Design	Artificial Intelligence	Advanced Networking Technologies
Department Level Elective-4			
Group A: Data Storage and Technology	**Group B: Electronics Core**	**Group C: Artificial Intelligence and Data Science**	**Group D: Computer Domain**
1UETDLC7041	1UETDLC7043	1UETDLC7044	1UETDLC7042
Data Compression	Robotics	Data Science and Applications	Cloud Computing
Institute Level Elective-1			
1UILC7051	**1UILC7052**	**1UILC7053**	**1UILC7054**
Product Life Cycle Management	Reliability Engineering	Management Information System	Design of Experiments
1UILC7055	**1UILC7056**	**1UILC7057**	**1UILC7058**
Operations Research	Cyber Security and Laws	Disaster Management and Mitigation Measures	Energy Audit and Management
1UILC7059			
Development Engineering			

Course Code	Course Name	Credits (TH+P+TUT)
1UETC701	Power Electronics	(3+0+0)

Prerequisite:	Electrical Network Analysis and Synthesis Electronic Devices and Circuits-I Electronic Devices and Circuits-II
Course Objectives:	1. To teach power electronic devices and their characteristics. 2. To highlight power electronics based rectifiers, inverters and choppers.
Couse Outcomes:	After successful completion of the course, student will be able to 1. Analyse behaviour of semiconductor devices as power switches. 2. Design different triggering circuits for SCR 3. Analyse various single phase controlled rectifiers 4. Analyse various DC-AC inverter circuits. 5. Simulate various DC-DC converter circuits 6. Analyse AC voltage controllers and Cyclo-converters

Module No. & Name	Sub Topics	CO mapped	Hrs./ Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Power semiconductor devices	1.1 Principle of operation of SCR, static and dynamic characteristics, gate Characteristics	CO1	02	03
	1.2 Principle of operation, characteristics, ratings and applications of: TRIAC, DIAC		01	
2. SCR: Triggering, commutation and Protection Circuits	2.1 Methods of turning ON SCR (types of gate signal), firing circuits (using R, RC, UJT, Ramp and pedestal, inverse cosine)	CO2	02	06
	2.2 Design of commutation circuits		02	
	2.3 Protection of SCR		02	
3. Single-phase Controlled Rectifiers	3.1 Introduction to uncontrolled rectifiers, Half wave controlled rectifiers with R, RL load, effect of free-wheeling diode	CO3	02	08
	3.2 Full wave fully controlled rectifiers (centre-tapped, bridge configurations), full-wave half controlled (semi-converters) with R, RL load, effect of freewheeling diode and effect of source inductance.		03	
	3.3 Calculation of performance parameters, input performance parameters (input power factor, input displacement factor (DF), input current distortion factors (CDF), input current harmonic factor (HFD), Crest Factor (CF)), output performance parameters.		03	
4. Inverters	4.1 Introduction to basic and improved series/parallel inverters, limitations.	CO4	02	08
	4.2 Introduction, principle of operation, performance parameters of Single phase half *I* full bridge voltage source inverters with R and R-L load		03	

	4.3 Voltage control of single phase inverters using PWM techniques, harmonic neutralization of inverters, applications		03	
5. DC-DC converters	5.1 Basic principle of step up and step down DC-DC converters, DC-DC switching mode regulators: Buck, Boost, Buck-Boost, Cuk Regulators(CCM mode only)	CO5	03	08
	5.2 Voltage commutated, current commutated and load commutated DC-DC converters		03	
	5.3 Applications in SMPS, Battery charging systems.		02	
6. AC Voltage Controllers and Cyclo-convertors	6.1 Principle of On-Off control, Principle of phase control, single phase bidirectional control with R and RL load	CO6	03	06
	6.2 Introduction, single phase and three phase Cyclo-converters applications		03	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:	
Text Books	1.M. H. Rashid, "Power Electronics", Prentice-Hall of India 2. L. Umanand, "Power Electronics Essentials and Applications", Wiley India Pvt. Ltd 3.Ned Mohan, "Power Electronics", Undeland, Robbins, John Wiley Publication
Reference Books	1. P. S. Bhimbra, "Power Electronics", Khanna Publishers, 2012 2. M.D. Singh and K. B. Khanchandani, "Power Electronics", Tata McGraw Hill 3. Ramamurthy, "Thyristors and Their Applications" 4. P. C. Sen, "Modern Power Electronics", Wheeler Publication.

Useful Links:

1.https://www.coursera.org/specializations/power-electronics

2.https://nptel.ac.in/courses/108/102/108102145/

1.https://onlinecourses.nptel.ac.in/noc21_ee01/preview

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UETC702	Internet of Things	(3+0+0)

Prerequisite:	1.Micro-controllers and Applications 2.Embedded Systems and RTOS 3.Computer Communication Network 4.Wireless Communication
Course Objectives:	The objectives of this course are to: 1.Understand the design features of Internet of Things(IoT) 2.Understand importance of data handling in IoT Way. 3.Introduce multiple ways of data communication and networking. 4.Understand design issue in IoT
Couse Outcomes:	On successful completion of the course the students will be able to: 1.Explain the concepts of Internet of Things. 2.Analyze basic multiple way of data communication and networking in IoT 3.Apply design methodology for solving IoT case studies. 4.Analyze data handling in IoT. 5.Implementation of IoT Devices. 6.Illustrate various IoT case studies.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to IoT	1.1 Introduction;-Defining IoT, Characteristics of IoT, Physical design of IoT, Logical design of IoT, Functional blocks of IoT	CO1	04	08
	1.2 IoT and M2M:- IoT/M2M System layers and Design Standardization, M2M, Difference between IoT and M2M		01	
	1.3 IoT Levels:-IoT Levels and Deployment Templates		03	
2. Network & Communication aspects	2.1 Design Principles & Web Connectivity:, Web Communication Protocols for connected devices, Web connectivity using Gateway, SOAP, REST, HTTP, RESTful and WebSockets, (Publish – Subscribe),MQTT, AMQP, CoAP Protocols	CO2	04	08
	2.2 Internet Connectivity: Internet based communication, IP addressing in IoT, Media Access Control, Application Layer Protocols. LPWAN Fundamentals :LORA, NBIoT, CAT LTE M1,SIGFOX		04	
3. IoT Design Methodology	Introduction, Purpose & requirements, process, domain model, information model, service, IoT level, Functional view, Operational view, Device andComponent Integration	CO3	03	05
4. Data Handling in IoT	4.1 Data Acquiring, Organizing, Processing: - Data acquiring and storage, Organizing the data, Transactions, Business Processes, Integration and Enterprise Systems, Analytics.	CO4	03	06
	4.2 Data Collection and Storage:- Cloud Computing Paradigm for Data Collection,storage and		03	

	computing, Cloud Service Models, Xively, Nimbits			
5. Components of IoT DHT	5.1 Exemplary Devices: Arduino Boards, Arduino Interfacing, ESP8266, DHT Sensor, Ultrasonic Sensor, IR Sensor	CO5	05	08
	5.2 Raspberry Pi, R-Pi Interfaces, Programming R-Pi,		03	
6. IoT Case Studies	Home Automation- Smart Lighting, Home Intrusion Detection, Smart Cities- Smart Parking, Environment- Weather monitoring, Weather Reporting Bot, Forest Fire Detection, Agriculture: Smart Irrigation	CO6	04	04
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1. ArshdeepBahga 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

Useful Links:

https://onlinecourses.nptel.ac.in/noc21_cs17/preview

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Internet of Things".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Course Code	Course Name	Credits (TH+P+TUT)
1UETDLC7031	Mixed Signal VLSI Design	(3+0+0)

Prerequisite:	1.Electronic Devices and Circuits I 2.Digital Circuit Design 3.Electronic Devices and Circuits II 4.Linear Integrated Circuits 5.VLSI Design
Course Objectives:	1. To teach analysis and design of building blocks of CMOS Analog VLSI Circuits. 2. To highlight the issues associated with the CMOS analog VLSI circuit design. 3. To emphasize upon the issues related to mixed signal layout design.
Couse Outcomes:	After successful completion of the course student will be able to 1. Discuss tradeoffs involved in analog VLSI Circuits. 2. Explain single stage amplifier, differential amplifier. 3. Explain MOS operational amplifier. 4. Explain Mixed signal circuits, oscillators and phase locked loop. 5. Discuss verifications of issues involved in analog and mixed signal circuits. 6. Describe about Data converters fundamentals and architecture.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Analog building blocks	1.1 Need for CMOS analog and mixed signal designs, MOS Transistor as sampling switch, active resistances, current source and sinks, current mirror.	CO1	04	08
	1.2 Voltage References: Band Gap References, General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing		04	
2.Amplifier Fundamentals	2.1 Single Stage Amplifiers: Basic concepts, Gain Bandwidth (GBW),Common-source stage (with resistive load, diode connected load, current-source load, triode load, source degeneration), source follower, common-gate stage, cascode stage, folded cascade stage.	CO2	04	10
	2.2 Differential Amplifiers: Single ended and differential operation, Basic differential pair, large signal and small signal behaviours, Common-mode response, Differential pair with MOS loads.		03	
	2.3 Noise: Statistical Characteristics of Noise, Types of Noise, Representation of Noise in circuits, Noise in Single stage amplifiers (CS, CD, CG stages),noise in differential pairs, noise bandwidth, noise figure, noise temperature.		03	
3. MOS Operational Amplifiers	3.1 Stability and Frequency Compensation: General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps	CO3	02	06

	3.2 Op-amp Design: General Considerations, performance parameters, One- stage op- amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations (ICMR), Slew Rate, Power supply rejection, Noise in op-amps. Design of single ended and double ended two stage Op-amps		04	
4. Mixed Signal Circuits	4.1 Basic Concepts: AMS design flow, ASIC, Full custom design, Semi- custom design, System on Chip, System in package, Hardware software co-design, and mixed signal layout issues.	CO5	03	07
	4.2 Oscillators: General considerations, Ring oscillators, LC oscillators,VCO,		02	
	4.3 Phase-Locked Loop: Simple PLL, Charge pump PLL, Non-ideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits		02	
5. Data Converter Fundamentals and Architectures	5.1 Fundamentals: Analog versus discrete time signals, converting analog signals to data signals, sample and hold characteristics. DAC specifications, ADC specifications.	CO6	03	08
	5.2 DAC architectures: Digital input code, resistors string, R-2R ladder networks, current steering, charge scaling DACs, Cyclic DAC, pipeline DAC ADC architectures: Flash, Two Step Flash, Pipeline ADC, Integrating ADCs, Successive approximation ADCs		05	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1.B Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, 1st Edition. 2.R. Jacaob Baker, Harry W. Li, David E. Boyce, "CMOS Circuit Design, Layout, and Simulation", Wiley, Student Edition
Reference Books	1. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design", Oxford University Press, 3rd Edition. 2. Gray, Meyer, Lewis, Hurst, "Analysis and design of Analog Integrated Circuits", Willey, 5th Edition

Useful Links:

1.https://nptel.ac.in/courses/117/101/117101105/

2.https://www.coursera.org/lecture/vlsi-cad-layout/basics-1MtuT

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course " Mixed Signal VLSI Design ".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.

