

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

Course Code	Course Name	Teaching Scheme (Hrs.) TH - P - TUT	Total (Hrs.)	Credits Assigned TH - P - TUT	Total Credits	Course Category
EXC801	Optical Communication Networks	3-0-0	03	3-0-0	03	PC
EXDLC802	Department Level Elective Course -V	3-0-0	03	3-0-0	03	DLE
EXDLC803	Department Level Elective Course - VI	3-0-0	03	3-0-0	03	DLE
ILC804	Institute Level Optional Course -II	3-0-0	03	3-0-0	03	ILE
EXL801	Optical Communication Networks Laboratory	0-2-0	02	0-1-0	01	PC
EXDLL802	Department Level Elective Course - V Laboratory	0-2-0	02	0-1-0	01	DLE
EXDLL803	Department Level Elective Course - VI Laboratory	0-2-0	02	0-1-0	01	DLE
EXPR86	Project Based Learning - Major Project - B	0-12*-0	12*	0-6-0	06	PBL
Total		12-18-0	30	12-09-00	21	

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

Department Level Optional Courses	Group	Course Code	Course Name^
Department Level Elective - V	A	EXDLC8021	Augmented Reality and Virtual Realty
	B	EXDLC8022	5G Technology
	C	EXDLC8023	System On-Chip
	D	EXDLC8024	Web Design
Department Level Elective - VI	A	EXDLC8031	Natural Language Processing
	B	EXDLC8032	RF Design
	C	EXDLC8033	Autonomous Vehicle
	D	EXDLC8034	Fundamentals of Data Science

^ 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 - II	ILC8041	Project Management
	ILC8042	Finance Management
	ILC8043	Entrepreneurship Development and Management
	ILC8044	Human Resource Management
	ILC8045	Professional Ethics and CSR
	ILC8046	Research Methodology
	ILC8047	IPR and Patenting
	ILC8048	Digital Business Management
	ILC8049	Environmental Management

Common with all branches

Program Structure for Last Year UG Technology (EX)
Semester- VIII- Examination Scheme

Course Code	Course Name	Examination Scheme									
		Marks									
		CA				ESE	TW	O	P	P&O	Total
T1	T2	Average (T1&T2)	IA								
EXC801	Optical Communication Networks	30	30	30	10	60	-	-	-	-	100
EXDLC802	Department Level Elective Course – V	30	30	30	10	60	-	-	-	-	100
EXDLC803	Department Level Elective Course – VI	30	30	30	10	60	-	-	-	-	100
ILC804	Institute Level Optional Course –II	30	30	30	10	60	-	-	-	-	100
EXL801	Optical Communication Networks Laboratory	-	-	-	-	-	25	25	-	-	50
EXDLL802	Department Level Elective Course – V Laboratory	-	-	-	-	-	25	25	-	-	50
EXDLL803	Department Level Elective Course – VI Laboratory	-	-	-	-	-	25	-	25	-	50
EXPR86	Project Based Learning – (Major Project – B)	-	-	-	-	-	50	-	-	100	150
Total		120	120	120	40	240	125	50	25	100	700

Course Code	Course Name	Credits (TH+P+TUT)
EXC801	Optical Communication Networks	3 + 0 + 0
Prerequisite:	1. Principles of Communication Engineering 2. Electromagnetics and Antenna 3. Digital Communication	
Course Objectives:	1. To optical fiber communication concepts, essentials, structures wave guide, and signal degradation in fiber. 2. To the characteristics of optical sources and detectors. 3. To link budget and optical networks, design and management. 4. To Study the multiplexing schemes.	
Course Outcomes:	1. Apply the fundamental principles of optics and light wave to design optical fiber communication systems. 2. Identify structures, functions, materials, and working principles of optical fibers, light sources, couplers, detectors, and multiplexers.	

