Program Structure for Last Year UG Technology (EX)
Semester-VII-Credit Scheme

Course Code	Course Name	Teaching Scheme (Hrs.)		Credits Assigned		Course Category
		TH – P – TUT	Total (Hrs.)	TH – P – TUT	Credits	
EXC701	Mici1urowave Engineering	3– 0 – 0	03	3 – 0 – 0	03	PC
EXC702	Mobile Communication Systems	3– 0 – 0	03	3 – 0 – 0	03	PC
EXDLC703	Department Level Elective Course – III	3– 0 – 0	03	3 – 0 – 0	03	DLE
EXDLC704	Department Level Elective Course – IV	3 – 0 – 0	03	3 – 0 – 0	03	DLE
ILC705	Institute Level Optional Course – I	3 – 0 – 0	03	3 – 0 – 0	03	ILE
EXL701	Microwave Engineering Laboratory	0 – 2 – 0	02	0 – 2 – 0	01	PC
EXDLL703	Department Level Elective Course – III Laboratory	0 – 2 – 0	02	0 – 2 – 0	01	DLE
EXDLL704	Department Level Elective Course – IV Laboratory	0 – 2 – 0	02	0 – 2 – 0	01	DLE
EXPR75	Project Based Learning – Major Project-A#	0 – 6# - 0	06#	0 – 3 – 0	03	PBL
Total		**15– 12– 00**	**27**	**15 - 09 - 00**	**21**	

 # PBL Major -PR-A- (Preparation for Conference paper, TPP, participation in competitions, start-up, innovation along with contents as per curriculum for consideration of Term work)

Department Level Elective Courses	Group	Course Code	Course Name^
Department Level Elective –III	A	EXDLC7031	Artificial Intelligence
	B	EXDLC7032	Satellite and Nano Satellite Communication
	C	EXDLC7033	Embedded Systems & RTOS
	D	EXDLC7034	Big Data Analytics
Department Level Elective – IV	A	EXDLC7041	Neural Network and Deep Learning
	B	EXDLC7042	Wireless Networks
	C	EXDLC7043	Robotics
	D	EXDLC7044	Cloud Computing & Security

^ Student have freedom to select any course from Group A / B / C / D from Semester V to VIII

Institute Level Optional Course	Course Code	Course Name

Institute Level Elective – I	ILC7051 ILC7052 ILC7053 ILC7054 ILC7055 ILC7056 ILC7057 ILC7058 ILC7059	Product Life Cycle Management Reliability Engineering Management Information System Design of Experiments Operation Research Cyber Security and Laws Disaster Management and Mitigation Measures Energy Audit and Management Development Engineering

 # Common with all branches

Program Structure for Last Year UG Technology (EX)

Semester-VII - Examination Scheme

Course Code	Course Name	Examination Scheme								
		Marks								
		CA				ESE	TW	O	P&O	Total
		T1	T2	Average (T1&T2)	IA					
EXC701	Microwave Engineering	30	30	30	10	60	-	-	-	100
EXC702	Mobile Communication Systems	30	30	30	10	60	-	-	-	100
EXDLC703	Department Level Elective Course – III	30	30	30	10	60	-	-	-	100
EXDLC704	Department Level Elective Course – IV	30	30	30	10	60	-	-	-	100
ILC705	Institute Level Optional Course – I	30	30	30	10	60	-	-	-	100
EXL701	Microwave Engineering Laboratory	-	-	-	-	-	25	25	-	50
EXDLL703	Department Level Elective Course – III Laboratory	-	-	-	-	-	25	25	-	50
EXDLL704	Department Level Elective Course – IV Laboratory	-	-	-	-	-	25	25	-	50
EXPR75	Project Based Learning – Major Project – A	-	-	-	-	-	25	-	50	75
Total		150	150	**150**	**50**	**300**	**100**	**75**	**50**	**725**

Course Code	Course Name	Credits (TH+P+TUT)
EXC701	**Microwave Engineering**	**3+0+0**
Prerequisite:	1. Electromagnetics and Antenna 2. Principles of Communication Engineering	
Course Objectives:	1. To learn the fundamentals of microwave systems. 2. To learn to make system level design decisions. 3. To learn passive and active device characteristics. 4. To learn the applications of microwaves.	
Course Outcomes:	1. Explain the basic concepts and theory of Microwave Engineering. 2. Design microwave transmission lines and matching techniques. 3. Analyze microwave passive components and semiconductor devices. 4. Classify the microwave tubes. 5. Measure microwave parameters. 6. Explain the applications of microwaves in day to day life.	

Module No. & Name	Sub Topics	CO Mapped	Hrs. / Sub Topic	Total Hrs./ Module
. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
. Introduction to Microwaves	Microwave Frequency and Band designation, Characteristics, Advantages, disadvantages and Applications of Microwaves and its hazards.	1, 2	01	08
	Scattering parameters: Characteristics and Properties.		01	
	3 Strip lines, Micro strip lines and coupled lines: Analysis and design. (Numerical)		01	
	Impedance Matching with Reactive Elements, Single and Double stub matching. (Numerical)		05	
Waveguides and Passive Devices	Rectangular and circular waveguides: Construction, Working and Mode analysis. (Numerical)	2, 3	04	08

Module No. & Name	Sub Topics	CO Mapped	Hrs. / Sub Topic	Total Hrs./ Module
	2 Resonators, Re-entrant cavities, Tees (E, H and Magic), Hybrid ring, Directional couplers, Phase shifters, Terminations, Attenuators and Ferrite devices such as Isolators, Gyrators, and Circulators.		04	
3. Microwave Generators	Two-Cavity Klystron. Reflex Klystron: Construction, Operating Mechanism, Modes, velocity modulation (Analytical treatment) (Numerical)	4	03	07
	Magnetron: Cylindrical type, Construction, Operation, Bunching effect, Hull cut-off conditions, modes, mode bunching. (Numerical)		02	
	Traveling Wave Tubes: Types, Construction, Operation, Propagation Modes, Analytical treatment (Numerical)		01	
	3.4 Gyrotron's, Backward Wave Oscillator		01	
4. Microwave Semiconductor Devices	1 Diodes: Varactor, PIN, Tunnel, Point Contact, Schottky Barrier, Gunn, IMPATT, TRAPATT, and BARITT	3	04	07
	Transistors: BJT, Hetro junction BJT, MESFET, and HEMT		02	
	3 Parametric Amplifiers and Applications. (No derivation)		01	
Microwave Measurements	VSWR, Frequency, Power, Noise, Q-Factor, Impedance, Attenuation, Dielectric Constant, Antenna Gain.	5	05	05
5. Microwave Applications	6.1 Industrial application of microwaves: Microwave heating, Industrial control and measurements e.g. thickness measurement and moisture content measurements and medical applications e.g. diathermy and hyperthermia	1, 6	01	04
	6.2 Microwave Radar systems: Basic radar system, radar equation, Introduction of Radar, Radar Parameters and their Classification (Freq., waveform, PRF & application based)- Pulse, CW/FMCW/SFCW, MTI/MST, SAR, Tracking/ Phase Array Radar (Basic Only)		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs. / Sub Topic	Total Hrs./ Module
Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:

Text Books	1. Samuel Liao, "Microwave Devices and Circuits", Prentice Hall. 2. David Pozar, "Microwave Engineering", Wiley Publication (Fourth Edition).. Matthew M. Radmanesh, "Radio Frequency and Microwave Electronic", Pearson Education. 3. Annapurna Das and S. K Das, "Microwave Engineering", McGraw Hill Education (Third Edition). 4. Merill Skolnik, "Introduction to RADAR Systems", Tata McGraw Hill (Third Edition). 5. G.S.N. Raju, "Radar Engineering and Fundamentals of Navigational Aids", Wiley Publication.
Reference Books	1. Colin, "Foundations of Microwave Engineering" Wiley Interscience. (Second Edition) 2. Devendra Mishra, "Radio Frequency and Microwave Communication Circuits- Analysis and Design" John Wiley & Sons. (Second Edition)

Useful Links:

1.www.nptelvideos.in
2.www.tutorialspoint.com
3.https://onlinecourses.nptel.ac.in/noc19_ee57/preview

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA): Marks will be allotted as per designed rubrics.
End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Course Name	Credits (TH+P+TUT)
EXC702	**Mobile Communication Systems**	**3+0+0**
Prerequisite:	1. Digital Communication 2. Computer Communication and Networks	
Course Objectives:	1. To understand the cellular fundamentals 2. To understand different types of radio propagation models. 3. To study the system architecture of 2G, 2.5 G and 3G. 4. To develop the concepts of emerging technologies for 4 G standards and beyond.	
Course Outcomes:	1. Explain the cellular fundamentals and estimate the coverage and capacity of cellular systems. 2. Classify different types of propagation models and analyse the link budget. 3. Illustrate the fundamentals, system architecture signalling protocol of GSM, 2.5G and IS-95. 4. Apply the concepts of 3G technologies of UMTS and CDMA 2000. 5. Elaborate the principles of 3GPP LTE. 6. Describe the emerging technologies for upcoming mobile communication systems.	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Fundamentals of Mobile Communication	1 Introduction to wireless communication: Mobile radio telephony, Examples of Wireless Communication Systems, Related design problems	1	02	06
	2 The Cellular Concept System Design Fundamentals: Frequency Reuse, Channel Assignment Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage and Capacity in Cellular Systems		03	
	3 Features of all conventional multiple access techniques: Frequency division		01	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	multiple access (FDMA), time division multiple access (TDMA), space spectrum multiple access (SSMA), space division multiple access (SDMA), OFDM-PAPR, OFDMA			
2. Mobile Radio Propagation	Large scale fading: Free space propagation model, the three basic propagation mechanisms, reflection, ground reflection (two-ray) model, diffraction, scattering, practical Link budget design using path loss models	2	04	08
	2 Small scale fading: small scale multipath propagation, parameters of mobile multipath channels, types of small-scale fading, Rayleigh and Rician distributions		04	
3. 2G Technologies	1 GSM: GSM Network architecture, GSM signalling protocol architecture, identifiers used in GSM system, GSM channels, frame structure for GSM, GSM speech coding, authentication and security in GSM, GSM call procedures, GSM hand-off procedures, GSM services and features	3	04	07
	2 GSM evolution: GPRS and EDGE-architecture, radio specifications, channels.		01	
	3 IS-95: Architecture of CDMA system, CDMA air interface, power control in CDMA system, power control, handoff, rake receiver		02	
4. 3G Technologies	1 UMTS: Objectives, standardization and releases, network architecture, air interface specifications, channels, security procedure	4	04	06
	2 CDMA2000 cellular technologies: Forward and Reverse Channels, Handoff and Power Control.		02	
5. 3G PP LTE	1 Introduction, system overview: Frequency bands and spectrum flexibility, network structure, protocol structure	5	02	06
	2 Logical and Physical Channels: Mapping of data onto (logical) sub-channels.		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	3 Physical layer procedures: Establishing a connection, retransmissions and reliability, scheduling, power control, handover.		02	
6. Advanced techniques for 4G deployment	1 Multi-antenna Techniques: Smart antennas, multiple input multiple output systems	6	02	06
	2 Cognitive radio: Architecture, spectrum sensing		02	
	Relaying multi-hop and cooperative communications: Principles of relaying, fundamentals of relaying		01	
	4 Introduction to 5G network and technologies used in 5G such as small cell concept, Massive MIMO, Beamforming, NOMA, and mm wave).		01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Textbooks	1. Theodore S. Rappaport ―Wireless Communications - Principles and Practice, PEARSON, Second edition 2. T L Singal ―Wireless Communications, McGraw Hill Education 3. Andreas F. Molisch ― Wireless Communications Wiley India Pvt Ltd., Second Edition 4. Raj Pandya- Mobile and Personal Communication Services and Systems (IEEE Series on Mobile & Digital Communications) 5. An Introduction to 5G: The New Radio, 5G Network and Beyond, First Edition, Christopher Cox, Chris Cox Communications Ltd Cambridge, UK © 2021 John Wiley & Sons Ltd, 2021 6. Evolution of Air Interface Towards 5G Radio Access Technology and Performance Analysis, Suvra Sekhar Das and Ramjee Prasad, c 2018 River Publishers, 2018
Reference Books	1. Upena Dalal ―Wireless and Mobile Communications‖, Oxford University Press. 2. Vijay K. Garg ―Wireless Communications and Networking‖, Morgan–Kaufmann series in Networking-Elsevier
Useful Links:	
1. MIT Open Courseware 2. https://ocw.mit.edu/courses/electrical-engineering-and-computerscience/6-452-principles-of-wireless-communications-spring-2006/ 3. http://nptel.ac.in/courses/117104099/	