4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Course Code	Course Name	Credits (TH+P+TUT)
1UETDLC7032	Graphic Processor and Parallel Computing	(3+0+0)

Prerequisite:	1. Computer Architecture and Organisation. 2. Data Structures.
Course Objectives:	1. To understand the basics of GPU architectures. 2. To write programs for massively parallel processors. 3. To understand the issues in mapping algorithms for GPUs. 4. To introduce different GPU programming models.
Couse Outcomes:	1. Analyze performance trade-offs in computer design. 2. Analyze pipeline data-path for performance enhancement. 3. Describe data level parallelism and GPU architectures. 4. Describe issues related to instruction level parallelism. 5. Elaborate on multiprocessors and shared memory architectures. 6. Develop programs for GPU hardware.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Brief overview of data structures and computer organization fundamentals	---	02	02
1.Parallelism	Description of architecture, micro-architecture and instruction set architectures, Pipelining Review - basic concept of pipeline, Pipeline CPI, Processor Pipeline Hazards, Computer Architecture, Tech Trends, Processor Speed, Cost, Power, Measuring Performance, Benchmarks Standards, Iron Law of Performance, Moore's Law, Amdahl's Law	CO1, CO2	07	07
2. Instruction-Level Parallelism and Its Exploitation	Instruction-Level Parallelism: Data Hazards, Dynamic Scheduling, Hardware-Based Speculation, Multiple Issue, and Speculation, Multithreading	CO4	07	07
3. Data-Level Parallelism in Vector, SIMD, and GPU Architectures	Vector Architecture, SIMD Instruction Set Extensions for Multimedia, Graphics Processing Units, Loop-Level Parallelism, Mobile versus Server GPU	CO3	07	07
4. Thread-Level Parallelism	Centralized Shared-Memory Architectures, Symmetric Shared-Memory Multiprocessors, Distributed Shared-Memory and Directory-Based Coherence, Synchronization, Models of Memory Consistency	CO5	06	06
5. Introduction to CUDA programming	NVIDIA and CUDA, GPU Hardware Alternatives to CUDA. PC architecture, GPU Hardware	CO3, CO6	06	06
6. Parallel programming in CUDA C	Parallel programming, thread cooperation, shared memory and synchronisation	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42
Books:				

Text Books	1. D. A. Patterson and J. L. Hennessy, "Computer Organization and Design - The Hardware/Software Interface", Morgan Kaufmann, 1998. 2. Cook, Shane. CUDA programming: a developer's guide to parallel computing with GPUs. Newnes, 2012. 3. Sanders, Jason, and Edward Kandrot. CUDA by example: an introduction to general-purpose GPU programming. Addison-Wesley Professional, 2010.
Reference Books	1. Wilt, Nicholas. The cuda handbook: A comprehensive guide to gpu programming. Pearson Education, 2013. 2. Pacheco, Peter. An introduction to parallel programming. Elsevier, 2011. 3. Maurice Herlihy, and NirShavit, "The Art of Multiprocessor Programming, Revised Reprint", Morgan Kaufmann, 2012

Useful Links:

https://docs.nvidia.com/cuda/cuda-c-programming-guide/

https://course.fast.ai/start_colab#Using-a-GPU

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Graphic Processor and Parallel Computing".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Course Code	Course Name	Credits (TH+P+TUT)
1UETDLC7033	Artificial Intelligence	(3+0+0)

Prerequisite:	1. Basic mathematics (Statistics, Probability) 2. Knowledge of any programming language 3. Algorithms
Course Objectives:	1. To create appreciation and understanding of both the achievements of AI and the theory underlying those achievements. 2. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems. 3. To create an understanding of the basic issues of knowledge representation and Logic and blind and heuristic search, as well as an understanding of other topics such as minimal, resolution, etc. that play an important role in AI programs.
Couse Outcomes:	1. Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents. 2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game-based techniques to solve them. 3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing. 4. Attain the capability to represent various real life problem domains using logic-based techniques and use this to perform inference or planning. 5. Formulate and solve problems with uncertain information using Bayesian approaches. 6. Apply concept Natural Language processing to problems leading to understanding of cognitive.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Artificial Intelligence (AI)	1.1 Introduction and Definition of Artificial Intelligence.	CO1	01	03
	1.2 Intelligent Agents: Agents and Environments, Rationality, Nature of Environment, Structure of Agent, types of Agents		02	
2. Problem Solving	2.1 Problem Solving Agent, Formulating Problems, Example Problems	CO2, CO3, CO4	02	10
	2.2 Uninformed Search Methods: Depth Limited Search, Depth First Iterative Deepening (DFID), Informed Search Method: A* Search		04	
	2.3 Optimization Problems: Hill climbing Search, Simulated annealing, Genetic algorithm		04	
3. Knowledge, Reasoning and Planning	3.1 Knowledge based agents	CO4, CO5	01	10
	3.2 First order logic: syntax and Semantic, Knowledge Engineering in FOL Inference in FOL: Unification, Forward Chaining, Backward Chaining and Resolution		05	
	3.3 Planning Agent, Types of Planning: Partial Order, Hierarchical Order, Conditional Order		04	

4. Artificial Neural Network	4.1 Introduction – Fundamental concept– Basic Models of Artificial Neural Networks – Important Terminologies of ANNs – McCulloch-Pitts Neuron	CO5	02	04
	4.2 Neural Network Architecture: Perceptron, Single layer Feed Forward ANN, Activation functions		02	
5. Supervised, Unsupervised and Reinforcement learning	5.1 Supervised Learning: Delta learning rule, Back Propagation algorithm.	CO5	04	08
	5.2 Un-Supervised Learning algorithm: Self-Organizing Maps		04	
6. Applications of Artificial Intelligence	6.1 Language Models, Natural Language for Communication:	CO6	02	04
	6.2 Architectures of expert system, hybrid, NLP, cognitive computing and Robotics		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1. Stuart J. Russell, Peter Norvig, "Artificial Intelligence: A Modern Approach" Prentice Hall, 4th edition, 1994. 2. S. Rajasekaran and G. A. Vijayalakshmi Pai "Neural Networks, Fuzzy Logic and Genetic Algorithms" PHI Learning. 3. Elaine Rich, Kevin Knight, Shivshankar B Nair, Artificial Intelligence, McGraw Hill, 3rd Edition 4. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication. 5. Steven Bird, Ewan Klein, Edward Loper "Natural Language Processing with Python: Text with the Natural Language Toolkit. 1st edition.
Reference Books	1. George Lugar, .AI-Structures and Strategies for Complex Problem Solving., 4/e, 2002, Pearson Education. 2. Nils J. Nilsson, Principles of Artificial Intelligence, Narosa Publication.

Useful Links:

1. www.youtube.com/watch?v=XCPZBD9lbVo&list=PLbMVogVj5nJQu5qwm-HmJgjmeGhsErvXD
2. www.youtube.com/watch?v=TMLyKcBtHuo&ab_channel=nptelhrdnptelhrdVerified
3. www.youtube.com/watch?v=wTbrk0suwbg&t=34s&ab_channel=SimplilearnSimplilearnVerified

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Artificial Intelligence".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Course Code	Course Name	Credits (TH+P+TUT)
1UETDLC7034	Advanced Networking Technologies	(3+0+0)

Prerequisite:	Computer Communication Networks
Course Objectives:	1.Understand the characteristic features of Various Wireless networks. 2.Understand Optical networking and significance of DWDM. 3.Introduce the need for network security and safeguards. 4.Understand the principles of network management.
Course Outcomes:	On successful completion of the course the students will be able to: 1. Appreciate the need for IEEE 802.11 standards. 2. Explain the features of emerging wireless networks: Bluetooth, Zigbee, WSN. 3. Analyze the importance of Optical networking. 4. Demonstrate knowledge of network design layers. 5. Identify Enterprise Network Security methods. 6. Determine the network performance using different monitoring tools and manage network.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction: Fundamentals of Wireless Communication, Advantages, limitations and application, wireless media, Frequency Spectrum: Radio and Infrared; OSI Model and TCP/IP model	---	02	02
1.Wireless LAN and WAN Technologies	1.1 Introduction to Wireless networks: Infrastructure networks, Ad-hoc networks, IEEE 802.11 architecture and services, Medium Access Control sub-layers, CSMA/CA Physical Layer, 802.11 Security considerations	CO1	03	07
	1.2 Wireless LANs: i. 802.11 Physical Layer (PHY) Techniques ii Diffused Infrared, iii FHSS, iv DSSS, Orthogonal Frequency Division Multiplexing (OFDM), MIMO, 802.11—11 Mbps and Beyond, 802.11b, 802.11a, ac, ax, 802.11g,Comparing 802.11 Standards		04	
2. Wireless Technologies	2.1 Wireless Personal Area Network(WPAN): WPAN 802.15.1 architecture ,Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	CO2	04	09
	2.2 802.15.3- Ultra Wide Band , 802.15.4- Zigbee , RFID		03	