	<p>3. Describe the operation of transmitters and detectors in optical fiber communication.</p> <p>4. Identify the basic components in an optical network system.</p> <p>5. Explain the concepts of SONET/SDH and access networks.</p> <p>6. Discuss the various design considerations in optical networks.</p>
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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. Optical fiber Communications	Historical development, The general system, Advantages of optical fiber communication	1, 2	02	07
	Optical fiber waveguides: Ray theory transmission, Modes in planar guide, Phase and group velocity, Cylindrical fiber: Modes, Step index fibers, Graded index fibers, Single mode fibers, Cutoff wavelength, Mode field diameter, effective refractive index. Fiber Materials, fiber cables.		05	
2. Transmission characteristics of optical fiber	Attenuation, Material absorption losses, Linear scattering losses, Nonlinear scattering losses, Fiber bend loss, Dispersion, Chromatic dispersion, Intermodal dispersion: Multimode step index fiber	2, 3	04	06
	Optical Fiber Connectors: Fiber alignment and joint loss, Fiber splices, Fiber connectors, Fiber couplers.		02	
3. Optical sources and Detectors	Optical Sources: Working principle and characteristics of sources (LED, LASER), and optical amplifiers	3	02	08
	Photodetectors: Working principle and characteristics of detectors (PIN, APD), noise analysis in detectors, coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance.		03	
	Point to point links system considerations, link power budget, and rise time budget Optical Receiver: Optical Receiver Operation: Error sources, Front End Amplifiers, Receiver sensitivity,		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Quantum Limit			
4. WDM Concepts and Optical Components	WDM Concepts: Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM, Introduction of Solitons	4	02	07
	Optical Components: Mach-Zehnder Interferometer Multiplexers, Couplers, Isolators, Circulators, Multiplexers, Filters, Fiber gratings, Fabry Perot filters, Arrayed waveguide grating, Switches and Wavelength converters Optical amplifiers: Basic application and Types, Semiconductor optical amplifiers, Erbium Doped Fiber Amplifiers, Raman Amplifiers, Wideband Optical Amplifiers.		05	
5. Optical Networks	SONET and SDH standards, architecture of optical transport networks (OTNs), network topologies, protection schemes in SONET/SDH, and wavelength routed architectures.	5	03	07
	OTDM, multiplexing and demultiplexing, synchronization and broadcast OTDM networks.		02	
	Network architecture overview, OTDN networks, optical access networks, and future access networks		02	
6. Network Design and Management	Transmission system model, power penalty-transmitter, receiver optical amplifiers, crosstalk, dispersion, wavelength stabilization.	6	02	04
	Network management functions, configuration management, performance management, fault management, optical safety, and service interface		02	
ii. Course Conclusion	cap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	42

Books:										
Text Books	<ol style="list-style-type: none"> 1. John M. Senior, —Optical Fiber Communication, Prentice Hall of India Publication, Chicago, 3rd Edition, 2013 2. Gred Keiser, —Optical Fiber Communication, Mc-Graw Hill Publication, Singapore, 4th Edition, 2012 3. Rajiv Ramaswami and Kumar N. Sivarajan, —Optical Networks: A Practical Pererspective, Elsevier Publication Elsevier India Pvt. Ltd, 3rd Edition, 2010 									
Reference Books	<ol style="list-style-type: none"> 1. G. Agrwal, —Fiber optic communication Systems, John Wiley and Sons, 3rd Edition, New York 2014 2. Biswanath Mukherjee, —Optical Communication Networks, McGraw-Hill, 1997. 3. Le Nguyen Binh, —Optical Fiber Communication System: Theory and Practice with MATLAB and Simulink, CRC Press, 2010 4. P. E. Green, —Optical Networks, Prentice Hall, 1994 									
Useful Links:										
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/117/101/117101054/ 2. https://nptel.ac.in/courses/117/104/117104127/ 3. https://nptel.ac.in/courses/108/106/108106167/ 										
Continuous Assessment (CA):										
The distribution of Continuous Assessment marks will be as follows –										
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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 – V	Credits (TH+P+TUT)
EXDLC8021	Augmented Reality & Virtual Reality	3 + 0 + 0
Prerequisite:	Image Processing and Machine Vision	

Course Objectives:	<ol style="list-style-type: none"> 1. To learn the background of VR including a brief history of VR, different forms of VR and related technologies, and a broad overview of some of the most important concepts. 2. To provide background in perception to educate VR creators on concepts and theories of how we perceive and interact with the world around us. 3. To make learners aware of high-level concepts for designing/building assets and how subtle design choices can influence user behaviour. 4. Learning about art for VR and AR should be optimized for spatial displays with spatially aware input devices to interact with digital objects in true 3D.
Course Outcomes:	<ol style="list-style-type: none"> 1. Apply the concepts of VR and AR in real life 2. Discuss 3D user interfaces 3. Explore VR, AR and today's resources 4. Elaborate 3D interaction techniques 5. Summarize strategies for designing and developing 3D user interfaces 6. Discuss AR and mixed reality