4. Virtual Lab : http://vlab.co.in/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	**Department Level Elective Course – III**	**Credits (TH+P+TUT)**
EXDLC7031	**Artificial Intelligence**	**3+0+0**
Prerequisite:	1. Programming 2. Data Structures	
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 review the different stages of development of the AI field from human-like behaviour to Rational Agents. 4. To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques like searching and game playing. 5. 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. 6. To introduce advanced topics of AI such as planning, Bayes networks, and applications of natural language processing and Robotics.	

Course Outcomes:	1. Demonstrate knowledge of the building blocks of AI as presented in terms of intelligent agents. 2. Analyse 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. Demonstrate 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 AI to solve the real time problems.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Intelligent Systems and Intelligent Agents	Introduction to AI, AI Problems and AI techniques, solving problems by searching, Problem Formulation. State Space Representation .model based and learning based agents, PEAS	1, 2	04	04
2. Search Techniques	Uninformed Search: DFS, BFS, Uniform cost search, Depth Limited Search, Iterative Deepening. Informed Search: Heuristic functions, Best First Search, A* Local Search: Hill Climbing, Simulated Annealing, Adversarial Search: Game Playing, Min-Max Search, Alpha Beta Pruning	2, 3	09	09
3. Knowledge and Reasoning	A Knowledge Based Agent, Overview of Propositional Logic, First Order Predicate Logic, Inference in First Order Predicate Logic: Forward and Backward Chaining, Resolution.	4	10	10

4. Planning	Introduction to Planning, Planning with State Space Search, Partial Ordered planning, Hierarchical Planning, Conditional Planning.	4	06	06
5. Uncertain Knowledge and Reasoning	Uncertainly, Representing Knowledge in an Uncertain Domain, Conditional Probability, Joint Probability, Bayes' theorem, Belief Networks, Simple Inference in Belief Networks.	5	06	06
6. AI Application	Architecture of Expert system and its components Robotics - Robots, Robot hardware, Problems Robotics can solve AI applications in Healthcare, Retail, Banking Application of NLP- chat bot	6	04	04
. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:

Text Books	1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2nd Edition, Pearson Education. 2. Elaine Rich, Kevin Knight, Shivshankar B Nair, Artificial Intelligence, McGraw Hill, 3rd Edition 3. Judith S. Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computi ng and Big Data Analytics, Wiley India
Referenc e 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. 3. Patrick H. Winston, Artificial Intelligence, 3rd edition, Pearson Education. 4. Deepak Khemani, A First Course in Artificial Intelligence, McGraw Hill Publication 5. John Kelly , Steve Hamm, Smart Machines - IBM′s Watson and the Era of Cognitive Computing, Columbia Business School Publishing

Useful Links:

1. https://nptel.ac.in/courses/106/105/106105078/
2. https://thestempedia.com/blog/simple-ai-and-machine-learning-projects-for-students-and-beginners/
3. https://nptel.ac.in/courses/106/105/106105079/

Continuous Assessment (CA):

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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Department Level Elective Course – III	Credits (TH+P+TUT)
EXDLC7032	**Satellite and Nano Satellite Communication**	**3+0+0**
Prerequisite:	1. Principles of Communication Engineering 2. Digital Communication	
Course Objectives:	1. To understand the basics of satellite communications and different satellite communication orbits. 2. To provide an in-depth understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology. 3. To explain the tools necessary for the calculation of basic parameters in a satellite communication system. 4. To review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite.	
Course Outcomes:	1. Explain basics of satellite communication, space segment and earth segment. 2. Explain different satellite orbits and orbital parameters. 3. Analyse and design link budget of satellite signal for proper communication. 4. Explain various applications of satellite communications. 5. Explain the basics of the Nano satellite and its design. 6. Compare the Space segment access techniques.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Overview of Satellite Systems, Orbits and Launching	1.1 An overview of space and satellite Frequency allocation for satellite communication Polar orbiting satellites, Kepler's First, second and third law, orbital elements, apogee, perigee heights, orbital perturbations (Numerical), effects of a non-spherical earth, atmospheric drag	1	03	08
	1.2 Selection of launching site, launch window, zero and non-zero degree latitude launching, sea launch, launch vehicles; satellite launch vehicle (SLV), augmented satellite launch vehicle (ASLV), polar SLV, geostationary satellite launch vehicle (GSLV)	1	02	
	1.3 Sub-satellite Point, predicting satellite position, antenna look angles, polar mount antenna, limits of visibility, near geostationary orbits, earth eclipse of satellite, sun transit outage	2	03	
2. Space Segment	2.1 Satellite configuration, Transponder sub-system, Antenna sub-system, AOC Sub-system, TT&C Sub-system, power sub-system, Thermal sub-system	2	05	06
	2.2 Reliability and quality Assurance	2	01	
3. Earth Station	3.1 General configuration- Block diagram, Antenna system, Feed system, Tracking system, LNA, HPA	1	02	04
	3.2 Optical/laser communication, advantage disadvantage of optical communication, optical ground station	1	01	
	3.3 Introduction of Software defined radio	5	01	
4. Satellite Links	4.1 Isotropic radiated power, transmission losses, free-space transmission, feeder losses, antenna	3	02	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	misalignment losses, fixed atmospheric and ionospheric losses, link power budget			
	4.2 System noise, antenna noise, amplifier noise temperature, amplifiers in cascade, noise factor, noise temperature of absorptive networks, overall system noise temperature, carrier to noise ratio	3	02	
	4.3 Uplink: Saturation flux density, input back off, earth station HPA, Downlink: Output back off, satellite TWTA output	3	02	
	4.4 Effects of rain, uplink rain-fade margin, downlink rain-fade margin, combined uplink and downlink C/N ratio, intermodulation noise	3	02	
5. The Space Segment Access and Utilization	5.1 Space segment access methods, pre-assigned FDMA, demand assigned FDMA, SPADE system, bandwidth-limited and power-limited TWT amplifier operation	6	03	08
	5.2 TDMA: Reference Burst; Preamble and Postamble, carrier recovery, network synchronization, unique word detection, traffic date, frame efficiency, channel capacity, preassigned TDMA, demand assigned TDMA, satellite switched TDMA	6	03	
	5.3 Code Division Multiple Access: Direct-sequence spread spectrum– acquisition and tracking, spectrum spreading and despreading – CDMA throughput	6	02	
6. Nano Satellite	6.1 The evolution of nano satellite, Nano satellite structure. Microsatellites, Nano satellites, Pico satellites (CubeSats), Femto satellites	5	02	05
	6.2 Areas of Application: Military, Commercial, Civilian, Educational, Experimental Notable Missions and Trends	4	03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Small satellite mega-constellations: Starlink, OneWeb, Kuiper, Guowang InSight Mission- MarCO CubeSats, CubeSat Launch Initiative (NASA), Artemis1, Artemis 2, KiboCUBE, Nanosatellite Launch System (NLS), QB50, StudSat, Q-SAT			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Dennis Roddy, "Satellite Communications", 4th Ed., Mc. Graw-Hill International Ed. 2009 2. Gerard Maral, "VSAT Networks", John Willy & Sons 3. Timothy Pratt, Charles Bostian, and Jeremy Allmuti, "Satellite Communications", John Willy & Sons (Asia) Pvt. Ltd. 2004 4. Wilbur L. Pritchard, Henri G. Suyderehoud, and Robert A. Nelson, "Satellite Communication systems Engineering", Pearson Publication . 5. Planet Aerospace India "Quintessence of Nano-Satellite Technology", Notion Press
Reference Books	1. M. Richharia, "Satellite Communication Systems Design Principles", Macmillan Press Ltd. Second Edition 2003 2. R. N. Mutangi, "Satellite Communication", Oxford University Press, 2016. 3. Gerard Maral and Michel Bousquet, "Satellite Communication Systems", 4th Edition Wiley Publication, TMH (2009)
Useful Links:	
1.https://nptel.ac.in/courses/117/105/117105131/ 2 https://www.udemy.com/course/nep-certification/	

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

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Continuous Assessment. **Internal Assessment(IA):** Marks will be allotted as per designed rubrics.
End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	**Department Level Elective Course – III**	**Credits (TH+P+TUT)**
EXDLC7033	**Embedded Systems & RTOS**	**3+0+0**
Prerequisite:	1. Microcontrollers 2. Digital Communication 3. Digital Logic Design	
Course Objectives:	1. To develop background knowledge on Embedded Systems. 2. To understand communication techniques used in embedded systems 3. To understand the embedded product development life cycle 4. To write programs for embedded systems and real time operating systems	
Course Outcomes:	1. Classify embedded systems 2. Choose appropriate hardware platform for an Embedded application 3. Choose appropriate communication technique for an Embedded application 4. Analyse the task communication and synchronization issues 5. Write programs for embedded applications using RTOS 6. Design an embedded system using Embedded Product Development Life Cycle concepts	