	2.3 Wireless Sensor Networks: Introduction and Applications, Wireless Sensor Network Model, Sensor Network Protocol Stack		02	
3.Optical Networking	3.1 SONET : SONET/SDH, Architecture, Signal, SONET devices, connections, SONET layers, SONET frames, STS Multiplexing, SONET Networks	CO3	05	08
	3.2 WDM and DWDM: WDM, Frame format, DWDM architecture ,Optical Amplifier , Optical cross connect Performance and design considerations		03	
4.Network Design	Three tier Network design layers: Application layer, Access layer, Backbone layers, Ubiquitous computing and Hierarchical computing	CO4	04	04
5.Network Security	5.1 Network Security: Security goal, Security threats, security safeguards, Firewalls, Types of firewalls	CO	02	07
	5.2 Enterprise Network security: DMZ, NAT, SNAT, DNAT, Port forwarding, Proxy, Transparent Proxy, Packet Filtering and Layer 7 filtering		05	
6.Network management and Control	6.1 Network Management definitions, Functional Areas(FACPS), SNMP, RMON	CO	02	04
	6.2 Designing a network management solutions, Monitoring and control of network activity and network project management		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1. Behrouz A. Forouzan, "Data communication and networking ", McGraw Hill Education, Fourth Edition. 2. Darren L. Spohn , "Data Network Design" , McGraw Hill Education ,Third edition.
Reference books	1. William Stallings, "Wireless Communications and Networks", Pearson Ed., 2nd Edition. 2. Vijay Garg ,"Wireless Communication and networking" , Morgan Kaufmann Publishers. 3. Prof. Dayanand Ambawade, Dr. Deven Shah, Prof. Mahendra Mehra, Prof. Mayank Agarwal , "Advance computer networks", Wiley Publications.

Useful Links:

1.https://www.nptel.ac.in

2. https://swayam.gov.in

3. https://www.coursera.org/

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Advanced Networking Technologies".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Course Code	Course Name	Credits (TH+P+TUT)
1UETDLC7041	Data Compression	(3+0+0)

Prerequisite:	1. Digital Communication 2. Digital Signal Processing 3. Signals and Systems
Course Objectives:	1.Students will understand types, need and significance of modelling and coding in data compression 2. Students will study different source coding techniques of data compression. 3. Students will study different image, audio and video compression techniques. 4. Students will learn vector quantization and types of vector quantization.
Couse Outcomes:	1. Students will be able to apply appropriate data model and coding scheme to different applications. 2. Students will be able to apply Huffman and Arithmetic coding methods to solve data compression problems. 3. Students will be able to apply Dictionary methods to text compression. 4. Students will be able to apply image and video compression techniques for different signal processing applications. 5. Students will be able to apply audio and vector quantization to solve signal processing problems.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs. /Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction to Data Compression	1.1 Introduction, Need of data compression, Compression techniques, Measure of performance, Significance of Modelling and Coding	CO1	02	06
	1.2 RLE Text compression, RLE Image compression, Lossy image compression, Conditional Image RLE, Move to front coding.		02	
	1.3 Models: Physical Models, Probability Models, Markov Models, Composite Source Model		02	
2. Huffman and Arithmetic Coding	2.1 Variable size codes, Prefix codes, The Golomb Code, The Kraft-MacMillan Inequality Criteria.	CO2	03	12
	2.2 Minimum Variance Huffman Code, Extended Huffman Codes, Ternary Huffman codes, Canonical Huffman codes, Adaptive Huffman Coding, Huffman Decoding, Rice Codes, Tunstall Codes		06	
	2.3 Difficulties in Huffman Coding, Arithmetic Coding and Decoding: Tabular and Tag generation methods		03	
3. Dictionary Methods	3.1 Static Dictionary, Digram coding, Adaptive Dictionary: LZ77 (Sliding Window), LZSS, LZ78, LZW	CO3	04	07
	3.2 GIF Images, Zip and Gzip, PNG, XML compression, Context Based Compression: PPM, The Burrows-Wheeler Transform		03	

4.Image and Video Compression	4.1 Approaches to Image compression, Gray codes, Error Metrics, CALIC, DCT, JPEG, JPEG–LS, JBIG, Differential Lossless Compression, DPCM, JPEG – 2000 Standards, Multi-resolution Approaches, Facsimile Encoding	CO4	06	08
	4.2 Analog Video, Digital Video, Video compression methods, MPEG 4, Protocols, H–264 Encoder		02	
5. Audio Compression	Sound, Digital Audio, The Human Auditory System, μ-Law and A-Law Companding, ADPCM Audio compression, MLP Audio, MPEG Audio coding-Layer 1, 2 and 3 (MP3 Format), The MDCT Audio compression	CO5	03	03
6. Vector Quantization	Advantages of Vector Quantization over Scalar Quantization, The Linde-Buzo-Gray Algorithm, Tree structured Vector Quantizers, Structured Vector Quantizers.		03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1. Mark Nelson, Jean-Loup Gailly, The Data Compression Book, BPB Publications, SecondEdition, 1995. 2.Khalid Sayood, Introduction to Data Compression, Morgan Kaufmann Publishers, Second Edition, 2006. 3.Timothy C, Text Compression, Bell Prentice Hall, First Edition, 1990.
Reference Books	1. David Salomon, Data Compression: The Complete Reference, Springer, Third Edition, 2005. 2. Drozdek, Elements of Data Compression, Cengage Learning, First Edition, 2001.

Useful Links:

1. http://www.nptelvideos.com/video.php?id=989
2. https://www.coursera.org/lecture/algorithms-part2/introduction-to-data-compression-OtmHU
3. https://nptel.ac.in/courses/106102064/19
4. http://www.iitk.ac.in/karmaa/DownloadTools/MCIT_DataCompressionProject/Data_Compression_Techniques_for_E-Learning.html
5. http://www.digimat.in/nptel/courses/video/106106182/L191.html

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Data Compression".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Course Code	Course Name	Credits (TH+P+TUT)
1UETDLC7042	Cloud Computing	(3+0+0)

Prerequisite:	1. Operating System 2. Computer Communication Networks
Course Objectives:	1. To understand basics of cloud computing. 2. To discuss about Key concepts of virtualization. 3. To discuss Cloud programming. 4. Describe Amazon Web Services
Couse Outcomes:	1. Define Cloud Computing and memorize the different Cloud service and deployment models 2. Describe importance of virtualization along with their technologies. 3. Use and Examine different cloud computing services 4. Analyze the components of open stack & Google Cloud platform 5. Discuss about mobile computing architecture. 6. Describe the key components of Amazon web Service

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction	1.1 Defining Cloud Computing, Cloud and other similar configurations, Components of Cloud Computing	CO1	02	04
	1.2 Cloud types: NIST and Cloud Cube Models, Cloud Deployment Models and Service Models, Cloud computing architecture, Advantages and Disadvantages of Cloud Computing.		02	
2. Virtualization	2.1 Concept of Virtualization, Characteristics of virtualized environment, Understanding the importance of Hypervisors, Type I & Type II Hypervisors	CO2	02	07
	2.2 Taxonomy of virtualization, Implementation Levels of Virtualization, Virtualization of CPU		02	
	2.3 Memory and I/O Devices, Virtualization and Cloud Computing, Pros and Cons of virtualization, Technology Examples: KVM, Xen, Vmware and HyperV		03	
3. Cloud Computing Services	3.1 Exploring Cloud Computing Services: SPI Model: Software as a service, Platform as a service, Infrastructure as a service, anything as a service or Eeverything as a service (XaaS), Security as a Service.	CO1, CO3	01	05
	3.2 Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service, Compliance as a Service, Monitoring as a Service		02	

	3.3 Communication as a Service, Network as a Service, Disaster recovery as a service, Analytics as a Service, Backup as a Service.		02	
4. Cloud Implementation	4.1 Open Stack Cloud Architecture: Feature of Open Stack, Components of Open stack, mode of operations.	CO4	03	06
	4.2 Programming support for Google apps engine-GFS, Big tables, Chubby, Google APIs		03	
5.Mobile Cloud Computing	5.1 Mobile Cloud Computing: Definition, architecture, benefits and challenges of mobile cloud computing	CO5	01	05
	5.2 Architecture of Edge-computing		01	
	5.3 Architecture of fog computing		01	
	5.4 Comparison between MCC and CC		01	
	5.5Role of Cloud Computing in IoT and Big Data Application.		01	
6.Exploring the Components of Amazon Web Services	AWS cloud computing Platforms like : 6.1 Elastic Compute Cloud (EC2): Compute Basics, Instance types, Life cycle of instances.	CO6	01	12
	6.2 Simple Storage Service (S3): Basics and Operations, Features, Amazon Glacier, Glacier vs S3.		02	
	6.3 Elastic Block Storage (EBS):Basics and Types of EBS Volumes		01	
	6.4 Amazon Virtual Private Cloud (Amazon VPC): Subnets, Route tables, Elastic IP Addresses (EIP)		02	
	6.5 Elastic Network Interfaces (ENIs) & Security groups & ACL.		02	
	6.6 Exploring Elastic Load Balancing (ELB): Basics, Types of load balancers, Configuring Elastic Load Balancing, Basics of Cloud Watch & Auto Scaling.		02	
	6.7 Amazon AWS IoT Core Services		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1. Barrie Sosinsky,"Cloud Computing Bible", Wiley Publication. 2. Kailash Jayaswal, Jagannath Kallalurchi, Donald J. Houde, Dr. Deven Shah,"Cloud Computing" Black Book", Dreamtech Press. 3. Joe Baron et.al, "AWS Certified Solution Architect", Sybex Publication. 4. Mastering Cloud Computing, Rajkumar Buyya, MGH Publication
Reference Books	1. Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, "Algorithms", Thomas Erl, Robert Cope, Amin Naserpour, "Cloud Computing Design Patterns", Pearson Publication. 2. Judith Hurwitz, "Cloud Computing for Dummies", Wiley Publication.