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. Virtual Reality and Virtual Environments	The historical development of VR: Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, benefits of Virtual reality.	1	03	08
	Visual Physiology & Visual Perception- Photoreceptors, Sufficient resolution for VR, light intensity, Eye movements and its issues for VR		03	
	Neuroscience of vision, Depth perception, Motion perception, Frame rates and displays		02	
2. 3D User Interface Hardware	Input device characteristics, Desktop input devices, Tracking Devices, 3D Mice, Special Purpose Input Devices, Direct Human Input, Home - Brewed Input Devices, Choosing Input Devices for 3D Interfaces	2	03	05
	Visual Displays Auditory Displays, Haptic Displays, Choosing Output Devices for 3D User Interfaces.		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Software Technologies	Database - World Space, World Coordinate, World Environment, Objects - Geometry, Position / Orientation, Hierarchy, Bounding Volume, Scripts and other attributes	3	03	09
	VR Environment - VR Database, Tessellated Data, LODs, Cullers and Occluders, Lights and Cameras, Scripts		03	
	Interaction - Simple, Feedback, Graphical User Interface, Control Panel, 2D Controls, Hardware Controls, Room / Stage / Area Descriptions, World Authoring and Playback, VR toolkits		03	
4. 3D Interaction Techniques	3D Manipulation tasks, Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation, Design Guidelines - 3D Travel Tasks, Travel Techniques, Design Guidelines - Theoretical Foundations of Wayfinding, User Centered Wayfinding Support, Environment Centered Wayfinding Support, Evaluating Wayfinding Aids, Design Guidelines - System Control, Classification, Graphical Menus, Voice Commands, Gestural Commands, Tools, Multimodal System Control Techniques, Design Guidelines	4	03	06
	Case Study: Mixing System Control Methods, Symbolic Input Tasks, symbolic Input Techniques, Design Guidelines, Beyond Text and Number entry		03	
5. Designing and Developing 3d User Interfaces	Strategies for Designing and Developing Guidelines and Evaluation	5	02	03
	Virtual Reality Applications- Engineering, Architecture, Education, Medicine, Entertainment, Science, Training		01	
6. Augmented and Mixed Reality	Taxonomy, technology and features of augmented reality, difference between	6	03	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	AR and VR, Challenges with AR, AR systems and functionality			
	Augmented reality methods, visualization techniques for augmented reality, wireless displays in educational augmented reality applications		03	
	Mobile projection interfaces, marker-less tracking for augmented reality, enhancing interactivity in AR environments, evaluating AR systems		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	42

Books:							
Text Books	<ol style="list-style-type: none"> “Developing Virtual Reality Applications: Foundations of Effective Design”, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009. “Designing Virtual Systems: The Structured Approach”, Gerard Jounghyun Kim, 2005. “3D User Interfaces, Theory and Practice”, Doug A Bowman, Ernest Kujiff, Joseph J LaViola, Jr and Ivan Poupyrev, Addison Wesley, USA, 2005. <p>“Understanding Augmented Reality, Concepts and Applications”, Alan B. Craig, , Morgan Kaufmann, 2013.</p>						
Reference Books	<p>“The VR Book, Human Centered Design for Virtual Reality”, Jason Jerald, ACM Books, First Edition, 2016.</p> <p>Creating Augmented and Virtual Realities, Erin Pangilinan, Steve Lukas, Vasanth Mohan, O’Reilly, First Edition, 2019.</p> <p>Virtual reality with VRTK4, Rakesh Baruah, APress, First Edition, 2020.</p> <p>Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, Morgan Kaufmann Publishers, San Francisco, 2002.</p>						
Useful Links:							
<ol style="list-style-type: none"> NPTEL: Augmented Reality & Virtual Reality https://www.youtube.com/watch?v=zLMgdYI82IE NPTEL: Virtual & Augmented Reality- https://www.youtube.com/watch?v=Nq3mPFgpREE 							
Continuous Assessment (CA):							
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3.	Internal Assessment	10 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 – V	Credits (TH+P+TUT)
EXDLC8022	5G Technology	3 + 0 + 0
Prerequisite:	Mobile Communication	
Course Objectives:	<ol style="list-style-type: none"> 1. To understand the basic architecture of Core network and Radio Access Network of 5G. 2. To study massive MIMO systems in 5G. 3. To know spectrum, Antenna and wave propagation. 4. To understand security in 5G technology. 	
Course Outcomes:	<ol style="list-style-type: none"> 1. Explain the fundamentals of 5G mobile technologies and their access schemes. 2. Describe Core network of 5G technology 3. Illustrate architecture and radio access network of 5G. 4. Discuss the concept of MIMO. 5. Elaborate on spectrum, antennas and wave propagation. 6. Describe security in 5G and applications of 5G. 	