Module No. & Name	**Sub Topics**	**CO Mapped**	**Hrs/ Sub Topic**	**Total Hrs/ Module**
Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	Definition of Embedded System, Embedded Systems Vs General Computing Systems, Classification, Major Application Areas	1	02	04
	Characteristics and quality attributes (Design Metric) of embedded systems. Real time system‘s requirements, real time issues, interrupt latency	1	02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
. Embedded Hardware Elements	Features of Embedded cores- µC, ASIC, ASSP, SoC, FPGA.	2	01	06
	ARM Cortex-M3 Features, Architecture, Programmer's model, Special Registers, Operating Modes and States, MPU, Memory map and NVIC.	2	05	
3. Communication	CAN bus, I2C, MOD bus, SPI, RS - 485, USB, RS-232	3	05	07
	3.2 Wi-Fi, Bluetooth	3	02	
. Real Time Operating Systems [RTOS]	4.1 Operating system basics, Types of OS	5	01	07
	4.2 Task, Process, Thread	4, 5	02	
	4.3 Multiprocessing and Multitasking	4, 5	01	
	4.4 Task scheduling, Schedulability	4	02	
	Threads, Process , Scheduling :- Putting them all together	5	01	
. RTOS- Synchronization	Task communications: Pipes, Memory Mapped Object, Message queues, Mailbox, Signalling/ Task Notification, Remote Procedure Call and Socket	4, 5	03	08
	Synchronization Problems: Racing, Deadlock, Livelock, Starvation, Dining Philosopher's problem, Producer-Consumer problem, Reader-Writer problem, Priority Inversion, etc.	3, 4	02	
	Task synchronization Techniques: Mutex, Semaphore, etc.	3, 4	02	
	Device drivers	5	01	
	5.5 How to choose RTOS	6		
6. Design of Embedded applications and case studies	Program Modelling Concepts: DFG, CDFG, FSM, UML	6	02	07
	2 Embedded Product development life cycle	6		
	Testing & Debugging: Hardware	6	02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	testing tools, Boundary-scan/JTAG interface concepts, Emulator. Software Testing tools, Simulator, Debugger. White-Box and Black-Box testing			
	6.4 Case Study: a. Automatic Chocolate Vending Machine b. Digital Camera	6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization**.**	-	01	01
			Total	**42**

Books:	
Text Books	1. Introduction to Embedded Systems 2nd edition Shibu K.V Mc Graw Hill 2009 2. Embedded System Design: A unified Hardware/Software Introduction Frank Vahid and Tony Givargis Wiley Publication 1999 3. The definitive guide to the ARM Cortex-M3 2nd edition Jospeh Yiu Elesevier 2010
Reference Books	1. Embedded Real Time Systems: Concepts, Design & Programming Second edition K.V.K.K. Prasad Dreamtech Publication 2003 2. Embedded systems software primer First edition David Simon Pearson 2002 3. Embedded real systems Programming First edition Iyer, Gupta Tata MCgraw- Hill Publication 2010 4. Embedded Systems Architecture, Programming and design 3rd edition Raj Kamal Tata MCgraw- Hill Publication 2017

Useful Links:

1. https://www.freertos.org/
2. https://www.digikey.com/en/maker/projects/getting-started-with-stm32-introduction-to-freertos/ad275395687e4d85935351e16ec575b1
3. https://scienceprog.com/freertos-on-stm32/

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	**Department Level Elective Course – III**	**Credits (TH+P+TUT)**
EXDLC7034	**Big Data Analytics**	**3+0+0**
Prerequisite:	1. Database Management System	
Course Objectives:	1. To Provide an Overview of an exciting growing field of Big Data Analytics. 2. To introduce the tools required to manage and analyze big data using Hadoop, Map Reduce and Nosql 3. To teach the fundamental techniques in achieving big data analytics with scalability and streaming capability.	
Course Outcomes:	1. Describe the basic concepts of big data, Hadoop Framework and various clustering techniques. 2. Use various distributed storage system to Collect, manage, store, query and analyze big data. 3. Apply scalable algorithms based on hadoop to perform big data analytics. 4. Analyze various stream management algorithms used to solve the complex problems. 5. Apply different distance measure techniques for determining similar items from a large dataset. 6. Interpret Complex real world problems in various applications like recommender systems, social media applications, page ranking, etc.	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
Introduction to Big Data Analytics	Introduction to Big Data, Big Data characteristics, types of Big Data, Traditional vs. Big Data business approach.	1	02	04
	Technologies Available for Big Data, Infrastructure for Big Data, Big Data Challenges, Case Study of Big Data Solutions.	1	02	
2. Hadoop	Introduction to Hadoop. Core Hadoop Components, Hadoop Ecosystem, Physical Architecture, Hadoop limitations.	2	04	04
3. NoSQL	Introduction to NoSQL, NoSQL business drivers, NoSQL case studies.	3	02	08
	NoSQL data architecture patterns: Key-value stores, Graph stores, Column family (Bigtable) stores, Document stores, Variations of NoSQL architectural patterns	3	03	
	Using NoSQL to manage big data: What is a big data NoSQL solution? Understanding the types of big data problems; Analyzing big data with a shared-nothing architecture; Choosing distribution models: master-slave versus peer-to-peer; Four ways that NoSQL systems handle big data problems	3	03	
. Batch processing using MapReduce	MapReduce and The New Software Stack: Distributed File Systems, Physical Organization of Compute Nodes, Large Scale File-System Organization	4	02	08
	MapReduce: The Map Tasks, Grouping by Key, The Reduce Tasks, Combiners, Details of MapReduce Execution, Coping With Node Failures.	4	03	
	Algorithms Using MapReduce: Matrix-Vector Multiplication by MapReduce, Relational-Algebra Operations by MapReduce, Matrix Operations, Matrix	4	03	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Multiplication by MapReduce.			
. Stream data management in Big Data Analytics	Finding Similar Item: Nearest Neighbour Search, Similarity of Documents	1, 5	01	10
	Mining Data Streams: Data Stream Management Systems, Data Stream Model, Examples of Data Stream Applications: Sensor Networks, Network Traffic Analysis	5	03	
	Link Analysis: PageRank Definition, Structure of the web, dead ends, Using Page rank in a search engine, Efficient computation of Page Rank: Page Rank Implementation Using MapReduce	5	03	
	Frequent Itemset Mining : Market-Basket Model, Apriori Algorithm, Algorithm of Park-Chen-Yu	5	03	
. Big Data Analytics Applications	Recommendation Systems: Introduction, A Model for Recommendation Systems, Collaborative-Filtering System: Nearest Neighbour Technique, Example.	6	02	05
	Mining Social-Network Graphs: Social Networks as Graphs, Types of Social-Network. Clustering of Social Graphs: Applying Standard Clustering Techniques, Counting triangles using MapReduce.	6	03	
i. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Radha Shankarmani and M Vijayalakshmi "Big Data Analytics", Wiley 2. Alex Holmes "Hadoop in Practice", Manning Press, Dreamtech Press. 3. Dan McCreary and Ann Kelly "Making Sense of NoSQL" – A guide for managers and the rest of us, Manning Press.
Reference Books	**1.** Bill Franks "Taming the Big Data Tidal Wave: Finding Opportunities In Huge Data Streams With Advanced Analytics", Wiley **2.** Chuck Lam, "Hadoop in Action", Dreamtech Press

	3. Jared Dean, "Big Data, Data Mining and Machine Learning: Value Creation for Business Leadersand Practitioners", Wiley India Private Limited, 2014. **4.** Jiawei Han and MichelineKamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann Publishers, 3rd ed, 2010. **5.** LiorRokach and OdedMaimon, "Data Mining and Knowledge Discovery Handbook", Springer 2nd Edition, 2010 **6.** Ronen Feldman and James Sanger, "The Text Mining Handbook: Advanced Approaches in Analyzing Unstructured Data", Cambridge University Press, 2006 **7.** Vojislav Kecman, "Learning and Soft Computing", MIT Press, 2010. **8.** Tom White "Hadoop: The Definitive Guide", O'Reilly Media, Inc., June 2009

Useful Links:

1. https://hadoop.apache.org
2. https://hadoop.apache.org/docs/r2.8.0/hadoop-project-dist/hadoop-co mmon/core-default.xml
3. https://sqoop.apache.org/
4. https://hive.apache.org/
5. https://pig.apache.org/docs/r0.16.0/start.html
6. https://medium.com/@deepeshtripathi/setup-multi-node-hadoop-cluster-using-ambari-fc929cd1d0d4

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Department Level Elective Course – IV	Credits (TH+P+TUT)
EXDLC7041	**Neural Networks and Deep Learning**	**3 + 0 + 0**
Prerequisite:	Machine Learning	
Course Objectives:	1. To understand the fundamentals of neural networks To learn advanced topics such as recurrent neural networks, long short term memory cells and convolutional neural network 3. To understand tuning of the parameters of neural networks. 4. To learn applications of neural networks in real-world problem	
Course Outcomes:	1. Explain the basic concepts of perceptron. . Mathematically illustrate the forward and back propagation in Neural Networks. Use optimization models to overcome the limitations in Neural Networks. 4. Tune the parameters of Neural Networks. 5. Implement Deep Learning algorithm to the given dataset. 6. Describe the applications of the Neural Networks.	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Perceptron	Overview of Deep Learning Biological Neuron, Idea of computational units, McCulloch–Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability, Convergence theorem for Perceptron Learning Algorithm.	1	03	03

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Neural Network	1. One hidden layer Neural Network- Output, Vectorization, • Activation functions: types and comparison • Loss functions : Mean square loss, cross entropy loss • Optimizers : Gradient Descent Algorithm • Back propagation	2	05	06
	2. Random Initialization, Regularization, Learning rate Why Neural Network didn't take off?		01	
Better Training of Neural Networks	3. Over fitting, Under fitting, bias and variance • Vanishing gradients, exploding gradients • Second order methods for training • Saddle point problem in Neural Network	3	02	05
	Regularization methods (dropout, drop connect, batch normalization)		01	
	Newer optimization methods for neural networks (SDG, rmsprop, adam)		02	
Deep Neural Network	1 Forward propagation, Vectorised implementation, Backward propagation (2 hidden layers- introduction)	2, 4	03	06
	yper parameters Difficulty of training deep neural networks: Vanishing gradients, exploding gradients, etc. - Greedy layerwise training		03	
. Convolutional Neural Networks	• Convolution filters • Pooling • FC layers • Hyper parameters • LeNet • AlexNet. • VGG • ResNet	5	08	08
Recurrent Neural Networks and	6.1 Recurrent Neural Networks Back propagation through time	5	06	11

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Applications	• Why RNN? (Vanishing Gradient) • Types of RNN (Single input single output, etc.) • Long Short Term Memory • RNN using LSTM • Bidirectional LSTMs - Introduction to Transformers and attention			
	6.2 Applications of Neural Networks Applications in Healthcare , Marketing, Education, Business • Computer Vision • NLP • Speech	6	05	
. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	**42**