Useful Links:

1. https://nptel.ac.in/courses/106/105/106105167/

2 https://www.coursera.org/specializations/cloud-computing

3 https://www.edx.org/course/introduction-to-cloud-computing-6
Assessment:
Continuous Assessment for 40 marks: 1. Test 1 – 15 marks 2. Test 2 – 15 marks 3. Internal assessment - 10 marks Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty
End Semester Examination will be of 60 marks for 3 hours duration.
Term work:
1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Cloud Computing". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Course Code	Course Name	Credits (TH+P+TUT)
1UETDLC7043	Robotics	(3+0+0)

Prerequisite:	1.Applied Mathematics III, 2. Applied Mathematics IV, 3. Linear Control Systems
Course Objectives:	1. To study basics of robotics 2.To familiarize students with kinematics & dynamics of robots 3.To familiarize students with Trajectory & task planning of robots. 4. To familiarize students with robot vision
Couse Outcomes:	At the end of completing the course of Robotics, a student will be able to: 1. Describe the basic concepts of robotics. 2. Perform the kinematic and the dynamic analysis of robots. 3. Perform trajectory and task planning of robots. 4. Describe importance of visionary system in robotic manipulation. 5. Simulate Planer motion and Task planner.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Fundamentals of Robotics	Robot Classification, Robot Components, Robot Specification, Joints, Coordinates, Coordinate frames, Workspace, Languages, Applications.	CO1	04	04
2. Kinematics of Robots	2.1 Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation	CO2	04	08
	2.2 Denavit-Hatenberg representation of forward kinematics, Forward and inverse kinematic solutions of three and four axis robot		04	
3. Velocity Kinematics & Dynamics	3.1 Differential motions and velocities: Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian, Singularities.	CO3	05	09
	3.2 Dynamic Analysis of Forces : Lagrangian mechanics, Newton Euler formulation, Dynamic equations of two axis robot		04	
4. Trajectory planning	Basics of Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	CO4	06	06
5. Robot Vision	5.1 Image representation, Template matching, Polyhedral objects	CO5	03	06
	5.2 Shape analysis, Segmentation, Iterative processing, Perspective transform, Camera Calibration		03	
6.Task Planning	Task level programming, Uncertainty, Configuration Space, Gross motion Planning; Grasp planning, Fine-motion Planning, Simulation of Planer motion, Source and goal scenes, Task planner simulation.	CO6	06	06
II.Course Conclusion	Prerequisite Concepts and Course Introduction	---	01	01
Total hours				42

Books:	
Text Books	1.Robert Shilling, "Fundamentals of Robotics - Analysis and control, Prentice Hall of India, 2009 2.Saeed Benjamin Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011
Reference Books	1.John J. Craig, "Introduction to Robotics – Mechanics & Control", Third Edition, Pearson Education, India, 2009 2.Mark W. Spong , Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control ", Wiley India Pvt. Ltd., 2006 3.Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications", McGraw Hill , New York, 2008
Useful Links:	
1. https://nptel.ac.in/courses/112/101/112101098/	
2.https://nptel.ac.in/courses/112/105/112105249/	
Assessment:	
Continuous Assessment for 40 marks: 1. Test 1 – 15 marks 2. Test 2 – 15 marks 3. Internal assessment - 10 marks Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty	
End Semester Examination will be of 60 marks for 3 hours duration.	
Term work:	
1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Robotics". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.	

Course Code	Course Name	Credits (TH+P+TUT)
1UETDLC7044	Data Science and Applications	(3+0+0)

Prerequisite:	Database Management System
Course Objectives:	1. To provide strong foundation for data science and application area related to it and understand the underlying core concepts and emerging technologies in data science.
Couse Outcomes:	On completion of the course, learner will be able to - 1. Apply data science processes to an e-commerce data and demonstrate the use of estimation methods for analyzing this data. 2. Apply appropriate machine learning algorithms for classification. 3. Compare and choose one data visualization method for effective visualization of data. 4. Design a model of recommendation system based on the content of the data. 5. Apply standard clustering methods to analyze social network graph**.**

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Data Science	What is Data Science, Data Science Process, Data Science Toolkit, Types of data, Example and Applications	CO1	04	10
2. Data collection and management	Introduction, Sources of data, Data collection and APIs, Exploring and fixing data, Data storage and management using multiple data sources		06	
3. Exploratory Data Analysis	Introduction to exploratory data analysis, Typical data formats. Types of EDA, Graphical/Non graphical Methods. Univariate /multivariate methods Correlation and covariance. Degree of freedom Statistical Methods for Evaluation including ANOVA.	CO2	08	08
4. Data Visualization	What is Data Visualization, Importance of Data Visualization Design Principles of Data Visualization, Types of Data visualization: Basic charts, plots, Histogram Multivariate Data Visualization, Visualization of groups, trees, graphs, clusters, networks, Hierarchies, Reports, Metaphorical visualization	CO3	09	09
5. Recommendation Systems	Introduction to RS, Types of RS: content based RS, collaborative RS, hybrid RS, Issues and challenges of RS, Examples of real world RS, e.g., Amazon, mobile RS	CO4	05	05
6. Social Network Analysis	Social Networks as Graphs, Varieties of Social Networks, Graphs with Several Node Types, Clustering of Social-Network Graphs. Distance Measures for Social-Network Graphs, Applying Standard Clustering Methods, Betweenness, The Girvan-Newman Algorithm, Using Betweenness to Find Communities	CO5	07	07

II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:	
Text Books	1. Cathy O'Neil and Rachel Schutt, "Doing Data Science, Straight Talk from the Frontline" O' Reilly Media 2. Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. "Mining of Massive Datasets" v2.1, Cambridge University Press
Reference Books	1. Laura Igual and Santi Segui, "Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications", Springer, 1st Edition, 2017
Useful Links:	
1. https://nptel.ac.in/courses/106/106/106106179/	
2. https://nptel.ac.in/courses/106/106/106106179/	
3. https://www.coursera.org/browse/data-science	
Assessment:	

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Data Science and Applications".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7051	Product Life Cycle Management	(3+0+0)

Course 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 5. To familiarize the students with the need, benefits and components of PLM 6. To acquaint students with Product Data Management & PLM strategies 7. To give insights into new product development program and guidelines for designing and developing a product 8. To familiarize the students with Virtual Product Development
Couse Outcomes:	1. Apply the different phases of PLM, PLM strategies and methodology for PLM feasibility study and PDM implementation.(PO3) 2. Analysis various approaches and techniques for designing and developing products.(PO5) 3. Apply product engineering guidelines / thumb rules in designing products for moulding, machining, sheet metal working etc.(PO8) 4. Applying virtual product development tools for components, machining and manufacturing plant.(PO7) 5. Create an Integration of Environmental Aspects in Product Design(PO7) 6.Analysis the Life Cycle Assessment and Life Cycle Cost Analysis(PO11,12)

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Product Lifecycle Management (PLM)	1.1 Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications.	CO1	06	10
	1.2 PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM.		04	
2. Product Design	2.1 Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering.	CO2	05	09

	2.2 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		04	
3. 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	CO3	05	05
4.Virtual Product Development Tools	4.1 For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques.	CO4	03	05
	4.2 Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies		02	
5. 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	CO5	05	05
6. Life Cycle Assessment and Life Cycle Cost Analysis	6.1 Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment.	CO6	03	05
	6.2 Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:	
Text Books	1. Product Lifecycle Management Authors: Saaksvuori, Antti, Immonen, Anselmi ISBN 978-3-540-26906-9 2. Product Lifecycle Management: 21st Century Paradigm for Product Realisation Decision engineering, ISSN 1619-5736,2005
Reference Books	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
Useful Links:	
1. https://www.intechopen.com/books/product-lifecycle-management-terminology-and-applications/introductory-chapter-product-lifecycle-management-terminology	

2. https://www.spectechular.walkme.com/top-3-product-lifecycle-management-books/
3. https://dasme.co/wp-content/uploads/2016/07/plm.pdf
4.https://books.google.co.in/books/about/Product_Lifecycle_Management.html?id=PiVri4OyU7AC&redir_esc=y
Assessment:
Continuous Assessment for 40 marks: 1. Test 1 – 15 marks 2. Test 2 – 15 marks 3. Internal assessment - 10 marks Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty
End Semester Examination will be of 60 marks for 3 hours duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7052	Reliability Engineering	(3+0+0)

Prerequisites:	--
Course 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.
Couse Outcomes:	1.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. Apply the knowledge to improve reliability of complex system 5. Analysis the Maintainability and Availability of system 6. Identity a Failure Mode Effect and Criticality Analysis.

Module No. & Name	Sub Topics	CO mapped	Hrs./ Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Probability theory	1.1 Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem	CO1	02	08
	1.2 Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance.		03	
	1.3 Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.		03	
2. Reliability Concepts, Failure Data Analysis, Reliability Hazard Models	2.1 Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve.	CO2	02	08
	2.2 Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.		03	
	2.3 Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.		03	
3. System Reliability	System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	CO3	05	05
4. Reliability Improvement	4.1 Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis.	CO4	04	08

	4.2 System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.		**04**	
5.Maintainability and Availability	5.1 System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics.	CO5	03	05
	5.2 Parts standardization and Interchange ability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.		02	
6. Failure Mode, Effects and Criticality Analysis	6.1 Failure mode effects analysis, severity/criticality analysis, FMECA examples.	CO6	03	05
	6.2 Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:	
Text books	1. Introduction To Reliability Engineering 2Nd Edition by Lewis, Wiley India 2. Reliability Engineering Theory And Practice 8Ed (Hb 2017) by BIROLINI A., SPRINGER 3. The Certified Reliability Engineer Handbook by Donald W. Benbow, Hugh W. Broome, New Age International (P) Ltd., Publishers
Reference Books	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.
Useful Links:	
1. https://victorops.com/blog/the-comprehensive-site-reliability-engineering-sre-pdf	
2. https://nptel.ac.in/courses/105/108/105108128/	
3. https://nptel.ac.in/content/storage2/courses/112101005/downloads/Module_5_Lecture_3_final.pdf	
4. https://documents.in/document/curso-nptel-reliability-engineering.html	
5. https://www.coursera.org/learn/site-reliability-engineering-slos	
Assessment:	
Continuous Assessment for 40 marks: 1. Test 1 – 15 marks 2. Test 2 – 15 marks 3. Internal assessment - 10 marks Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty	
End Semester Examination will be of 60 marks for 3 hours duration.	