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
Introduction to 5G Mobile Technology	1.1 Historical background Industrial and technological revolution: from steam engines to the Internet Mobile communications generations: from 1G to 4G From mobile broadband (MBB) to extreme MBB 6 IoT: relation	1	04	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	to 5 1.3 Standardization activities			
	1.3.1 The 5G radio-access technologies-OFDMA, NOMA, SCMA, IDMA		02	
	1.3.2 Requirements of 5G 1.3.1 eMMB 1.3.2 URLLC 1.3.3 mMTC		02	
Architecture of the Core Network	2.1 The Evolved Packet Core 2.1.1 Release 8 Architecture 2.1.2 Control and User Plane Separation	2	02	07
	2.2 The 5G Core Network 2.2.1 Representation Using Reference Points 2.2.2 Representation Using Service-based Interfaces 2.2.3 Data Transport 2.2.4 Roaming Architectures 2.2.5 Data Storage Architectures 2.2.6 Non-3GPP Access to the 5G Core		03	
	2.3 Network Areas, Slices and Identities 2.3.1 Signalling Protocol 2.3.2 Signalling Protocol Architecture		02	
Architecture of the Radio Access Network	3.1 The Evolved UMTS Terrestrial Radio Access Network 3.1.1 Release 8 Architecture 3.1.2 Carrier Aggregation 3.1.3 Dual Connectivity	3	02	06
	3.2 The Next-generation Node B 3.2.1 High Level Architecture 3.2.2 Internal Architecture 3.2.3 Deployment Options		02	
	3.3 Network Areas and Identities and Signalling Protocols 3.4.1 Tracking Areas		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	3.4.2 RAN Areas 3.4.3 Cell Identities 3.4.4 Signalling Protocol Architecture 5 Signalling Radio Bearers References			
Massive multiple-input multiple-output (MIMO) systems	4.1 Introduction 4.1.1 MIMO in LTE	4	01	06
	4.2 Theoretical background 4.2.1 Single user MIMO 4.2.2 Multi-user MIMO 3 Capacity of massive MIMO: a summary Fundamentals of baseband and RF implementations in massive MIMO		03	
	1 Basic forms of massive MIMO implementation 2 Hybrid fixed BF with CSI-based precoding (FBCP) Hybrid beamforming for interference clustering and user grouping		02	
Spectrum, Antennas and Radio Propagation	5.1 Spectrum 1 Spectrum landscape and requirements 5.1.2 Spectrum Allocations for 5G 5.1.3 Bandwidth requirements 4 Spectrum access modes and sharing scenarios 5 Spectrum technologies- Spectrum toolbox, Main technology component	5	02	06
	5.2 Antennas 5.2.2 Antennas and Propagation 2.3 Antenna Gain		01	
	Radio Propagation Radio Propagation Issues for Millimetre Waves 1 Diffraction and Reflection 2 Penetration Losses		03	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	3 Foliage Losses 4 Atmospheric Losses Multipath, Fading and Coherence 1 Introduction 2 Angular Spread and Coherence Distance 3 Doppler Spread and Coherence Time			
Security and Applications of 5G	Security 1 Introduction, issues, challenges in 5G Communication 2 Overview of a Potential 5G Communications System Architecture 3 Mobile Malware Attacks Targeting UE 4 Access Networks	6	02	06
	User Equipment and External IP Networks 1 Attacks on 4G Access Network 2 HeNB Femtocell Attacks 3 Mobile Operator's Core Network		02	
	5G Applications and Future Scope		02	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:	
Text Books	<ol style="list-style-type: none"> 1. 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 2. 5G Mobile and Wireless Communications Technology, First Edition, Afif Osseiran Jose F. Monserrat Patrick Marsch, Cambridge University Press 2016 3. Fundamentals of 5G Mobile Network, Jonathan Rodriguez Senior Research Fellow Instituto de Telecomunications, Aveiro, Portugal, © 2015 John Wiley & Sons, Ltd., 2015

Reference Books	<ol style="list-style-type: none"> 1. Evolution of Air Interface Towards 5G Radio Access Technology and Performance Analysis, Suvra Sekhar Das and Ramjee Prasad, c 2018 River Publishers, 2018 2. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby Sensinode, Finland Carsten Bormann University Bremen TZI, Germany, This edition first published 2009 © 2009 John Wiley & Sons Ltd.
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Useful Links:										
<ol style="list-style-type: none"> 1. https://www.ericsson.com/en/5g/what-is-5g 2. https://5g-ppp.eu/ 3. https://techblog.comsoc.org/2020/07/10/5g-specifications-3gpp-5g-radio-standard-imt-2020-and-standard-essential-patents/ 										
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Internal Assessment(IA):										
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End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.										

Course Code	Department Level Elective Course – V	Credits (TH+P+TUT)
EXDLC8023	System On-Chip	3 + 0 + 0
Prerequisite:	<ol style="list-style-type: none"> 1. Digital VLSI Design 2. Project Based Learning 	
Course Objectives:	<ol style="list-style-type: none"> 1. To introduce modern system design using SoC 2. To understand the concept of hardware-software co-design 3. To learn integration of hardware and software design integration 	
Course Outcomes:	<ol style="list-style-type: none"> 1. Explain basics of SoC 2. Design and verify the SoC systems 3. Explain the physical design flow 4. Analyze routing issues in SoC 5. Interpret complex SoC systems 6. Explain non-technical issues related to the SoC 	