Books:	
Text Books	1. Deep Learning, Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT Press, 2016 2. Deep Learning Tutorial, LISA Lab, University of Montreal 3. Deep Learning: Methods and Applications By Li Deng and Dong Yu 4. Neural Networks and Deep Learning By Michael Nielsen
Reference Books	1. Neural Networks: A Systematic Introduction, Raúl Rojas, 1996 2. Pattern Recognition and Machine Learning, Christopher Bishop, 2007
Useful Links:	
1. https://www.deeplearningbook.org/ 2. http://deeplearning.net/tutorial/deeplearning.pdf 3. https://www.microsoft.com/en-us/research/wp-content/uploads/2016/02/DeepLearning-NowPublishing-Vol7-SIG-039.pdf 4. https://ee541.cankaya.edu.tr/course.php?page=Syllabus 5. https://d2l.ai/index.html 6. https://research.google.com/colaboratory/	
Continuous Assessment (CA):	

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	**Department Level Elective Course – IV**	**Credits (TH+P+TUT)**
EXDLC7042	**Wireless Networks**	**3+0+0**

Prerequisite:	1. Computer Communication Network
Course Objectives:	1. To Understand Basics of Wireless Networks 2. To Know different IEEE standards like IEEE 802.15, IEEE 802.11, IEEE 802.16 3. To develop the concept of Wireless Ad Hoc Networks and Sensor networks. 4. To understand Wireless sensor networks, mesh networks and IoT

Course Outcomes:	1. Explain the fundamentals, architecture, design issues and standards of wireless networks and Body area networks. 2. Discuss the specifications, architectures, protocol stack, security procedures of personal area network (PAN) technologies such as Zigbee, Bluetooth, UWB, RFID, NFC etc. 3. Classify different Wireless Local Area Networks based on their Architecture, Radio specifications, Protocol Stack, Security procedures. 4. Illustrate the fundamentals and architecture of wireless Metropolitan Area Networks (WMAN) and describe the phases of planning and design of wireless networks with link budgets 5. Describe the basic architecture, Protocol Stack and working of Wireless Ad hoc Networks. 6. Describe the basic architecture, Protocol Stack and working of Wireless Sensor networks, Ad hoc Networks and IOT

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
. Basics of Wireless Networks	1 Wireless network architecture, currently working Classifications, switching technology, communication problems	1	02	04
	2 Wireless body area networks: Properties Network architecture Network components Applications	1	02	
. Wireless Personal Area Networks	WPAN: Bluetooth (IEEE802.15.1): Radio specifications protocol stack link types security state model Error correction topologies application	2	02	10
	2 ZigBee (IEEE 802.15.4): Radio specifications components topologies protocol stack applications	2	02	
	RFID: Radio specifications architecture and types	2	02	
	Near field communication & UWB (IEEE 802.15.3a): Introduction and	2	02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	working			
	5 6LoWPAN: Features, Architecture, protocol stack and applications	2	02	
3. Wireless Local Area Network	Equipment Technologies Topologies Applications IEEE 802.11 WLAN	3	02	06
	Joining an existing basic service set Security and Power management	3	02	
	Main features of IEEE 802.11 a/ b/ g/ n/ ac/ ax	3	02	
. Wireless Metropolitan and Wide Area Networks	WMAN (IEEE 820.16): Introduction WMAN network architecture Network protocols. Broadband wireless networks application	4	02	07
	WWAN: Planning and design of Wireless network: radio link and Coverage planning	4	02	
	3 Link budgets for GSM, CDMA, CDMA 2000, HSDPA Systems	4	03	
. Wireless Ad- hoc networks	Wireless Ad hoc Networks: Features, advantages & applications	5	02	06
	Mobile Ad-hoc Networks: (MANETs) Network Architecture, MAC protocols	5	02	
	Vehicular Ad hoc Networks: (VANETs): Characteristics, Protocols and Applications	5	02	
. Wireless Sensor Networks	Wireless Sensor Networks: Network architecture, Protocols, technologies, and applications	6	02	06
	Wireless Mesh Networks: Network architecture, Protocols, technologies, Applications	6	02	
	Internet of Things: Framework, Architecture, Technology, and examples, M2M communication	6	02	
. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. Vijay K. Garg," Wireless Communication and networking", Morgan-Kaufmann Series in Networking-Elsevier 2. Dr. Sunil Kumar S. Manvi, Mahabaleshwar S. Kakkasageri, "Wireless & Mobile Networks: Concepts and Protocols" Wiley India.
Reference Books	1. Kazem Sohrby, Daniel Minoli and Taieb Znati," Wireless Sensor Networks: Technology, Protocols, and Applications", Wiley Student Edition 2. Raj Kamal," Internet of Things Architecture & Design Principles

Useful Links:

1. https://zigbeealliance.org/solution/zigbee/
2. https://www.bluetooth.com/
3. https://www.ieee802.org/
4. https://www.wi-fi.org/discover-wi-fi/wi-fi-certified-6

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Department Level Elective Course – IV	Credits (TH+P+TUT)
EXDLC7043	**Robotics**	**3+0+0**

Prerequisite:	1. Microcontroller 2. Linear Algebra, matrix transformation 3. Control system
Course	1. To introduce industrial Robotic ARM

Objectives:	2. To offer mathematical and engineering knowledge for sensor and actuators of Robotics 3. To offer understanding of control of Robot 4. To give exposure of intelligent Robotics
Course Outcomes:	After taking this course student will be able to 1. Describe the steps involved in ARM manipulator design 2. Select a suitable drive System for robot application 3. Select a suitable sensor for robot application 4. Solve Direct Kinematics and inverse kinematics problem 5. Explain working of semi and autonomous Robot for structure and unstructured environment. 6. Describe Algorithm for Robot Navigation in structured and unstructured environment

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
Fundamentals of Robotics	Evolution of Robotics: Automation to AI Robotics, Robotic Paradigm: Sense, plan and act, Laws of Robotics, D-H Algorithm	5	03	04
	Specification of Robot, Classification of Robot, Robot Configuration	5	01	
. Industrial Robotics	Simple manipulators: two / three ARM manipulators and their kinematics equation, Work space homogeneous	1, 4	02	06
	D-H Procedure, ROBOT Parameter, ARM matrix, DH matrix	1, 4	02	
	2.3 Inverse kinematics for manipulators	4	02	
. Actuators, sensors and their control	DC motors, Brushless PM DC motor, AC/DC servomotor	2	01	06
	Sensors for Robots: camera, position encoders, tactile, hall, Force Sensors, Lidar	3, 5	02	
	Spring mass damper model, Combination of P,I and D control, PID control, Case study of Robocon Bots designed by KJSIEIT Robocon students team.	2, 5	03	
Introduction to Software for	4.1 ARM training, VAL	5, 6	01	08

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Robotics	Matlab /octave for fast prototyping of Robots, Introduction to C++, C ++ for Robot Operating System (ROS)	5, 6	07	
. Probabilistic Robotics for Navigation	Basics of Probability, Recursive state Estimation: Bayes filter	5, 6	03	07
	Mobile Robot Localization problem, path planning strategies: BFS; DFS; Dijsktra; A star ; D star; SLAM algorithm	5, 6	04	
. AI Robotics and case study	State machine for Behavioural planning Machine Learning for Robotics, Supervised learning, Unsupervised Learning, Reinforcement Learning: State, action and award, RL for Robotics, Convolution Neural Networks for supervised Learning: Object detection, NLP for Robotics	5, 6	04	08
	Business Use Cases : Swaaytt Robotics, Boston Dynamics	5, 6	04	
Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

Books:	
Text Books	1. ROBOTICS, Appu Kuttan K.K., I.K. international Publishing house,1st Edition 201`2 2. Introduction to Autonomous Mobile Robots, Roland Siegwart, Illah Reza Nourbakhsh and Davide Scaramuzza, Bradford Company Scituate, USA 2004
Reference Books	1. Fundamental of Robotics: Analysis and Control Robert J. Schilling 2. Introduction to AI Robotics, 2nd Edition, R. Murphy, MIT Press
Useful Links:	
1. http://www.swaayatt-robots.com/ 2. https://www.bostondynamics.com/	

3. http://www.iitg.ac.in/cse/robotics/?page_id=1349
4. https://modernrobotics.northwestern.edu/nu-gm-book-resource/2-2-degrees-of-freedom-of-a-robot/#department

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Department Level Elective Course – IV	Credits (TH+P+TUT)
EXDLC7044	**Cloud Computing & Security**	**3+0+0**
Prerequisite:	1. Computer Communication Networks 2. Data Structures & Algorithms	
Course Objectives:	1. Basics of cloud computing. 2. Key concepts of virtualization. 3. Different Cloud Computing services 4. Cloud Implementation, Programming and Mobile cloud computing 5. Key components of Amazon Web Services 6. Cloud computing security	
Course Outcomes:	1. Describe basics of cloud computing and memorize the different Cloud service and deployment models 2. Explain the Key concepts of virtualization along with their technologies. 3. Select the cloud computing services based on business requirements 4. Analyze the components of open stack & Google Cloud platform and understand Mobile Cloud Computing 5. Explore the Components of Amazon Web Service 6. Apply security measures in cloud computing environments	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	Introduction to Cloud Computing, Cloud Characteristics, Cloud Computing Components	1	02	04
	Cloud Deployment model (Cloud types- Public, Private, Community, Hybrid), Cloud Service Models-(IaaS, PaaS, SaaS)		02	
2. Virtualization	Virtualization: Characteristics of virtualized environment, Hypervisors, Type I & Type II Hypervisors	2	02	06
	Taxonomy of virtualization, Virtualization of CPU, Memory and I/O Devices Virtualization, Pros and Cons of virtualization		02	
	Virtualization structure/tools and mechanisms: KVM, Xen, VMware, HyperV		02	
. Cloud Computing Services	Exploring Cloud Computing Services: SPI Model: Software as a service, Platform as a service, and Infrastructure as a service.	3	03	10
	Anything as a service or Everything as a service (XaaS): Security as a Service, Identity management as a Service, Database as a Service, Storage as a Service, Collaboration as a Service		04	
	Compliance as a Service, Monitoring as a Service, Communication as a Service, Network as a Service, Disaster recovery as a service, Analytics as a Service, Backup as a Service.		02	
	Cloud Backup Solutions and their features, Cloud data management interface (CDMI), Cloud Storage gateways (CSG)		01	
. Cloud Implementation, Programming and Mobile Cloud Computing	Introduction to Open Source Cloud Software - CloudStack, Eucalyptus, OpenStack etc. OpenStack Cloud Architecture: Feature of Open stack, Components of Open stack, mode of operations	4	02	08
	Google apps engine, GFS, Bigtables,		05	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Chubby, Google APIs.			
	Introduction to Mobile Cloud Computing		01	
. Exploring the Components of Amazon Web Service	1 AWS cloud computing Platform Elastic Compute Cloud (EC2): Compute Basics, Instance types, Life cycle of instances. Simple Storage Service (S3): Basics and Operations, Features, Amazon Glacier, Glacier vs S3.	5	02	05
	5.2 Elastic Block Storage (EBS): Basics and Types of EBS Volumes Amazon Virtual Private Cloud (Amazon VPC): Subnets, Route tables, Elastic IP Addresses (EIP), Elastic Network Interfaces (ENIs) & Security groups & ACL. Exploring Elastic Load Balancing (ELB): Basics, Types of load balancers, Configuring Elastic Load Balancing, Basics of Cloud Watch & Auto Scaling		02	
	Comparison between different cloud platforms: Amazon web services & Open stack (Based on Type of deployment, Services supported and their components).		01	
6. Cloud computing security	Risk associated with cloud computing, Security challenges in cloud computing environment, Security for SAAS, IAAS, PAAS	6	04	06
	IAM-Identity access managements, AAA model – SSO for Clouds – Authentication management and Authorization management in clouds – Accounting for Clouds Resource utilization		02	
. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			TOTAL	**42**