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7053	Management Information System	(3+0+0)

Prerequisites:	--
Course 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.
Couse Outcomes:	Upon completion of the course, the learners will be able to: 1. Describe how information system transforms business. 2. Identify the impact information systems have on an organization. 3. Describe IT infrastructures and its components and its current trends. 4. Explain the principal tools and technologies for accessing information from databases. 5. Apply to improve business performance and decision making. 6. Identify the types of systems used for enterprise wide knowledge management.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Information System	1.1 Computer Based Information Systems, Impact of IT on organizations.	CO1	02	04
	1.2 Importance of IS to Society. Organizational Strategy, Competitive Advantages and IS.		02	
2. Data and Knowledge Management	2.1 Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management.	CO2, CO3	04	07
	2.2 Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results.		03	
3. Ethical Issues and Privacy	3.1 Ethical issues and Privacy: Information Security.	CO3	03	07
	3.2 Threat to IS and Security Controls.		04	
4. Social Computing (SC)	4.1 Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing.	CO4	03	07
	4.2 Operational and Analytic CRM, E-business and E-commerce – B2B B2C. Mobile commerce.		04	
5. Computer Networks	5.1 Computer Networks Wired and Wireless technology.	CO5	03	06
	5.2 Pervasive computing, Cloud computing model.		03	
6. Project leadership and Ethics and	6.1 Information System within Organization: Transaction Processing Systems, Functional Area Information System.	CO6	04	08

Closing the projects	6.2 ERP and ERP support of Business Process. Acquiring Information Systems and Applications: Various System development life cycle models. Managing without authority; Areas of further study.		04	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1. K. Rainer, Brad Prince, Management Information Systems, Wiley. 2. K.C. Laudon and J.P. Laudon, Management Information Systems: Managing the Digital Firm10th Ed., Prentice Hall.
Reference Books	1. S. Jawadekar's Management Information Systems: published by McGraw-Hill Education. 2. D. Boddy, A. Boonstra, Managing Information Systems: Strategy and Organization, Prentice Hall.

Useful Links:

1.https://www.nptel.ac.in/

2.https://www.coursera.org/

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7054	Design of Experiments	(3+0+0)

Prerequisites:	--
Course 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
Couse Outcomes:	Upon completion of the course, the learners will be able to: 1. Plan data collection, to turn data into information and to make decisions that lead to appropriate action. 2. Analyze the different fitting regression models. 3. Apply the different two level factorial designs. 4. Distinguish the different fractional factorial methods. 5. Apply the methods taught to real life situations. 6. Plan, analyze, and interpret the results of experiments.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction	1.1 Strategy of Experimentation, Typical Applications of Experimental Design.	CO1	01	02
	1.2 Guidelines for Designing Experiments, Response Surface Methodology.		01	
2. Fitting Regression Models	2.1 Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression.	CO2	04	08
	2.2 Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.		04	
3. Two-Level Factorial Designs and Analysis	3.1 The 2^2 Design, The 2^3 Design, The General2k Design.	CO3	04	08
	3.2 A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, Blocking in the 2^k Factorial Design, Split-Plot Designs.		04	
4. Two-Level Fractional Factorial Designs and Analysis	4.1 The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design.	CO4	04	08
	4.2 Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.		04	
5. Conducting Tests	5.1 Introduction to Response Surface Methodology, The Method of Steepest Ascent.	CO5	04	08
	5.2 Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.		04	
6. Taguchi Approach	6.2 Crossed Array Designs and Signal-to-Noise Ratios.	CO6	03	05
	6.3 Analysis Methods, Robust design examples.		02	

II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:	
Text Books	1. R. Mayers, D. Montgomery and C. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, John Wiley & Sons, New York. 2. D. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, New York. 3. W. Dimond, Peactical Experiment Designs for Engineers and Scientists, John Wiley and Sons.
Reference Books	1. G. Box, J Hunter and W. Hunter, Statics for Experimenters: Design, Innovation and Discovery, Wiley. 2. A. Dean, and D. Voss, Design and Analysis of Experiments, Springer. 3. P. Ross, Taguchi Technique for Quality Engineering, McGraw Hill. 4. M. Phadake, Quality Engineering using Robust Design, Prentice Hall.
Useful Links:	
1. https://nptel.ac.in/courses/110/105/110105087/	
2.https://www.udemy.com/course/design-of-experiments-i/	
Assessment:	
Continuous Assessment for 40 marks: 1. Test 1 – 15 marks 2. Test 2 – 15 marks 3. Internal assessment - 10 marks Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty	
End Semester Examination will be of 60 marks for 3 hours duration.	

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7055	Operations Research	(3+0+0)

Prerequisites:	--
Course 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
Couse Outcomes:	**Learner will be able to…** 1. Explain the models, limitation and relate it with problems related to operations 2. Examine the operation environment and its resources. 3. Explain and Analyze the simulation algorithms 4. Apply dynamic programming to solve the problems 5. Apply various algorithms to collect, analyse and report data. 6. Judge classical and probabilistic inventory models

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Operations Research	1.1 Introduction, Structure of the Mathematical Model, Limitations of Operations Research.	CO1	01	14
	1.2 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,		03	
	1.3 Duality, Primal – Dual construction, Symmetric and Asymmetric Dual, Weak Duality Theorem, Complimentary Slackness Theorem, Main Duality Theorem, Dual Simplex Method, Sensitivity Analysis		02	
	1.4 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.		03	
	1.5 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, Travelling Salesman Problem		02	
	1.6 Integer Programming Problem: Introduction, Types of Integer Programming Problems, Gomory's cutting plane Algorithm, Branch and Bound Technique. Introduction to Decomposition algorithms.		03	
2. Queuing models	Queuing systems and structures, single server and multi-	CO2	05	05

	server models, Poisson input, exponential service, constant rate service, finite and infinite population			
3. 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	CO3	05	05
4. 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.	CO4	05	05
5. 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.	CO5	05	05
6. Inventory Models	Classical EOQ Models, EOQ Model with Price Breaks, EOQ with Shortage, Probabilistic EOQ Model.	CO6	05	05
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	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.
Reference Books	1.Operations Research, S. D. Sharma, Kedar Nath Ram Nath-Meerut 2.Operations Research, Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Useful Links:

https://onlinecourses.nptel.ac.in/noc20_ma23/preview

https://web.itu.edu.tr/topcuil/ya/OR.pdf

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7056	Cyber Security and Laws	(3+0+0)

Prerequisites:	--
Course 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
Couse Outcomes:	Learner will be able to… 1. Explain the concept of cybercrime and its effect on outside world 2. Classify and Examine the Cyber Offences and security implication. 3. Illustrate and identify the modus operandi followed in cyber-crimes. 4. Explain the aspects in Indian Cyber Laws 5. Explain the penalties in cyber law 6. Apply Information Security Standards compliance during software design and development

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1. Introduction to Cybercrime	Cybercrime definition and origins of the world, Cybercrime and information security, Classifications of cybercrime, Cybercrime and the Indian ITA 2000, A global Perspective on cybercrimes.	CO1	04	04
2. Cyber offenses & Cybercrime	How criminal plan the attacks, Social Engg, Cyber stalking, Cyber café and Cybercrimes, Botnets, Attack vector, Cloud computing, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit Card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication Service Security, Attacks on Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations, Organizational Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops	CO2	09	09
3. 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)	CO3	06	06
4. The Concept of Cyberspace	E-Commerce , The Contract Aspects in Cyber Law ,The Security Aspect of Cyber Law, The Intellectual Property Aspect in Cyber Law, The Evidence Aspect in Cyber Law , The Criminal Aspect in Cyber Law, Global Trends in Cyber Law , Legal Framework for Electronic Data Interchange Law Relating to	CO4	08	08

	Electronic Banking , The Need for an Indian Cyber Law			
5 Indian IT Act.	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	CO5	06	06
6. Information Security Standard compliances	SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	CO6	06	06
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1. Nina Godbole, Sunit Belapure, Cyber Security, Wiley India, New Delhi 2. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi 3. The Information technology Act, 2000; Bare Act- Professional Book Publishers, New Delhi. 4. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai
Reference Books	1.Nina Godbole, Information Systems Security, Wiley India, New Delhi 2.Kennetch J. Knapp, Cyber Security &Global Information Assurance Information Science Publishing. 3.William Stallings, Cryptography and Network Security, Pearson Publication 4.Websites for more information is available on: The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in 5.Website for more information, A Compliance Primer for IT professional

Useful Links:

1. Websites for more information is available on : The Information Technology ACT, 2008- TIFR : https://www.tifrh.res.in

2. Website for more information , A Compliance Primer for IT professional https://www.sans.org/reading-room/ whitepapers/ compliance/ compliance-primer-professionals- 33538

Assessment:

Continuous Assessment for 40 marks:

1. Test 1 – 15 marks
2. Test 2 – 15 marks
3. Internal assessment - 10 marks

Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty

End Semester Examination will be of 60 marks for 3 hours duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7057	Disaster Management and Litigation Measures	(3+0+0)