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 SoC Design	The fundamental trends of SoC design, SoC design flow, The Semiconductor Economics, Challenges in SoC design	6	03	06
	Hardware system structure, Software structure, Accelerating Processors for traditional software task, System Design with multiple processor design	1	05	
2. System Level Design	Complex SoC system architecture, Processor centric SoC organization, Communication Design – Hardware and Software interconnects	2	03	06
	Balancing computation and Communication, SoC Design flow, Non-processor building block in SoC design	5	03	
3. RTL Synthesis	Review of Verilog - RTL Coding and RTL Synthesis RTL coding guidelines, Synthesizable coding	2	08	08
4. SoC Verification	Verification technology options, Verification methodology. System level verification, block-level verification. Timing verification.	1	08	08
5. Physical Design	Partitioning, Floor Planning, Placement, Routing, Goals of routing - Global routing –Maze routing, Detailed routing, Over the Cell Routing, Physical verification and design sign-off.	3	07	07
6. Routing	Clock routing, Power and Ground routing, Clock tree synthesis	4	04	04
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	42

Books:

Text Books	<ol style="list-style-type: none"> 1. Engineering the Complex SOC: Fast, Flexible Design with Configurable Processors, Chris Rowen Pearson 2004 2. System on a chip verification: Methodology and Verification, Second edition, Prakash Rashinkar, Peter Paterson, Leena Singh, Kluwer Academic Publishers, 2013 3. Digital Design with RTL design, VHDL and VERILOG, Second edition, Frank Vahid, John Wiley and Sons Publisher 2010 									
Reference Books	<ol style="list-style-type: none"> 1. System-on-a-Chip: Design and Test, First Edition, Rochit Rajsuman, Artech House 2. VLSI Physical design Automation: Theory and Practice, Sadiq Sait, Habib Youssef 3. World Scientific Publishing 4. Surviving the SoC revolution, Second Edition, Henry Chang, Larry Cooke, Grant Martin, Kluwer Academic Publishers 									
Useful Links:										
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/117/101/117101058/ 2. https://nptel.ac.in/courses/108/107/108107129/ 3. http://cmosedu.com/ 										
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Course Code	Department Level Elective Course – V	Credits (TH+P+TUT)
EXDLC8024	Web Designing	3 + 0 + 0
Prerequisite:	1. Data Structures Basics of Programming Languages	
Course Objectives:	<ol style="list-style-type: none"> 1. To design and create web pages using HTML5 and CSS3 2. To Create web pages and provide client side validation 3. To create dynamic web pages using server side scripting 4. To use MVC framework for web application development 	
Course	1. Describe the core concepts and features of Web Technology	

Outcomes:	<ol style="list-style-type: none"> 2. Design static web pages using HTML5 and CSS3 3. Apply the concept of client side validation and design dynamic web pages using JavaScript and JQuery. 4. Evaluate client and server side technologies and create Interactive web pages using PHP , AJAX with database connectivity using MySQL 5. Apply the basics of XML, DTD and XSL and develop web pages using XML / XSLT 6. Analyse end user requirements and Create web application using appropriate web technologies and web development framework
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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 WWW	Internet Standards – Introduction to WWW – WWW Architecture – SMTP – POP3 – File Transfer Protocol	1	02	04
	Overview of HTTP, HTTP request – response — Generation of dynamic web pages- W3C Validator, How web works - Setting up the environment (LAMP/XAMP/WAMP server)		02	
2. Client Side Programming	Markup Language (HTML): Introduction to HTML and HTML5 - Formatting and Fonts –Commenting Code – Anchors – Backgrounds – Images – Hyperlinks	2	02	08
	Lists – Tables – Frames - HTML Forms and controls		02	
	Cascading Style Sheet (CSS): The need for CSS, Introduction to CSS 3 – Basic syntax and structure ,CSS Properties-Inline Styles – Embedding Style Sheets		02	
	Linking External Style Sheets – Backgrounds –Box Model(Introduction , Border Properties, Padding Properties, Margin Properties), Manipulating text - Margins and Padding - Positioning using CSS., Creating page Layout and Site Designs		02	
3. Introduction to Java Script	Introduction - Core features - Data types and Variables - Operators, 6 Expressions, and Statements, Functions - Objects - Array, Date and Math	3	02	08