Books:	
Text Books	1. Enterprise Cloud Computing by Gautam Shroff, Cambridge, 2010 2. Cloud Security by Ronald Krutz and Russell Dean Vines, Wiley - India, 2010

	3. Getting Started with OwnCloud by Aditya Patawar , Packt Publishing Ltd, 2013 4. Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice) 1st Edition, Kindle Edition by Tim Mather
Reference Books	1. Rajkumar Buyya et. el., Cloud Computing: Principles and Paradigms, Wiley India Edition 2. Sosinsky B., "Cloud Computing Bible", Wiley India 3. Mastering Cloud Computing by Rajkumar Buyya, C. Vecchiola & S. Thamarai Selvi Mc GRAW Hill Publication 4. Miller Michael, "Cloud Computing: Web Based Applications that Change the Way You Work and Collaborate Online", Pearson Education India 5. Velte T., Velte A., Elsenpeter R., "Cloud Computing – A practical Approach", Tata Mc Graw Hill

Useful Links:

1. www.openstack.org
2. https://www.nist.gov/news-events/news/2011/10/final-version-nist-cloud-computing-definition-published
3. https://cloudsecurityalliance.org/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
ILC7051	**Product Life Cycle Management**	**3+0+0**

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

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs /Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Product Lifecycle Management (PLM)	Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications PLM Strategies: Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy ,Change management for PLM	1	10	10
2. Product Design:	Product Design: 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	2	09	09

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs /Module
	Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process.			
3. Product Data Management (PDM)	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.	3	05	05
4. Virtual Product Development Tools	Virtual Product Development Tools: For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies.	4	05	05
5. Integration of Environmental Aspects in Product Design	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	5	05	05

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs /Module
	Considerations for Product Design			
6. Life Cycle Assessment and Life Cycle Cost Analysis	Life Cycle Assessment and Life Cycle Cost Analysis: Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**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: 08493272293. Saaksvuori Antti, Immonen Anselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314 **3.** Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN:0070636265

Useful Links:

1. https://www.intechopen.com/books/product-lifecycle-management-terminology-and-applications/introductor y-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

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
ILC7052	**Reliability Engineering**	**3+0+0**
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	
Course 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/ Sub Topic	Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Probability	1 Probability theory: Probability: Standard definitions and concepts; Conditional Probability, Baye's Theorem.	1	03	08
	2 Probability Distributions: Central tendency and Dispersion; Binomial, Normal, Poisson, Weibull,		03	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Module
	Exponential, relations between them and their significance.			
	3 Measures of Dispersion: Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.		02	
2. Reliability Concept	1 Reliability Concepts: Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve	2	03	08
	2 Failure Data Analysis: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions.		03	
	3 Reliability Hazard Models: Constant Failure Rate, Linearly increasing, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.		02	
3. System Reliability	System Reliability: System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	3	05	05
4. Reliability Improvement	1 Reliability Improvement: Redundancy Techniques: Element redundancy, Unit Redundancy, Standby redundancies. Markov analysis.		04	08
	2 System Reliability Analysis – Enumeration method, Cut-set method, Success Path method, Decomposition method.	4	04	
5. Maintainability and Availability	Maintainability and Availability: System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects.	5	05	05
6. Failure Mode,	Failure Mode, Effects and Criticality	6	05	05

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Hrs/ Module
Effects and Criticality Analysis	Analysis: Failure mode effects analysis, Severity/ criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	-	01	01
			Total	**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	L.S. Srinath, "Reliability Engineering", Affiliated East-Wast Press (P) Ltd., 1985. Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980. P.D.T. Conor, "Practical Reliability Engg.", John Wiley & Sons, 1985. K.C. Kapur, L.R. Lamberson, "Reliability in Engineering Design", John Wiley & Sons. 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	
Continuous Assessment (CA):	

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	**Institute Level Elective Course - I**	**Credit (TH+P+TUT)**
ILC7053	**Management Information System**	**3+0+0**
Course Objectives:	1. To discuss the roles played by information technology in business and define various technology architectures on which information systems are built. 2. To define and analyze typical functional information systems and identify how they meet the needs of the firm to deliver efficiency and competitive advantage. 3. To identify the basic steps in systems development.	
Course Outcomes:	1. Describe how information systems transform 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/ Sub Topic**	**Hrs/ Module**
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Information System	1 Computer Based Information Systems, Impact of IT on organizations.	1	02	04
	2 Importance of IS to	1	02	

	Society. Organizational Strategy, Competitive Advantages and IS.			
2. Data and Knowledge Management	1 Data and Knowledge Management: Database Approach, Big Data, Data warehouse and Data Marts, Knowledge Management.	2,3	04	07
	Business intelligence (BI): Managers and Decision Making, BI for Data analysis and Presenting Results.	2,3	03	
3. Ethical Issues and Privacy	Ethical issues and Privacy: Information Security.	3	03	07
	hreat to IS and Security Controls.	3	04	
4. Social Computing (SC)	Social Computing (SC): Web 2.0 and 3.0, SC in business-shopping, Marketing.	4	03	07
	Operational and Analytical CRM, E-business and E-commerce – B2B B2C. Mobile commerce.	4	04	
5.Computer Networks	Computer Networks Wired and Wireless technology.	5	03	06
	2 Pervasive computing, Cloud computing model.	5	03	
6.Project leadership and Ethics and Closing the projects	6.1 Information System within Organization: Transaction Processing Systems, Functional Area Information System.	6	04	08
	3 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.	6	04	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**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 Firm 10th 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/

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
ILC7054	**Design of Experiments**	**3+0+0**

Prerequisites:	---
Course Objectives (COBs):	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
Course Outcomes(COs):	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/Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction	1.1 Strategy of Experimentation, Typical Applications of	1	01	03

Module No & Name	Sub Topics	CO Mapped	Hrs/Sub Topic	Total Hours
	Experimental Design.			
	1.2 Guidelines for Designing Experiments, Response Surface Methodology.	1	02	
. **Fitting Regression Models**	2.1 Linear Regression Models, Estimation of the Parameters in Linear Regression Models, Hypothesis Testing in Multiple Regression.	2	04	08
	2.2 Confidence Intervals in Multiple Regression, Prediction of new response observation, Regression model diagnostics, Testing for lack of fit.	2	04	
. **Two Levels Factorial Designs**	3.1 The 2^2 Design, The 2^3 Design, The General2k Design.	3	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.	3	04	
. **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.	4	04	08
	4.2 Resolution III Designs, Resolution IV and V Designs, Fractional Factorial Split-Plot Designs.	4	04	
. **Response Surface Methods and Designs**	5.1 Introduction to Response Surface Methodology, The Method of Steepest Ascent.	5	04	08
	5.2 Analysis of a Second-Order Response Surface, Experimental Designs for Fitting Response Surfaces.	5	04	
. **Taguch Approach**	6.11 Crossed Array Designs and Signal-to-Noise Ratios.	6	02	04
	6.2 Analysis Methods, Robust design examples.	6	02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications	-	02	01

Module No & Name	Sub Topics	CO Mapped	Hrs/Sub Topic	Total Hours
	and Summarization			
			Total	**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/	
Continuous Assessment (CA): The distribution of Continuous Assessment marks will be as follows – 1. Class Test 1 (T-1) 30 marks 2. Class Test 2 (T-2) 30 marks 3. Internal Assessment 10 marks **Class Tests (30 Marks):** Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment. **Internal Assessment(IA):** Marks will be allotted as per designed rubrics.	
End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.	

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
ILC7055	**Operation Research**	**3+0+0**
Course Objectives:	1. To understand Research and Research Process 2. To acquaint students with identifying problems for research and develop	

	research strategies 3. To familiarize students with the techniques of data collection, analysis of data and interpretation
Course Outcomes:	1. Define and formulate linear programming problems and solve them by applying appropriate techniques. 2. Determining the optimum solution for transportation and Assignment models. 3. Choose the appropriate queuing model for a given practical application and propose the best strategy and value of the given game model. 4. Use CPM and PERT techniques, to plan, schedule and control project activities. Determining the optimum sequence to process jobs. 5. Judge classical & probabilistic inventory models and simulate different real life probabilistic situation using Monte Carlo simulation technique. 6. Selecting the best strategy from various alternatives by applying various tools and methodology for decision-making.

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite concepts, Introduction, Structure of the Mathematical Model, Limitations of operational research.	-	01	01
1. Linear Programming	1.1 Linear Programming: Problem formulation, Graphical Method and simplex method.	1	04	10
	1.2 Artificial Variable Simplex Techniques: Big-M Method and Two-Phase Method.	1	03	
	1.3 Advanced Topics in Linear Programming: Duality in Linear Programming and the Dual Simplex Method.	1	03	
2. Transportation models and Assignment models	2.1 Transportation Model: North-west corner method, Row Minima method, Column Minima method, Least – cost method, Vogel's Approximation method, Optimality by MODI method and Unbalanced Transportation Problem.	2	03	06
	2.2 Assignment Model: The	2		

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Hungarian method for solution of Assignment problems, Unbalanced assignment problem and maximization problem.		03	
3. Queuing Model and Game Theory	3.1 Queuing Models: Introduction, Single-channel, Finite population model with Poisson Arrivals and Exponential Service Times (Limited Source Model).	3	03	06
	3.2 Game Theory, 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.	3	03	
. Network analysis in project planning and Sequencing models	4.1 Project Management: Phases of project management, Network construction, Critical Path Method (CPM) and Process Evaluation & Review Techniques (PERT). (Exclude Cost analysis, crashing, resource scheduling and updating)	4	04	07
	4.2 Sequencing Models: Processing n jobs through one machine, two machines and three machines, Processing n jobs through m machines.	4	03	
5. Inventory Control and Simulation	5.1 Inventory Models: Introduction, Inventory models with Deterministic demand (with and without shortages) and Inventory models with price breaks.	5	04	07

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	5.2 Simulation: Definition, Types of Simulation Models, Monte Carlo Technique, Practical Problems, Applications in Queuing and Inventory problems.	5	03	
6. Decision Theory	Steps in Decision theory approach, Decision – Making Environments, Decision making under conditions of certainty and uncertainty, Decision making under conditions of Risk and Decision Trees.	6	04	04
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	_	01	01
			Total	**42**