Prerequisite:	--
Course 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 or 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.
Couse Outcomes:	Upon completion of the course, the learners 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 Dos and Don'ts in Such Extreme Events and act accordingly. 5. Examine Financing Relief Measures. 6. Study Preventive and Mitigation Measures.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction	1.1 Definition of Disaster, Hazard, Global and Indian Scenario, General Perspective, Importance of Study in Human Life.	CO1	02	04
	1.2 Direct and Indirect Effects of Disasters, Long Term Effects of Disasters.		02	
2.Natural Disaster and Manmade disasters	2.1 Natural Disaster: Meaning and Nature of Natural Disaster, Flood, Flash Flood, Drought, Cloud Burst.	CO2	01	07
	2.2 Earthquake, Landslides, Avalanches, Volcanic Eruptions, Mudflow, Cyclone, Storm, Storm Surge.		01	
	2.3 Climate Change, Global Warming, Sea Level Rise, Ozone Depletion.		02	
	2.4 Manmade Disasters: Chemical, Industrial, Nuclear and Fire Hazards. Role of Growing Population and Subsequent Industrialization.		02	
	2.5 Urbanization and Changing Lifestyle of Human Beings in Frequent Occurrences of Manmade Disasters.		01	
3.Disaster Management, Policy and Administration	3.1 Disaster Management: Meaning, Concept, Importance.	CO3	02	06
	3.2 Objective of Disaster Management Policy, Disaster Risks in India, Paradigm Shift in Disaster Management.		02	

	3.3 Policy and Administration Importance and Principles of Disaster Management Policies, Command and Co-Ordination of in Disaster Management.		01	
	3.4 Rescue Operations: How to Start With And How to Proceed in Due Course of Time, Study of Flowchart Showing the Entire Process.		01	
4.Institutional Framework for Disaster Management in India	4.1 Importance of Public Awareness, Preparation and Execution of Emergency Management Programme. Scope and Responsibilities of National Institute of Disaster Management (NIDM) and National Disaster Management Authority (NDMA) in India.	CO4	02	06
	4.2 Methods and Measures to Avoid Disasters, Management of Casualties, Set Up of Emergency Facilities, Importance of Effective Communication Amongst Different Agencies in Such Situations.	CO4	02	
	4.3 Use of Internet and Software for Effective Disaster Management. Applications of GIS, Remote Sensing and GPS.	CO3,4	02	
5.Financing Relief Measures	5.1 Ways to Raise Finance for Relief Expenditure, Role of Government Agencies and NGO's in this Process.	CO5	02	08
	5.2 Legal Aspects Related to Finance Raising as well as Overall Management of Disasters.		02	
	5.3 Various NGO's and the Works they have Carried Out in the Past on the Occurrence of Various Disasters, Ways to Approach these Teams.		02	
	5.4 International Relief Aid Agencies and Their Role in Extreme Events.		02	
6. Preventive and Mitigation Measures	6.1 Pre-Disaster, During Disaster and Post-Disaster Measures in Some Events in General.	CO6	02	08
	6.2 Structural Mapping: Risk Mapping, Assessment and Analysis, Sea Walls and Embankments, Bio Shield, Shelters, Early Warning and Communication.		02	
	6.3 Non-Structural Mitigation: Community Based Disaster Preparedness, Risk Transfer and Risk Financing, Capacity Development and Training, Awareness And Education, Contingency Plans.		02	
	6.4 Do's And Don'ts in Case of Disasters and Effective Implementation of Relief Aids.		02	
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:

Text Books	1. H Gupta Disaster Management, Universities Press Publications. 2. O Dagur, Disaster Management: An Appraisal of Institutional Mechanisms in India, Centre for Land Warfare Studies. 3. C Damon and Butterworth, Introduction to International Disaster Management, Elseveir Publications.
Reference Books	1. K. Yonng, Concepts and Techniques of GIS –C.P.Lo, Prentice Hall (India) Publications. 2. R Singh, Natural Hazards and Disaster Management, Vulnerability and Mitigation, Rawat Publications.

Useful Links:
1. www.msme.gov.in/
2. www.dcmesme.gov.in/
3. www.msmetraining.gov.in/
Assessment:
Continuous Assessment for 40 marks: 1. Test 1 – 15 marks 2. Test 2 – 15 marks 3. Internal assessment - 10 marks Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty
End Semester Examination will be of 60 marks for 3 hours duration.

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7058	Energy Audit and Management	(3+0+0)

Prerequisites	--
Course 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.
Couse Outcomes:	After the successful completion of this course, the learner will be able to: 1. Illustrate present state of energy security and its importance. 2. Describe the basic principles and methodologies adopted in energy audit of an utility. 3. Apply the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. Evaluate the energy performance evaluation of some common thermal installations and identify the energy saving opportunities 5. Analyze the data collected during performance evaluation and recommend energy saving measures. 6. Reviewing the concepts of Energy Conservation in buildings

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.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	CO1	04	04
2. 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)	CO2	08	08
3. Energy Management and Energy Conservation in Electrical System	Electricity billing, Electrical load management and maximum demand Control; Power factor improvement, Energy efficient equipment 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.	CO3	10	10

4. 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.	CO4	10	10
5. 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.	CO5	04	04
6. Energy conservation in Buildings	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	CO6	03	03
II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42
Books:				
Text Books	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			
Reference Books	1. Energy Conservation Guidebook, Dale R. Patrick, S. Fardo, Ray E. Richardson, Fairmont Press 2. Handbook of Energy Audits, Albert Thumann, W. J. Younger, T. Niehus, CRC Press			
Useful Links:				
1.www.energymanagertraining.com				
2.www.bee-india.nic.in				
Assessment:				
Continuous Assessment for 40 marks: 1. Test 1 – 15 marks 2. Test 2 – 15 marks 3. Internal assessment - 10 marks Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty				
End Semester Examination will be of 60 marks for 3 hours duration.				

Course Code	Course Name	Credits (TH+P+TUT)
1UILC7059	Development Engineering	(3+0+0)

Prerequisites	----
Course 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 designs for robustness and optimization.
Couse Outcomes:	Upon completion of the course, the learners will be able to: 1. Plan data collection to turn data into information and to make decisions that lead to appropriate action. 2. Analyze the different fitting regression models. 3. Apply different two-level factorial designs. 4. Differentiate the different fractional factorial methods. 5. Apply the methods taught to real life situations. 6. Explain methods to plan, analyze, and interpret the results of experiments.

Module No. & Name	Sub Topics	CO mapped	Hrs. /Subtopic	Total Hrs./ Module
I. Prerequisite and Course Outline	Prerequisite Concepts and Course Introduction	---	02	02
1.Introduction	1.1 Strategy of Experimentation, Typical Applications of Experimental Design.	CO1	01	03
	1.2 Guidelines for Designing Experiments, Response Surface Methodology.		02	
2. Fitting Regression Models	2.1 Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression.	CO2	04	08
	2.2 Confidence Intervals in Multiple Regression, Prediction of new Response Observation, Regression Model Diagnostics, Testing for Lack of Fit.		04	
3.Two Levels Factorial Designs	3.1 The 2^2Design, The 2^3 Design, The General 2^k Design	CO3	03	08
	3.2 A Single Replicate of the 2^k Design, The Addition of Center Points to the 2^k Design, blocking in the 2^k Factorial Design, Split-Plot Designs.		05	
4.Two Levels Fractional Factorial Methods	4.1 The One-Half Fraction of the 2^k Design, The One-Quarter Fraction of the 2^k Design, The General 2^{k-p} Fractional Factorial Design.	CO4	04	08
	4.2 Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.		04	
5.1 Response Surface Methods and Designs	5.1Introduction to Response Surface Methodology, The Method of Steepest Ascent.	CO5	04	08
	5.2Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.		04	
6.Taguchi Approach	6.1Crossed Array Designs and Signal-to-Noise Ratios.	CO6	02	04
	6.2Analysis Methods, Robust Design examples.		**02**	

II. Course Conclusion	Recap of Modules, Outcomes, Applications, and Summarization.	---	01	01
Total hours				42

Books:	
Text Books	1. R. Mayers, D. Montgomery and C. Anderson-Cook, Response Surface Methodology: Process and Product Optimization using Designed Experiment, John Wiley & Sons, New York. 2. D. Montgomery, Design and Analysis of Experiments, John Wiley & Sons, New York. 3. W. Dimond, Peactical Experiment Designs for Engineers and Scientists, John Wiley and Sons.
Reference Books	1. G. Box, J Hunter and W. Hunter, Statics for Experimenters: Design, Innovation and Discovery, Wiley. 2. A. Dean, and D. Voss, Design and Analysis of Experiments (Springer text in Statistics), Springer. 3. P. Ross, Taguchi Technique for Quality Engineering, McGraw Hill. 4. M. Phadake, Quality Engineering using Robust Design, Prentice Hall.
Useful Links:	
guide.berkeley.edu/graduate/degree-programs/development-engineering	
Assessment:	
Continuous Assessment for 40 marks: 1. Test 1 – 15 marks 2. Test 2 – 15 marks 3. Internal assessment - 10 marks Internal assessment will be based on assignments/quizzes /case study/activity conducted by the faculty	
End Semester Examination will be of 60 marks for 3 hours duration.	