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	related Objects			
	Document Object Model - Event Handling Controlling Windows & Frames and Documents Form handling and validations		02	
	Advanced JavaScript - Browser Management and Media Management – Classes – Constructors – Object-Oriented Techniques in JavaScript		02	
	Object constructor and Prototyping - Sub classes and Super classes – JSON - jQuery and AJAX., Rich Internet Application with AJAX, JQuery Framework		02	
4. Server Side Programming	Mixers: Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers	4	02	09
	Operators, Control structures and looping structures – Functions – Reading Data in Web Pages		02	
	Embedding PHP within HTML - Establishing connectivity with MySQL database, cookies, sessions and Authentication		03	
	AJAX with PHP - AJAX with Databases		02	
5. XML	Dynamic page generation (adding interactivity, styles, using HTML, DHTML, XHTML, CSS, Java Script), XML –DTD(Document Type Definition) - XML Schema	5	03	06
	XML –DTD(Document Type Definition) - XML Schema - Document Object Model - Presenting XML - Using XML Parsers: DOM and SAX,XSL-eXtensible Style sheet Language		03	
6. Web Development Framework	Introduction to Composer - MVC Architecture	6	02	04
	Web Application Development using		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	web development framework :- Introduction to Laravel, Development of Web pages using Laravel., Example web applications – Interactive websites, web based information systems , blogs, social networking sites etc.			
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:	
Text Books	<ol style="list-style-type: none"> 1. Ralph Moseley , M.T. Savliya , Developing Web Applications , Willy India, Second Edition, ISBN: 978-81-265-3867-6 2. Web Technology Black Book , Dremtech Press, First Ediction, 978-7722-997 3. Robin Nixon, "Learning PHP, MySQL, JavaScript, CSS & HTML5" Third Edition, 4. O'REILLY,2014. 5. (http://www.ebooksbucket.com/uploads/itprogramming/javascript/Learning_PHP_MySQL_Javascri 6. pt_CSS_HTML5__Robin_Nixon_3e.pdf) 7. Professional Rich Internet Applications: AJAX and Beyond, Dana Moore, Raymond Budd, Edward 8. Benson, Wiley publications. https://ebooks-it.org/0470082801-ebook.htm
Reference Books	<ol style="list-style-type: none"> 1. Harvey & Paul Deitel& Associates, Harvey Deitel and Abbey Deitel, —Internet and World Wide Web - How To Program , Fifth Edition, Pearson Education, 2011. 2. Achyut S Godbole and AtulKahate, —Web Technologies , Second Edition, Tata McGraw Hill, 2012. 3. Thomas A Powell, Fritz Schneider, —JavaScript: The Complete Referencel, Third Edition, Tata McGraw Hill, 2013. 4. David Flanagan, —JavaScript: The Definitive Guide, Sixth Edition , O'Reilly Media, 2011 5. Steven Holzner, —The Complete Reference - PHP , Tata McGraw Hill, 2008 6. 6. Mike Mcgrath, —PHP & MySQL in easy Steps , Tata McGraw Hill, 2012
Useful Links:	
<ol style="list-style-type: none"> 1. www.nptelvideos.in 2. www.w3schools.com 3. http://spoken-tutorial.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	Department Level Elective Course – VI	Credits (TH+P+TUT)
EXDLC8031	Natural Language Processing	3+0+0
Prerequisite:	<ol style="list-style-type: none"> 1. Data structures & Algorithms 2. Project Probability Theory 	
Course Objectives:	<ol style="list-style-type: none"> 1. To understand natural language processing and apply basic algorithms in this field. 2. To get acquainted with the basic concepts and algorithmic description of the main language levels: morphology, syntax, semantics, and pragmatics. 3. To design and implement various language Models and applications of NLP techniques in real life applications 	
Course Outcomes:	<ol style="list-style-type: none"> 1. Explain about the basics of natural language processing. 2. Explore capabilities and limitations of current natural language technologies 3. Build model linguistic phenomena with formal grammars. 4. Apply algorithms for NLP based pragmatics problems 5. Analyze mathematical and linguistic foundations underlying approaches to the various areas in NLP 6. Apply NLP techniques to design real world NLP applications. 	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topics	Total Hrs.
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Natural Language Processing	Introduction to data and its significance in NLP. History of NLP, Generic NLP system, levels of NLP	1	01	03
	Knowledge in language processing,		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topics	Total Hrs.
	Ambiguity in Natural language, stages in NLP, challenges of NLP, Applications of NLP			
2. Word Level Analysis	Morphology analysis —survey of English Morphology, Inflectional morphology & Derivational morphology, Lemmatization, finite automata	2	04	08
	Finite state transducers (FST), Morphological parsing with FST, Lexicon free FST Porter stemmer. N —Grams- N-gram language model, N-gram for spelling correction		04	
3. Syntax analysis	Part-Of-Speech tagging(POS)- Tag set for English (Penn Treebank) , Rule based POS tagging, Stochastic POS tagging, Issues—Multiple tags & words, Unknown words. Introduction to CFG, Types of Parsing.	3	05	08
	Sequence labelling: Hidden Markov Model (HMM), Maximum Entropy, and Conditional Random Field (CRF).		03	
4. Symantec Analysis	Lexical Semantics, Attachment for fragment of English- sentences, noun phrases, Verb phrases, prepositional phrases, Relations among lexemes & their sense	4	05	08
	Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD), Dictionary based approach		02	
5. Pragmatics	Discourse—reference resolution, reference phenomenon , syntactic & semantic constraints on co reference	5	06	06
6. Applications of NLP	Machine translation, Information retrieval, Question answers system, categorization, summarization, sentiment analysis, Named Entity Recognition	6	06	06
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topics	Total Hrs.
			Total:	42