Reference 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. 4. Operations Research, S. D. Sharma, KedarNath Ram Nath-Meerut 5. Operations Research, KantiSwarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons

Useful Links:

1. https://onlinecourses.nptel.ac.in/noc19_ma29/preview
2. https://www.coursera.org/courses?query=operations%20research

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be

one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment. **Internal Assessment(IA):** Marks will be allotted as per designed rubrics.
End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	**Institute Level Elective Course - I**	**Credits (TH+P+TUT)**
IUILC7056	**Cyber Security and Laws**	**3+0+0**
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 compliance	
Course Outcomes:	Explain the concept of cybercrime and its effect on outside world Classify and Examine the Cyber Offences and security implications. Illustrate and identify the modus operandi followed in cyber-crimes. Explain the aspects in Indian Cyber Laws Explain the penalties in cyber law. Apply Information Security Standards compliance during software design and development	

Module No. & Name	**Sub Topics**	**CO Mapped**	**Hrs/ Sub Topic**	**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	1	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	2	09	09

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Measures for Handling Mobile, Devices-Related Security Issues, Organizational Security Policies and Measures in Mobile Computing Era, Laptops			
3. Tools and Methods Used in Cyber line	Phishing, Password Cracking, Keyloggers and Spywares, Virus and Worms, Steganography, DoS and DDoS Attacks, SQL Injection, Buffer OverFlow, Attacks on Wireless Networks, Phishing, Identity Theft (ID Theft)	4	04	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 Electronic Banking , The Need for an Indian Cyber Law	3	08	08
5. Indian IT Act	Cyber Crime and Criminal Justice: Penalties, Adjudication and Appeals Under the IT Act, 2000, IT Act. 2008 and its Amendments	5	06	06
. Information Security Standard compliance	SOX, GLBA, HIPAA, ISO, FISMA, NERC, PCI.	6	06	06
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	–	01	01
			Total	**42**

Books:	
Text Books:	1. William Stallings, *Cryptography and Network Security*, Pearson Publication The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi 2. Nina Godbole, Sunit Belapure, *Cyber Security*, Wiley India, New Delhi 3. Cyber Law & Cyber Crimes By Advocate Prashant Mali; Snow White Publications, Mumbai

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

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

Continuous Assessment (CA):

The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):

Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):

Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
ILC7057	**Disaster Management and Mitigation Measures**	**3+0+0**
Prerequisites:	Basics of Physics	
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 Minimize it. 4. To Understand Application of GIS in the Field of Disaster Management. 5. To Understand the Emergency Government Response Structures Before, During and after Disaster.
Course Outcomes:	1. Illustrate the importance of Disaster Management 2. Discuss natural as well as man made disaster and their extent and possible effects on the economy. 3. Use government policies, acts and various organizational structures associated with an emergency. 4. Devise various Framework for Disaster Management in India. 5. Reviewing various approaches of disaster relief measures. 6. Generalize the simple do‘s and don‘ts in such extreme events and act accordingly

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	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.	1	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.	2	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 Man Made 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	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Disaster Management, Policy and Administration	3.1 Disaster Management: Meaning, Concept, Importance.	3	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 Coordination of 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.	4	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.		02	
	4.5 Use of Internet and Software for Effective Disaster Management. Applications of GIS, Remote Sensing and GPS.		02	
5. Financing Relief Measures	5.1 Ways to Raise Finance for Relief Expenditure, Role of Government Agencies and NGO's in this Process.	5	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,		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Ways to Approach these Teams.			
	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.	6	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	**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/	
Continuous Assessment (CA): The distribution of Continuous Assessment marks will be as follows –	

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.

Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	**Institute Level Elective Course - I**	**Credits (TH+P+TUT)**
ILC7058	**Energy Audit and Management**	**3+0+0**

Prerequisite:	——
Course Objectives:	1. To understand the importance of 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.
Course Outcomes:	1. Identify and describe the present state of energy security and its importance. 2. Identify and describe the basic principles and methodologies adopted in energy audit of an utility. 3. Describe the energy performance evaluation of some common electrical installations and identify the energy saving opportunities. 4. Describe 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/ Sub Topic**	**Total Hrs/ Module**
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-		02

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
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	1	04	04
2. Energy Audit Principles	Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Benchmarking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution. Elements of monitoring & targeting; Energy audit Instruments; Data and information-analysis. Financial analysis techniques: Simple payback period, NPV, Return on investment (ROI), Internal rate of return (IRR)	2	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 equipments and appliances, star ratings. Energy efficiency measures in lighting systems, 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	3		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	4	10	10

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	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.			
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.	5	04	04
6. Energy conservation in Buildings	Energy Conservation Building Codes (ECBC): Green Building, LEED rating, Application of Non-Conventional and Renewable Energy Sources	6	03	03
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization	-	01	01
			Total	**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 Link	

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

Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1.	Class Test 1 (T-1)	30 marks
2.	Class Test 2 (T-2)	30 marks
3.	Internal Assessment	10 marks

Class Tests (30 Marks):
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Internal Assessment(IA):
Marks will be allotted as per designed rubrics.

End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.

Course Code	Institute Level Elective Course - I	Credits (TH+P+TUT)
ILC7059	**Development Engineering**	**3+0 +0**
Prerequisite:	-	
Course Objectives:	1. To understand the characteristics of rural Society and the Scope, Nature and Constraints of rural Development 2. To study Implications of 73rd CAA on Planning, Development and Governance of Rural Areas 3. To explain exploration of human values, which go into making a 'good' human being, a 'good' professional, a 'good' society and a 'good life' in the context of work life and the personal life of modern Indian professionals 4. To understand the Nature and Type of Human Values relevant to Planning Institutions	
Course Outcomes:	1. Apply knowledge for Rural Development. 2. Demonstrate post-independence rural development. 3. Apply knowledge for Initiatives and Strategies 4. Develop acumen for higher education and research. 5. Master the art of working in groups of different nature. 6. Develop confidence to take up rural project activities independently	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1.Introduction to Rural Development	Introduction to Rural Development Meaning, nature and scope of development; Nature of rural society in India; Hierarchy of settlements; Social, economic and ecological constraints for rural development Roots of Rural Development in India Rural reconstruction and Sarvodaya programme before independence; Impact of voluntary effort and Sarvodaya Movement on rural development; Constitutional direction, directive principles; Panchayati Raj - beginning of planning and community development; National extension services	1	08	08
2. Post-Independence rural Development	Post-Independence rural Development Balwant Rai Mehta Committee – three tier system of rural local Government; Need and scope for people's participation and Panchayati Raj; Ashok Mehta Committee - linkage between Panchayati Raj, participation and rural development	2	05	05
3. Rural Development Initiatives in Five Year Plans	Rural Development Initiatives in Five Year Plans Five Year Plans and Rural Development; Planning process at National, State, Regional and District levels; Planning, development, implementing and monitoring organizations and agencies; Urban and rural interface - integrated approach and local plans; Development initiatives and their convergence; Special component plan and sub-plan for the weaker section; Micro-eco zones; Database for local planning; Need for decentralized planning; Sustainable rural development.	3	06	06

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
4. Post 73rd Amendment Scenario	Post 73rd Amendment Scenario 73rd Constitution Amendment Act, including - XI schedule, devolution of powers, functions and finance; Panchayati Raj institutions - organizational linkages; Recent changes in rural local planning; Gram Sabha - revitalized Panchayati Raj; Institutionalization; resource mapping, resource mobilization including social mobilization; Information Technology and rural planning; Need for further amendments	4	05	05
5. Values and Science and Technology Material development	Values and Science and Technology Material development and its values; the challenge of science and technology; Values in planning profession, research and education. Types of Values Psychological values — integrated personality; mental health; Societal values — the modern search for a good society; justice, democracy, rule of law, values in the Indian constitution; Aesthetic values — perception and enjoyment of beauty; Moral and ethical values; nature of moral judgment; Spiritual values; different concepts; secular spirituality; Relative and absolute values; Human values— humanism and human values; human rights; human values as freedom, creativity, love and wisdom.	5	10	10
6. Ethics Canons of ethics	Ethics Canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility; Work ethics; Professional ethics; Ethics in planning profession, research and education	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	**42**

<table>
<tr><td colspan="2">Books:</td></tr>
<tr><td>Text Books</td><td>1. ITPI, “Village Planning and Rural Development”, ITPI, New Delhi
2. Thooyavan, K.R, “ Human Settlements: A 2005”, MA Publication, Chennai
3. GoI, “Constitution (73rd GoI, New Delhi Amendment) Act”, GoI, New Delhi
4. Planning Commission, Five Year Plans, Planning Commission
5. Planning Commission, Manual of Integrated District Planning, 2006, Planning Commission New Delhi</td></tr>
<tr><td>Reference Books</td><td>1. Planning Guide to Beginners
2. Weaver, R.C., The Urban Complex, Doubleday.
3. Farmer, W.P. et al, Ethics in Planning, American Planning Association, Washington.
4. How, E., Normative Ethics in Planning, Journal of Planning Literature, Vol.5, No.2, pp. 123-150.
5. Watson, V. , Conflicting Rationalities: -- Implications for Planning Theory and Ethics, Planning Theory and Practice, Vol. 4, No.4, pp.395– 407</td></tr>
<tr><td colspan="2">Continuous Assessment (CA):
The distribution of Continuous Assessment marks will be as follows –

1. Class Test 1 (T-1) 30 marks
2. Class Test 2 (T-2) 30 marks
3. Internal Assessment 10 marks

Class Tests (30 Marks):
Two class tests of 30 marks each should be conducted in a semester. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 40% syllabus (but excluding contents covered in Test I) is completed. Duration of each test shall be one hour and 15 Minutes. Average of the two class tests (T-1 and T-2) will be considered for Continuous Assessment.
Internal Assessment(IA):
Marks will be allotted as per designed rubrics.</td></tr>
<tr><td colspan="2">End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.</td></tr>
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Course Code	Course Name	Credits (P+TUT)
EXL701	**Microwave Engineering Laboratory**	**1+0**
Prerequisite:	1. Electromagnetic and Antenna Laboratory 2. Principles of Communication Engineering Laboratory	