Course Code	Course Name	Credits (P+TU)
1UETL702	Internet of Things Lab	(1+0)

Lab Prerequisite:	1.Micro-controllers and Applications 2.Embedded Systems and RTOS 3.Computer Communication Network 4.Wireless Communication
Lab Objectives:	1. Understand Arduino IDE for IoT practical. 2. Implementation of Arduino board and Nodemcu interfacing with LED, IR, Ultrasonic, DHT sensors. 3. Demonstration of IoT based case study. 4. Implementation of data storage using AWS cloud. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.
Lab Outcomes (LOs):	After completing practical student will be able to: 1. Use Arduino IDE for IoT based practical. 2. Implement interfacing of Arduino board and nodemcu with LED, IR, Ultrasonic, DHT sensors. 3. Demonstrate IoT based case study. 4. Implement storing of data to AWS. 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	LED and IR sensor interfacing with Nodemcu.	LO1, LO5, LO6	02
2.	Ultrasonic sensor interfacing with Nodemcu for distance measurement.		02
3.	Temperature/Humidity monitoring using Blynk App.		02
4.	DHT sensor interfacing with Nodemcu and communication of data using MQTT protocol		02
5.	To study the MQTT and ThingSpeak and upload the DHT sensor data on ThingSpeak		02
6.	To study Amazon Web Service Platform.	LO4, LO5, LO6	02
7.	Study of IoT based industrial process monitoring and control system	LO3, LO5, LO6	02
8.	Case Study for IoT Application		04

Virtual Lab Links:

1. https://aws.amazon.com/
2. https://thingspeak.com/
3. https://blynk.io/

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Internet of Things".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Oral: Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
1UETDLL7031	**Mixed Signal VLSI Design Lab**	**(1+0)**

Lab Prerequisite:	1.Electronic Devices and Circuits I 2.Digital Circuit Design 3.Electronic Devices and Circuits II 4.Linear Integrated Circuits 5.VLSI Design
Lab Objectives:	1. To study building blocks of CMOS Analog VLSI Circuits. 2. To design different types of CMOS analog VLSI circuit. 3. To generate layout of various CMOS analog VLSI circuits. 4. To emphasis upon the issues related to mixed signal layout design.
Lab Outcomes (LOs):	After successful completion of the course student will be able to 1. Explain different types of analog VLSI Circuits. 2. Design building blocks of CMOS analog VLSI circuits 3. Generate Layout of analog and mixed signal circuits 4. Write accurate documentation for experiments performed. 5. Apply ethical principles like timeliness and adhere to the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Study analog VLSI circuits	LO1, LO4, LO5	02
2.	Analysis of MOSFETs for analog performance	LO2, LO4, LO5	02
3.	Design and simulate various types of current mirror circuits		02
4.	Design and simulate various common source amplifier circuits		02
5.	Design and simulate various types of single stage amplifiers		02
6.	Design and simulate differential amplifier		02
7.	Design and simulate operational transconductance amplifier		02
8.	Design and simulate switch capacitor circuits		02
9.	Design and simulate various types of oscillators		02
10..	Design and simulate mixed mode circuit		02
11..	Generate layout for the simple and cascode current mirror	LO3, LO4. LO5	02
12.	Generate layout for common source amplifier		02
13.	Generate layout for the differential amplifier		02
14.	Generate layout for the Oscillator		02
15.	Generate layout for Phase Detector		02

Virtual Lab Links:

https://vlsi-iitg.vlabs.ac.in/index.html

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Mixed Signal VLSI Design".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Oral: Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
1UETDLL7032	**Graphic Processors and Parallel Computing Lab**	**(1+0)**

Lab Prerequisite:	Knowledge of C, C++, Data Structures
Lab Objectives:	1. To develop parallel GPU programs. 2. To compare performance of GPU and CPU. 3. To implement machine learning algorithms on GPU.
Lab Outcomes (LOs):	1.To write programs for matrix and vector operations on GPU. 2.To analyse performance of GPU with respect to CPU. 3.To perform array operations on GPU. 4.To perform multithreading on GPU. 5.To perform Machine learning algorithms on GPU. 6.To complete the work as per directions and on time.

The following programs may be implemented using Google Colab. At least 4 experiments to be performed and a machine learning case study on Colab.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Function to add the elements of two arrays	LO3	02
2.	Vector addition in CUDA	LO1	02
3.	Matrix multiplication algorithm in CUDA C		02
4.	Odd even sorting of arrays	LO3	02
5.	Synchronizing threads	LO4	02
6.	Performance analysis of CPU and GPU	LO2	02
7.	Histogram algorithms on GPU	LO5	02
8.	Parallel Implementation of the K nearest Neighbors Classifier		02

Virtual Lab Links:

https://colab.research.google.com/notebooks/intro.ipynb

https://in.mathworks.com/solutions/gpu-computing/getting-started.html?#generate_cuda

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course “Graphic Processors and Parallel Computing”.
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Oral/Practical/P&O :

Oral/Practical /P&O examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
1UETDLL7033	Artificial Intelligence Lab	(1+0)

Lab Prerequisite:	Knowledge of programming language (C/ JAVA/ PYTHON)
Lab Objectives:	1. To impart basic proficiency in representing difficult real-life problems in a state space representation so as to solve them using AI techniques. 2. To make students understand various AI methods like searching and game playing and how to apply them to solve real applications 3. To explain to students the basic issues of knowledge representation and Logic so as to build inference engines.
Lab Outcomes (LOs):	1. Design the building blocks of an Intelligent Agent using PEAS representation. 2. Analyze and formalize the problem as a state space, graph, design heuristics and select amongst different search or game-based techniques to solve them. 3. Develop intelligent algorithms for constraint satisfaction problems and also design intelligent systems for Game Playing 4. Attain the capability to represent various real life problem domains using logic-based techniques and use this to perform inference or planning. 5. Formulate and solve problems with uncertain information using Bayesian approaches. 6. Apply concept Natural Language processing and cognitive computing for creation of domain specific ChatBots.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Identify the problem, PEAS (Performance measure, Environment, Actuator, Sensor) Description, Problem formulation	LO1, LO2	02
2.	Introduction to AI programming Language	LO2	02
3.	Start Implementation, Knowledge Representation and Create Knowledge Base	LO2, LO3	02
4.	Implement search algorithms to reach goal state	LO4	02
5.	Implement Mc-Culloch Pitts Model for a problem		02
7.	To implement Basic Supervised / Unsupervised Neural Network learning rules for a problem	LO5	02
8.	Case study on Hybrid Systems	LO6	02
9.	Case study of an AI application		02

Virtual Lab Links:

1. ps.iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
2. ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3. ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
4. cse22.iiith.vlabs.ac.in/exp_perceptron/Tutorial.html?domain=Computer%20Science&lab=Artificial%20Neural%20Networks
5. cse22.iiith.vlabs.ac.in/exp_tsp/Tutorial.html?domain=Computer%20Science&lab=Artificial%20Neural%20Networks

Term work:
1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "**Artificial Intelligence**". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.
Oral: Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
1UETDLL7034	Advanced Networking Technologies Lab	(1+0)

Lab Prerequisite:	Computer Communication Networks
Lab Objectives:	1.To make students familiar with wireless technologies and how to use them to: Design, Implement, Operate, Manage enterprise networks. 2.To introduce the different networking scenarios using simulation software
Lab Outcomes:	On successful completion of the course the students will be able to: 1.Monitor the network performance using different monitoring tools and manage the network. 2.Design personal firewalls for network security. 3.Simulate the different networking scenarios using simulation software. 4.Design and configure a campus area network. 5.Write clear documentation for and interpret the results of the performed experiments. 6.Stick to a timeline and follow the rules of the laboratory.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Network scanning: using NMAP	LO1	02
2.	Evaluation of home/campus network	LO4	02
3.	Network Visualization using Etherape	LO1	02
4.	Firewall Design using IP Tables	LO2	02
5.	Bluetooth protocol implementation	LO3	02
6.	ZigBee protocol implementation		02
7.	Wi-Fi protocol implementation		02
8.	Study of SNMP	LO1	02
9.	Remote Login service	LO4	02
10.	Packet Grab Analysis using Wireshark	LO1	02

Virtual Lab Links:

1.https://www.youtube.com/watch?v=m_F98NZ6K3

2.http://vlabs.iitkgp.ernet.in/ant/2/

3.http://vlabs.iitkgp.ernet.in/ant/5/

4.http://vlabs.iitkgp.ernet.in/ant/8/

5.http://vlabs.iitkgp.ernet.in/ant/9/

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "Advanced Networking Technologies".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.

4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.
Oral: Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
1UETLDLL7041	Data Compression Lab	(1+0)

Lab Prerequisite:	1. Digital Communication 2. Digital Signal Processing 3. Signals and Systems
Lab Objectives:	1. Students will understand how to use statistical methods for data compression 2. Students will understand use of dictionary techniques for text compressions. 3. Students will understand the concept of quantization and audio compression. 4. Students will be able to understand use of image compression techniques.
Lab Outcomes (LOs):	1. Students will able to program statistical coding techniques for data compression. 2. Student will be able to program for RLE and dictionary techniques of data compression 3. Students will be able to apply audio, image and vector quantization compression methods for signal processing. 4. Students will be able to write clear documentation for and interpret the results of the performed experiments 5. Students will be able to stick to a timeline and follow rules of the laboratory. 6.Student will able to communicate clearly and effectively

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Encode and decode the given messages and find code efficiency using Huffman coding method.	LO1, LO4, LO5, LO6	02
2.	Encode and decode the given messages and find code efficiency using Arithmetic coding method.		02
3.	Encode and decode the given text information using Run Length Encoding technique of text compression.	LO2, LO4, LO5, LO6	02
4.	Implement Discrete Cosine Transform for image compression a) One Dimensional DCT b) Two Dimensional DCT	LO3, LO4, LO5, LO6	02
5.	Study the effect of Delta Modulation and Demodulation on a given sinusoidal signal. Also show slope overload cases.		02
6.	Study the effect of Uniform and Non uniform quantization on the given speech signal.		02
7.	Implement PCM technique for audio compression.		02
8.	Implement DPCM method for audio compression		02
9.	Encode and decode dictionary contents using LZ 77/LZ 78/ LZW compression Techniques.	LO2, LO4, LO5, LO6	02

Virtual Lab Links:

1. https://www.ldrp.ac.in/images/syllabus/BE-Computer-CBCS/IT603-N%20Data%20Compression.pdf
2. http://www.nitttrc.edu.in/nptel/courses/video/105107160/lec14.pdf
3. http://www.digimat.in/nptel/courses/video/106106182/L191.html
4. http://www.iitk.ac.in/karmaa/DownloadTools/ MCIT_DataCompressionProject /Data_Compression _Techniques_for_E-Learning.html

Term work:

1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course “Data Compression”. 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.
Oral: Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
1UETDLL7042	Cloud Computing Lab	(1+0)