Books:										
Text Books	<ol style="list-style-type: none"> 1. Daniel Jurafsky, James H. Martin “Speech and Language Processing” Second Edition, Prentice Hall, 2008. 2. Christopher D. Manning and Hinrich Schutze, “Foundations of Statistical Natural Language Processing “, MIT Press, 1999 									
Reference Books	<ol style="list-style-type: none"> 1. Siddiqui and Tiwary U.S., Natural Language Processing and Information Retrieval, Oxford University Press (2008). 2. Daniel M Bikel and Inned Zitouni “ Multilingual natural language processing applications” Pearson, 2013 3. Alexander Clark (Editor), Chris Fox (Editor), Shalom Lappin Editor)“The Handbook of Computational Linguistics and Natural Language Processing “ ISBN: 978-1-118 4. Steven Bird, Ewan Klein, Natural Language Processing with Python, O’Reill 5. Brian Neil Levine, An Introduction to R Programming 6. Niel J le Roux, Sugnet Lubbe, A step by step Tutorial : An introduction into R application and programming 									
Useful Links:										
<ol style="list-style-type: none"> 1. http://wordnetweb.princeton.edu/perl/webwn 2. https://onlinecourses.nptel.ac.in/noc21_cs102/preview 3. Kaggle Databases 										
Continuous Assessment (CA):										
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3.	Internal Assessment	10 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 – VI	Credits (TH+P+TUT)
EXDLC8032	RF Design	3 + 0 + 0
Prerequisite:	Electromagnetic and Antenna Principles of Communication Engineering Microwave Engineering	
Course Objectives:	1. To learn RF circuit fundamentals for designing various circuit building blocks in a typical RF transceiver. 2. To learn the importance of EMI/EMC.	
Course Outcomes:	Analyze the impedance matching networks and passive RF filters. Analyze RF amplifiers. Analyze RF oscillators. Differentiate the RF mixers. Analyze EMI and EMC in RF circuits. 6. Analyze stability of RF trans-receiver.	

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. RF Filter Design	Introduction to Periodic Structure	1	01	08
	Filter design using Image parameter method (Theory and Numerical)		02	
	Filter design using Insertion loss method- Maximally flat low pass prototype, Equal ripple low pass prototype, Filter transformation and filter implementation. (Theory and Numerical)		05	
2. Microwave Amplifier Design	Two-port power gain derivation, signal flow graph (SFG) and stability criterion. (Theory and Numerical)	2, 6	03	10
	Single stage amplifier design: Design for maximum gain, design for specified gain, low noise amplifier design (Theory and Numerical)		05	
	Power amplifier design: Characteristics of power amplifiers and classes of amplifiers, design of class A power amplifier. (Theory and Numerical)		02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
3. Microwave Oscillator	1 One-port microwave oscillator design. (Theory and Numerical)	3, 6	02	06
	2 Two-port microwave oscillator design. (Theory and Numerical)		03	
	3 Analysis of phase noise in oscillators.		01	
4. Microwave Mixer	Mixers: Characteristics, Various types of Mixers: Single ended diode mixers, FET mixers, Balanced mixers, Image reject mixers and other types of mixers	4	05	05
5. Electromagnetic Interference in RF circuits	1 Introduction. Natural and Nuclear Sources of EMI, EMI From Apparatus and Circuits. Quantification of Communication System EMI.	5	01	04
	2 Elements of Interference, Including Antennas, Transmitters, Receivers and Propagation. Electronic Equipment And System EMI Concepts. Examples Of EMI Coupling Modes.		01	
	3 Mode of coupling: Common-Mode coupling, Differential mode coupling, and other coupling mechanisms (Power supply and victim amplifiers)		02	
6. Electromagnetic Compatibility	1 For Achieving EMC: Grounding, Bonding, Shielding Effectiveness, EMI Diagnostics And Fixes: Techniques Used In EMI Diagnostics Fixes, troubleshooting	5	02	06
	2 Instruments, Tools, used to measure Electromagnetic Field (Radiated and Conducted Emission):- voltage and current probe, LISN, CDN, Clamp, Field probes, Spectrum analyzer, Oscilloscope, EMI Receiver.		02	
	3 Electromagnetic Noise specification: - Surge, EFT (Electrical Fast transients), PFMF, Radiated and		01	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	conducted susceptibility, Voltage and dips interruption, Ring wave, Damped oscillatory wave.			
	EMC Specifications, Standards And Measurements. A Discussion of the Genesis of EMC documentation including a historical Summary, The Rationale, and A Review of MIL-Std., FCC And CISPR Requirements.		01	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:	
Text Books	<ol style="list-style-type: none"> 1. David Pozar, "Microwave Engineering", Wiley Publication (Fourth Edition). 2. Ludwig R. and Bogdanov G., "RF Circuit Design", Prentice Hall. 3. Jack Smith, "Modern Communication circuits", Tata McGraw Hill. 4. W. Prasad Kodali, "Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models", Wiley-IEEE Press (Second Edition). 5. David. A. Weston, "Electromagnetic Compatibility principles and applications", Marcel Dekker (Second Edition). 6. MARK I. MONTROSE EDWARD M. NAKAUCHI, "Testing for EMC compliance: Approaches and Techniques".
Reference Books	<ol style="list-style-type: none"> 1. Guillermo Gonzalez, "Microwave Transistor Amplifiers Analysis and Design" Prentice Hall. (Second Edition) 2. M. L. Sisodia, G. S. Raghuvanshi, " Microwave Circuits and Passive Devices", New Edge International Publisher (First Edition) 3. Clayton R. Paul, "Electromagnetic Compatibility", John Wiley & Sons. (Second Edition)
Useful Links:	
<ol style="list-style-type: none"> 1. www.nptelvideos.in 2. https://nptel.ac.in/courses/108/106/108106138/ 3. https://freevideolectures.com/course/4367/nptel-microwave-theory-techniques 	
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 – VI	Credits (TH+P+TUT)
EXDLC8033	Autonomous Vehicle	3 + 0 + 0
Prerequisite:	1. Basic Programming 2. Robotics 3. Control system	
Course Objectives:	To give Introduction to implementation of different levels of Autonomous vehicle (AV) To give exposure to the technologies involved in AV. To give Exposure to in the perception and path-planning techniques useful for AV	
Course Outcomes:	1. Differentiate levels of Autonomous vehicle (AV) 2. Differentiate role of Sensors in AV 3. Describe hardware for AV 4. Write API for AV 5. Explain Use cases of AV 6. Compare different technologies for AV	