Lab. Objectives:	1. To learn the design of matching circuits using simulation software. 2. To learn the mode analysis in waveguide using simulation software. 3. To learn microwave passive components and semiconductor devices. 4. To analyse the characteristics of microwave tubes (Reflex Klystron). 5. To measure microwave parameters using a microwave bench.
Lab. Outcomes:	1. Analyse microwave matching techniques and waveguide using any simulation software. 2. Analyse microwave passive components and semiconductor devices. 3. To measure microwave parameters using a microwave bench. 4. Write a code for the calculation of Speed, cross range & Range of Doppler Radar. 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 (suggested)	LO Mapped	Hrs. / Lab
0	**Lab Prerequisites**	-	02
1.	Measurement of Microwave Frequency Using Slotted Line section and verification using direct frequency meter.	3,5,6	02
2.	Study and analyse the characteristics of Reflex Klystron.	2,5,6	02
3.	Demonstrate the measurement of Voltage Standing Wave Ratio & Reflection Coefficient of Different load.	3,5,6	02
4.	Demonstrate the measurement of Guided Wavelength & Free Space Wavelength using Microwave bench.	3,5,6	02
5.	Study and modal analysis of Rectangular waveguide using simulation software.	1,5,6	02
6.	Demonstrate the measurement of dielectric constant of solid using Microwave bench.	3,5,6	02
7.	Simulation of impedance matching by using any familiar software.	1,5,6	02
8.	Write a code for the calculation of Speed, cross range & Range of Doppler Radar by using any familiar software.	4,5,6	02
9.	To analyses the performance of Gunn diode using Microwave bench.	2,5,6	02
10.	Mini Project/ Case study	1 to 6	08
11.	Assignment 1	-	-
12.	Assignment 2	-	-

Lab. No.	Experiment Title (suggested)	LO Mapped	Hrs. / Lab
		Total	**28**

Useful Links:
1. http://www.iitk.ac.in/mimt_lab/vlab/index.php 2. https://onlinecourses.nptel.ac.in/noc19_ee57/preview 3. https://www.youtube.com/c/KJSIEITofficial/videos
Term work:
1. Term work should consist of a minimum of 8 experiments 2. Journal must include assignments on content of theory and practical of the course 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/demo/presentation: 10-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory – III	Credits (P+TUT)
EXDLL7031	**Artificial Intelligence Laboratory**	**1+0**
Lab Prerequisite:	Programming, Data Structures	
Lab Objectives:	1. To introduce the concepts of a Rational Intelligent Agent and the different types of Agents that can be designed to solve problems 2. To impart basic proficiency in representing difficult real life problems in a state space representation so as to solve them using AI techniques. 3. To make students understand various AI methods like searching and game playing and how to apply them to solve real applications 4. To explain to students the basic issues of knowledge representation and Logic so as to build inference engines 5. To impart a basic understanding of some of the more advanced topics of AI such as planning. 6. To understand Bayes networks, natural language processing and introduce the concept of cognitive computing.	
Lab Outcomes (LOs):	Implement the building blocks of an Intelligent Agent using PEAS representation.	

	Implement the problem as a state space, graph, design heuristics and select amongst different search or game based techniques to solve them. Implement various real life problem domains using logic based techniques and use this to perform inference or planning. Solve problems with uncertain information using Bayesian approaches. rite accurate documentation for experiments performed. Apply ethical principles like timeliness and adhere to the rules of the Laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	**Lab Prerequisites**	-	02
1.	Tutorial exercise for a. Design of Intelligent System using PEAS b. Problem Definition with State Space Representation	1, 2,5,6	02
2.	Implementation of Uninformed (BFS/DFS) and Informed Search Algorithms (A*)	2,5,6	06
3.	Implementation of CSP and Game playing algorithms	2,5,6	04
4	Assignment on Predicate Logic, for forward and backward reasoning and resolution. Design of a Planning system using STRIPS.	3.4,5,6	04
5	Implementation of Bayes' Belief Network.	4,5,6	02
6	Mini project Construction of a domain specific Chat Bot using Natural Language Processing techniques. (Applications can include: Medical Diagnosis, Personal Shopping Assistant, Travel Agent, Troubleshooting etc.)	1,2,3,4,5,6	08
		Total	**28**

Virtual Lab Links:
1. https://nptel.ac.in/courses/106/105/106105078/ 2.https://thestempedia.com/blog/simple-ai-and-machine-learning-projects-for-students- and-beginners/ 3.https://nptel.ac.in/courses/106/105/106105079/
Term work:
Term work should consist of a minimum of 8 experiments Journal must include assignments on content of theory and practical of the course The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.

Total 25 Marks (Experiments: 15-marks, Assignments/Case study/demo/presentation: 10-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	**Department Level Elective Course Laboratory – III**	**Credits (P+TUT)**
EXDLL7032	**Satellite and Nano Satellite Communication Laboratory**	**1+0**
Lab Prerequisite:	1. Principles of Communication Engineering 2. Digital Communication	
Lab Objectives:	1. To understand the **basics** of satellite communications and different satellite communication orbits. 2. Provide an **in-depth** understanding of satellite communication system operation, launching techniques, satellite link design and earth station technology. 3. To explain the **tools** necessary for the calculation of basic parameters in a satellite communication system. 4. Review the state of the art in **new research** areas such as speech and video coding, satellite networking and satellite personal communications, mobile satellite communication, Laser satellite.	
Lab Outcomes (LOs):	1. Apply direct communication link between Uplink Transmitter & Down link Receiver using tone signal. 2. Apply AUDIO-VIDEO satellite link between Transmitter and Receiver. 3. Apply waveforms through satellite link. Explain Active satellite link and demonstrate link fail operation. 4. Analyze satellite link between Transmitter and Receiver using software. 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**
0	**Lab Prerequisites**	**-**	02
1.	To set up a communication link between uplink transmitter and downlink receiver using Satellite	1,5,6	02
2.	To transmit and receive three separate signals (Audio, Video, and Tone) simultaneously through satellite link.	2,5,6	02
3.	To transmit digital waveform through a satellite communication link.	3,5,6	02
4.	Active satellite link and demonstrate link fail operation	4,5,6	02
5.	To estimate the C/N ratio	3,5,6	02
6.	To estimate S/N ratio	3,5,6	02

Lab No.	Experiment Title	LO Mapped	Hrs./ Lab
7.	To find the gain of the antenna using Matlab software.	4,5,6	02
8.	To find the Speed and time period of a satellite as a function of Altitude using Matlab software.	4,5,6	02
9.	To calculate propagation delay in a SATCOM link.	3,5,6	02
10.	Velocity of satellite in given orbit at apogee and perigee using Matlab software.	4,5,6	02
11.	Case Study/Mini Project	1 to 6	06
		Total	**28**

Virtual Lab Links:
1. https://aero04-iitb.vlabs.ac.in/
Term work:
1. Term work should consist of a minimum of 8 experiments 2. Journal must include assignments on content of theory and practical of the course 3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/demo/presentation: 10-marks
Oral/Practical/P&O: Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory– III	Credits (P+TUT)
EXDLL7033	**Embedded System & RTOS Laboratory**	**1+0**
Lab Prerequisite:	**1.** Microcontroller Laboratory	
Lab Objectives:	1. To understand various communication protocols used in Embedded System 2. To learn configuration of Free RTOS 3. To learn Inter Task communication in Free RTOS 4. To learn Task synchronization in Free RTOS	
Lab Outcomes	1. Interface embedded system modules. 2. Write program for embedded application 3. Demonstrate Inter Process Communication in RTOS 4. Demonstrate task synchronization in RTOS 5. Develop applications to solve big data problems. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory	

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	**Lab Prerequisites**	-	02
1	Interfacing of I2C with ARM	1,2,5,6	02
2	Interfacing of SPI with ARM	1,2,5,6	02
3	Interfacing of UART with ARM	1,2,5,6	02
4	Simulation of multitasking using FreeRTOS	2,5,6	02
5	Simulation of mutex using FreeRTOS	2,4,5,6	02
6	Interprocess communication using Message Buffer in FreeRTOS	2,3,5,6	02
7	Interprocess communication using queues in FreeRTOS	2,4,5,6	02
8	Simulation of synchronization using Semaphore in FreeRTOS	2,4,5,6	02
9	Simulation of synchronization using Task Notification in FreeRTOS	2,4,5,6	02
10	Simulation of software timer using FreeRTOS	2,5,6	02
11	Case Study / Mini Project	1 to 6	06
		Total	**28**

Virtual Lab Links:

1. http://vlabs.iitkgp.ernet.in/rtes/exp15/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
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Assignments: 10-marks

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory– III	Credits (P+TUT)
EXDLL7034	**Big Data Analytics Laboratory**	**(1+0)**

Lab Prerequisite:	1. Database Management System 2. Java Programming
Lab Objectives:	1. To Interpret business models and scientific computing paradigms, and apply software tools for big data analytics
Lab Outcomes (LOs):	1. Apply scalable algorithms based on Hadoop and Map Reduce to perform Big Data Analytics. 2. Apply NoSQL tools to solve big data problems. 3. Implement commands of various technologies of the Hadoop Ecosystem. 4. Implement different algorithms of mining, use stream data models and to develop applications to solve big data problems. 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
0	**Lab Prerequisites**	-	02
1.	Hadoop distributions for installation of Hadoop And execution of Basic HDFS Commands	1,5,6	02
2.	Copying File to Hadoop. Copy from Hadoop File system and deleting file Moving and displaying files in HDFS	1,5,6	02
3.	Implementing simple algorithms in Map-Reduce: Matrix multiplication/ Aggregates and Joins/ Sorting and Searching, etc.	1,5,6	02
4	To install and configure MongoDB/ Cassandra/ HBase/ Hyper table to execute NoSQL commands.	2,5,6	02
5	Use Sqoop tool to transfer data to Hadoop and To execute basic commands of Sqoop.	3,5,6	02
6	Create HIVE Database and Descriptive analytics-basic statistics, visualization using Hive/PIG/R.	3,5,6	02
7	Implementing DGIM algorithm using any Programming Language/ Implement Bloom Filter using any programming language.	4,5,6	02
8	Implement a Frequent Item set algorithm on Big Data	4,5,6	02

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
9	Mini Project: One large data application to be implemented (Use standard Datasets available on the web) (mandatory)	1,2,3,4,5,6	10
		Total	**28**

Virtual Lab Links:
1. https://hadoop.apache.org 2. https://hadoop.apache.org/docs/r2.8.0/hadoop-project-dist/hadoop-common/core-default.xml **3.** https://sqoop.apache.org/ 4. https://hive.apache.org/ 5. https://pig.apache.org/docs/r0.16.0/start.html 6. https://medium.com/@deepeshtripathi/setup-multi-node-hadoop-cluster-using-ambari-fc929cd1d0d4
Term work:
1. Term work should consist of a minimum of 8 experiments **2.** Journal must include assignments on content of theory and practical of the course **3.** The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work. 4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/demo/presentation: 10-marks
Oral/Practical/P&O : Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	**Department Level Elective Course Laboratory – IV**	**Credits (P+TUT)**
EXDLL7041	**Neural Networks and Deep Learning Laboratory**	**(1+0)**
Lab Prerequisite:	Machine Learning	
Lab Objectives:	1. To simulate the various phenomenon related to CMOS circuits 2. To analyze simple CMOS circuits using SPICE tools 3. To simulate the logic circuits using various design style 4. To draw mask layout of various circuits	
Lab Outcomes (LOs):	**After taking the course students will be able to,** 1. Demonstrate implementation of perceptron. 2. Build Neural Network model for the given problem 3. Implement a Neural Network for the given problem using various	

	libraries. 4. Tune the parameters of Neural Networks. 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
0	**Lab Prerequisites**	-	02
1.	Implementation of perceptron	1,5,6	02
2.	Implementation of shallow dense neural network with one hidden layer	2,5,6	02
3.	Implementation of Stochastic Gradient Descent	2,5,6	02
4.	Implementation of dropout	4,5,6	02
5.	Implementation of regularization	4,5,6	02
6.	Implementation of RMSprop optimizer	4,5,6	02
7.	Implementation of Adam optimizer	4,5,6	02
8.	Build and implement A Deep Learning Model using Keras	3,5,6	02
9.	Hyper parameter tuning for Neural Network	4,5,6	02
10.	Implementation of ConvNet for using PyTorch	3,5,6	02
11.	Implementation of LeNet-5 using PyTorch	3,5,6	02
12.	Implementation of AlexNet using Keras	3,5,6	02
13.	Implementation of ResNet using Keras	3,5,6	02
		Total	**28**