Lab Prerequisite:	1. Object Oriented Programming with Java 2. Operating System 3. Computer Communication Networks
Lab Objectives:	To get familiar with: Key concepts of virtualization & different types of Hypervisors used in virtualization along with implementation 1. Concept of On demand Application Delivery like SaaS using Ulteo 2. Various Cloud services provided by Amazon Web Services 3. Programming on Platform as a Service cloud
Lab Outcomes (LOs):	Students should be able to: 1. Demonstrate the use of different types of Hypervisors. 2. Implement IAAS service using OpenStack. 3. Implement software as a service using Uleto OS. 4. Implement platform as service on the GCP platform. 5. Demonstrate Virtual Private cloud & its components. 6. Demonstrate S3, EC2, DAAB etc. of AWS.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Creating and running virtual machines on Hosted Hypervisors like KVM Type 1 ,Vmware Workstation, Oracle Virtualbox	LO1	02
2.	Creating and running virtual machines on Bare-Metal Hypervisors Type 0 like Xen,Vmware ESXI or HyperV		02
3.	Installation and Configuration of Ulteo to demonstrate on demand Application delivery over web browser to explore SaaS Environment.	LO3	02
4.	To demonstrate installation and Configuration of Open stack Private cloud.		02
5.	To demonstrate IAAS using AWS.	LO2	02
6.	To demonstrate virtual private computing & Networking.	LO5	02
7.	Explore database as a service using AWS.	LO6	02
8.	To demonstrate Simple storage service (S3) storage.		02
9.	To study and demonstrate load balancer in AWS.		02
10.	To demonstrate Platform as a Service using Google app Engine/IBM BlueMix/tSuru	LO4	02

Implementation of practicals can be in any language.

1.Hardware Configuration for server: Intel or AMD Multi Core processors (like i3/i5/i7/Quad core/Octa core) with Intel, VT-X or AMD-V support, GB RAM, 500 GB Harddisk, Gigabit Ethernet (GbE) network interface card (NIC)

2.Hardware Configuration for Cloud Client: PC/Laptop/Smart phone/Thin Client or Any device which has built-in Wifi, Ethernet or data connection facility.

3.Software Requirements for Server: Server OS for Physical Sever like CentOS /Fedora/Ubuntu/ Redhat Server, Pre-configured OpenSSH, Xen Server DVD 4.Ulteo DVD

4.Software Requirements for Clients: JDK 1.8 or higher & .NET Framework 4, Netbeans or Eclipse IDEs, OpenSSH client or putty 4.Vmware Workstation, 5.Oracle Virtualbox, 6. Built-in web browser, Internet Connection for each PC with at least 2 MBPS bandwidth and LAN bandwidth of 1 GBPS.

5.**Internet Connection** for each PC with at least 2 MBPS bandwidth and LAN bandwidth of 1 GBPS.
Useful Links:
1. www.cloudshare.com
2. http://vlabs.iitb.ac.in ›vlab ›labscse
3. https://aws.amazon.com/aws_training
Web Resources: 1. http://fosshelp.blogspot.in 2. https://aws.amazon.com/ 3. https://docs.openstack.org/ 4. https://owncloud.org/ 5. https://appengine.google.com
Term work:
1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Cloud Computing". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.
Oral: Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
1UETDLL7043	**Robotics Lab**	**(1+0)**

Lab Prerequisite:	1.Applied Mathematics III, 2.Applied Mathematics IV, 3.Linear Control Systems
Lab Objectives:	1. To study basics of robotics 2. To familiarize students with kinematics & dynamics of robots 3. To familiarize students with Trajectory & task planning of robots. 4. To familiarize students with robot vision
Lab Outcomes (LOs):	At the end of completing the course, a student will be able to: 1. Perform the kinematic and the dynamic analysis of robots. 2. Perform trajectory and task planning of robots. 3. Perform template matching, iterative processing and segmentation. 4. Simulate Planer motion. 5. Simulate Task planner.

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Experiment on Forward kinematics	LO1	02
2.	Experiment on Inverse kinematic		02
3.	Experiment on Dynamic analysis		02
4.	Experiment on Joint-space trajectory	LO2	02
5.	Experiment on Cartesian-space trajectory		02
6.	Experiment on Template matching	LO3	02
7.	Experiment on Iterative processing		02
8.	Experiment on Segmentation		02
9.	Experiment on motion planner	LO4	02
10.	Simulation on task planner	LO5	02

Virtual Lab Links:

http://vlabs.iitkgp.ernet.in/mr/#

Term work:

1. Term work should consist of a Minimum of 8 experiments.
2. Journal must include at least 2 assignments on content of theory and practical of the course "**Robotics**".
3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.

Oral: Oral examination will be based on experiment list and performance of experiment.

Lab Code	Lab Name	Credits (P+TUT)
1UETDLL7044	Data Science & Applications Lab	(1+0)

Lab Prerequisite:	1.Basic Python programming
Lab Objectives:	1. The objective of this course is to provide comprehensive knowledge of python programming paradigms required for Data Science.
Lab Outcomes (LOs):	1. Demonstrate the usage of built-in objects in Python 2. Analyze the significance of python program development environment by working on real world examples 3. Implement numerical programming, data handling and visualization through NumPy, Pandas and MatplotLib modules. 4. Students will be able to write clear documentation for and interpret the results of the performed experiments 5. Students will be able to stick to a timeline and follow rules of the laboratory. 6.Student will able to communicate clearly and effectively

Lab No.	Experiment Title	LO mapped	Hrs./Lab
I.	Lab Prerequisite	---	02
1.	Interactive commands in Python, data operations, simple programs for writing into files and reading from files. Data file manipulations programs.	LO1, LO2, LO4. LO5, LO6	02
2.	Familiarization with IDE in Python.		02
3.	Writing programs for standard algorithms of sorting and searching in Python.		02
4.	Plotting the data using X-Y graph, Bar- chart, and using other plotting techniques.	LO1, LO2, LO3, LO4. LO5, LO6	02
5.	Write programs to perform exploratory data analysis: variance, standard derivation, summarization, distribution, and statistical inference.	LO1, LO2, LO4. LO5, LO6	02
6.	Plotting the various distributions for given data sets.		02
7.	Classifying and presentation of data using support vector machine.		02
8.	Write programs for k-means clustering and presentation for given data sets.		02
9.	Write programs on graphs of social networks for community detection		02
10.	Write programs for analysis of graphs to find centrality and page-rank.		02

The case study may be chosen on any relevant topic which involves big data. Suggested case studies are as follows:
1.Sentiment Analysis for COVID-19.
2.Counting number of likes on Instagram.
3.Weather Forecasting.
4.Predicting the trend of the market.

Virtual Lab Links:

https://towardsdatascience.com/virtual-environments-for-data-science-running-python-and-jupyter-with-pipenv-c6cb6c44a405

Term work:
1. Term work should consist of a Minimum of 8 experiments. 2. Journal must include at least 2 assignments on content of theory and practical of the course "Data Science and Applications". 3. The final certification and acceptance of term work ensures that satisfactory performance of laboratory work and Minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Attendance Theory & Practical: 05-marks, Assignments: 05-marks.
Oral: Oral examination will be based on experiment list and performance of experiment.

Project Based Learning Code	Project Based Learning Name	Credits (P+TUT)
1UETPR75	**Major Project Lab-A**	**(3+0)**

PBL Prerequisite:	1.PBL Mini Project Lab-1 2.PBL Mini Project Lab-2 3.PBL Minor Project Lab-1 4.PBL Minor Project Lab-2
PBL Objectives:	The Project work enables the students, 1. To develop the required skills and knowledge about research. 2. To analyze a specific problem or issue by using the latest technologies with a multidisciplinary approach. 3. To demonstrate proficiency in the design of a research project, application with appropriate research methods. 4. To present and adopt various research ideas with appropriate solution
PBL Outcomes:	Learner will be able to, 1. Identify formulate, review research literature, and analyse complex engineering problems 2. Design solutions, components, or processes for complex engineering problems 3. Select appropriate modern engineering tools and analyse data to meet the problem statement. 4. Use standard norms of engineering practices and engage in lifelong learning. 5. Excel in writing reports with effective presentation. 6. Interact efficiently as an individual with the team members for timely and professional management of project.

Guidelines:

1. Project Topic:

To proceed with the project work it is very important to select the right topic. Projects can be undertaken on any domain of electronics and recent technology programmes.

- Research and development projects on problems of practical and theoretical interest should be encouraged.
- Project work must be carried out by the group of at least two students and maximum four and must be original.
- Students can certainly take ideas from anywhere, but be sure that they should evolve them in the unique way to suit their project requirements.
- The project work can be undertaken in a research institute or organization/company/any business establishment.
- Students must consult an internal guide along with external guide (if any) in selection of topic.
- Head of department and senior staff in the department will take decisions regarding selection of projects.
- Online log book to be prepared by each group, wherein the group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Students have to submit a weekly progress report to the internal guide whereas the internal guide has to keep track of the progress of the project and also has to maintain attendance reports. This progress report can be used for awarding the term work marks. In case of industry projects, visit by an internal guide will be preferred.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Project Report Format:

At the end of semester a project report should preferably contain at least following details,

1. Abstract
2. CO-PO mapping

3. Introduction
4. Literature Survey
    a) Comparative Survey of Existing system
    b) Limitation of the Existing system or research gap
5. Proposed System
    a) Problem Statement and Objective
    b) Methodology (your approach to solve the problem)
    c) Analysis/Framework/ Algorithm
    d) Details of Hardware & Software
    e) Design details
    f) Budget details
    g) Implementation Plan for next semester
6. Conclusion and future scope
7. References
8. Term Work:
   Distribution of marks for term work shall be as follows:
    a) Weekly Attendance on Project Day
    b) Contribution in the Project work
    c) Project Report (Spiral Bound)
    d) Term End Presentation (Internal)
9. The final certification and acceptance of TW ensures the satisfactory performance on the above aspects.

P&O: P&O examination will be based on presentations and demonstrations of Major Project-A.