Virtual Lab Links:
1. http://cse22-iiith.vlabs.ac.in/

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/demo/presentation: 10-marks

Oral/Practical/P&O:

Oral examination will be based on entire theory syllabus and carries 25 Marks

Lab Code	Department Level Elective Course Laboratory – IV	Credits (P+TUT)
EXDLL7042	**Wireless Networks Laboratory**	**1+0**
Lab Prerequisite:	Computer Communication Networks Laboratory	
Lab Objectives:	1. Study of Hardware and Software aspects of Wireless Network and IoT 2. Analysis of ZigBee network wireless transmission of information. 3. Configuration of WPAN using Bluetooth module. 4. Link budget analysis of GSM and CDMA network	
Lab Outcomes (LOs):	1. Implement capacity and network efficiency of different multiple access schemes like, SCMA, OFDMA, 2. Design WPAN, WLAN, WMAN and WWAN. 3. Estimate link budget of GSM, CDMA, HSDPA, CDMA2000 4. Implement Wireless Ad hoc Networks, Sensor Network and IoT. 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
0	**Lab Prerequisites**	**-**	02
1	Write Hardware and Software aspects of Wireless Network and Internet of Things	1,5,6	02
2	Establish Bluetooth a network connection	2,5,6	02
3	Estimate a range of Interference in Bluetooth and IEEE802.11a	2,5,6	02
4	Estimate a Capacity and Spectral Efficiency of CDMA system	1,5,6	02
5	Calculate the Uplink and downlink budget for CDMA system	3,5,6	02

6	Calculate SINR of HSDPA	3,5,6	02
7	To turn motor, relay on and off using ZigBee kit	2,5,6	02
8	Establish Wireless Local Area Network.	2,5,6	02
9	Write a program to randomly place the sensor node in the given space connecting each 2 nodes if distance between them is less than or equal to common radius.	4,5,6	02
10	To understand basic beam forming in wireless communication	1,5,6	02
11	Establish a WMAN	2,5,6	02
12	Mini projects based on wireless technologies simulation/ coding using MATLAB/NS3	1,2,3,4,5,6	04
		Total	**28**

Useful Links:

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

Term work:

1. Term work should consist of a minimum of 8 experiments
2. Journal must include assignments on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments, Assignments/Case study/Mini project demo/presentation: 10-marks

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks

Course Code	**Department Level Elective Course Laboratory - IV**	**Credits (P+TUT)**
EXDLL7043	**Robotics Laboratory**	**1+0**
Hardware Requirements:	PC With following Configuration 1. Intel Dual core Processor or higher 2. Minimum 4 GB RAM 3. Minimum 40 GB Hard disk	
Software Requirements:	1. Windows / Linux Desktop OS 2. Atmel Studio 3. ROS, Gajebo, Matlab/Octave	
Lab Prerequisite:	1. Control Lab **2.** Microcontroller Lab	

Lab Objectives:	1. To explain DC drive and control 2. To introduce Sensor for Robotics 3. To understand Kinematics of robot 4. To introduce ROS/Gajebo Environment
Lab Outcomes:	1. Write the program for Simple motor maneuver for Robotic movement 2. Calculate and simulate Direct/indirect kinematics for robot 3. Use DC drives for Robotic arms 4. Deploy Sensors/actuators/output devices for Wheeled Robots in ROS Environment 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	LOs Mapped	Hrs./ Lab
0	**Lab Prerequisites**	**-**	02
1	Software Installation and study of hardware and software required for practical: Motion Control of Firebird	1,3,5,6	02
2	Practicals on Firebird: Speed control	1,3,4,5,6	02
3	Different Maneuvers' using Firebird Robot	2,5,6	02
4	Obstacle Avoidance in structured Environment	1,5,6	03
5	Map Generation Using Robot	3,4,5,6	03
6	Study of ROS and Gajebo Environment	4,5,6	02
7	Study of 3d Printers as Cartesian Robot	2,5,6	02
8	Development of 3d objects for Robotic Parts	2,3,5,6	02
9	Practical on Navigation of Robot in structured/Non Structured Environment	2,4,5,6	02
10	Study and simulation of Industrial Robot	2,5,6	02
11	PID control of DC motors and Robotic ARM	1,3,5,6	02
12	Simulation of Wheeled Robot in ROS Environment	4,5,6	02
		Total	**28**

Virtual Lab Links:
1. 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 Lab" 3. Term work evaluation shall be for Total 25 Marks (Experiments: 15 Marks, Assignments: 10- Marks). 4. The final certification and acceptance of term work is based on satisfactory performance of laboratory work and minimum passing marks in term work evaluation.
Practical & Oral (P&O):
Oral examination will be based on entire theory syllabus and carries 25 Marks.

Lab Code	**Department Level Elective Course Laboratory - IV**	**Credits (P+TUT)**
EXDLL7044	**Cloud Computing & Security Lab**	**1+0**
Lab Prerequisite:	1. EXC604- Computer Communication Networks 2. EXDLC505-Data Structures & Algorithms	
Lab Objectives:	Students to get familiar with: 1. Key concepts of virtualization & different types of Hypervisors used in virtualization along with implementation 2. Understand the concept of on demand Application Delivery like SaaS 3. Open source cloud implementation and administration using OpenStack 4. Various Cloud services provided by Amazon Web Services 5. Programming on Platform as a Service cloud and Implementation of Storage as a service using Own Cloud	
Lab Outcomes (LOs):	Students should be able to: 1. Creating and running virtual machines 2. Demonstrate and implement IAAS/PAAS/SAAS service 3. Demonstrate the installation and configuration of Open stack private cloud. 4. Create a cloud, cloud storage bucket, apply security concepts to secure a private cloud. 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**
0	Lab Prerequisites	-	02

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
1	Installation of VMWare /Virtual Box on Window/Ubuntu	1,5,6	02
2	Creating and running virtual machines on Hosted Hypervisors like KVM Type 1,Vmware Workstation, Oracle Virtualbox	1,5,6	02
3	Creating and running virtual machines on Bare-Metal Hypervisors Type 0 like Xen,Vmware ESXI or HyperV	1,5,6	02
4	To demonstrate and implement IAAS service using Amazon Web Service/Google Cloud/Docker. (In AWS Use t2.Micro (Free tier eligible) instance.)	2,5,6	02
5	Configure your instance firewall (implement IAAS service using Amazon Web Service/Google Cloud/Docker. (In AWS use t2.Micro (Free tier eligible) instance.)	2,5,6	02
6	Replace or Attach an IAM Role to an Existing EC2 Instance by using the EC2 Console	4,5,6	02
7	Create your first Cloud Storage bucket using Amazon Simple Storage Service (Amazon S3)	4,5,6	02
8	To demonstrate installation and Configuration of Open stack Private cloud.(MS AZ and Google Cloud)	3,5,6	02

Note:
Suggested **8 lab exercises** based on virtualization, Cloud computing stack, cloud programming and cloud security using Amazon Web Service/Google Cloud/MS AZ/ Docker etc.

References:

1. Implementing and Developing Cloud Computing Applications, DAVID E.Y. SARNA, Auerbach Publications,2011
2. Handbook of Cloud Computing, Borko Furht, Armando Escalante, Springer, 2010

Virtual Lab Links:

https://www.vlab.co.in/

Useful Link:

1. www.openstack.org
2. https://www.nist.gov/news-events/news/2011/10/final-version-nist-cloud-computing-definition-published
3. https://cloudsecurityalliance.org/

Term work :

1. Term work should consist of a minimum of 8 experiments and one mini project
2. Journal must include one project on content of theory and practical of the course
3. The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
4. Total 25 Marks (Experiments: 10-marks, Project: 15-marks)

Oral/Practical/P&O :

Oral examination will be based on entire theory syllabus and carries 25 Marks.

Course Code	Project Based Learning	Credits(TH+P+TUT)
EXPR75	**Major Project - A**	**0+3+0**
Prerequisite:	1. Mini Project	
Lab Objectives:	The Project work enables the students, 1. To develop the required skills and knowledge about research. 2. To analyse 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	
Lab Outcomes:	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 and interpret data to meet the problem statement. 4. Apply ethical principles and commit to professional ethics, responsibilities norms of the engineering practice, and engage in independent and life-long learning. 5. Comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. 6. Interact efficiently and effectively as an individual with the team members or leader for timely and professional management of projects.	
Syllabus:		

Project Topic:

- To proceed with the project work it is especially important to select the right topic. Project can be undertaken on any domain of Electronics and Telecommunication programme. 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 three 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/project coordinator in the department will take decisions regarding selection of projects.
- 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, visits by internal guides will be preferred.
- Students shall be motivated to publish a paper based on the work in Conferences/Technical paper presentations/project competitions/Poster presentations.

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 Term Work will carry 25 Marls ensuring satisfactory performance on the above aspects.
10. Oral & Practical:
    Oral &Practical examination of Major Project-A should be conducted by Internal and External will carry 50 Marks based on satisfactory presentation, demonstration of implementation of the project

Useful Links:

1. https://ieeexplore.ieee.org/
2 https://www.electronicsforu.com/

Term Work:

Students have to submit a weekly progress report to the internal guide and the internal guide has to keep a track on the progress of the project and also has to maintain the attendance report. This progress report can be used for awarding the term work marks. In case of industry projects, visits by an internal guide will be preferred to get the status of the project.

Students shall be motivated to publish a paper based on the work in Conferences/Technical paper presentations/project competitions/Poster presentations.

Distribution of marks for term work shall be as follows:

a. Weekly Attendance on Project Day
b. Project work contributions as per objective
c. Project Report (soft Bound)
d. Term End Presentation (Internal)

The final certification and acceptance of Term Work ensures the satisfactory performance on the above aspects which carries 25 Marks.

Oral & Practical:

Practical examination of Major Project-A shall be conducted by Internal and External examiners. Students must give a presentation and demonstration on the Major Project-A. Practical will carry 50 Marks.