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 Autonomous Vehicle	Evolution in mobility, 6 Different levels of Autonomous Vehicle: Level 0 to Level 5, Block Diagram of Autonomous vehicle	1, 5	02	04
	Brief introduction on Technologies of AV, Modular Architecture of AV	5	02	

Module No. & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
2. Passive Perception	Passive Perception, Radar specification, FMCW radar, Finding range, Finding velocity of object using radar signal, Based on platform classification, Classification platform, range and requirement	2, 6	04	08
	mmWave radar deployment: Software (API) and hardware interface, Sonar Deployment	3, 4, 6	04	
3. Vehicle Communication System	Can Bus, CAN protocol layers, CAN message Format, CANopen, CANopenNode implementation flow chart	4, 5	03	06
	FlexRay, FlexRay topology, FlexRay communication Protocols		03	
4. Computer Vision	Hardware layers of vision system, Hardware Synchronization, Calibration, open source for calibration	2, 3, 4	03	07
	SLAM technique, Object Classification, detection using Neural networks	6	04	
5. Trajectory Planning and Control	TP&C architecture for AV, Path planning strategies, MDP	6	04	08
	Behavioural and motion Planning, Feedback control, PID controller and Auto tuning		04	
6. Case study	CASE study of L4 Autonomous Vehicle	2, 3,5	03	06
	Business Use cases: Tesla, Swayatta Robotics, Cruise		03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	42

Books:	
Text Books	Markus Maurer, J. hristian Gerde, Barbara Lenz, Hermann Winner, Autonomous Driving, Autonomous Driving, Springer publication, 2016 Xin Bi, Environmental Perception Technology for Unmanned Systems,

	Springer, 2021									
Reference Books	<ol style="list-style-type: none"> 1. Shaoshan Liu, Engineering Autonomous Vehicle and Robots, IEEE press, Wiley, 1st Edition 2020 2. Brooks Roodney, Cambrian Intelligence; The early history of New AI. MIT Press Bostorn, MA 									
Useful Links:										
<p>Virginia tech (2017). Automated vehicle crash rate comparison using naturalistic data. https://www.vtti.vt.edu/featured/?p=422</p> <p>Github. Mask R-CNN. https://github.com/matterport/Mask_RCNN</p> <p>Github Baidu Apollo. http://github.com/ApplloAuto/Apollo</p> <p>https://www.swaayatt-robots.com</p>										
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 – VI	Credits (TH+P+TUT)
EXDLC8034	Fundamentals of Data Science	3+0+0
Prerequisite:	<ol style="list-style-type: none"> 1. Basic Programming Knowledge 2. Knowledge of Machine Learning and Deep Learning 	
Course Objectives:	<ol style="list-style-type: none"> 1. To Identify the need for data science 2. To understand data collection methods 3. To apply Pre and post processing methods 4. To understand and implement the concept of exploratory data science and Data Mining. 	
Course Outcomes:	<ol style="list-style-type: none"> 1. Relate the concepts of python and mathematical concepts for data science 2. science 3. Solve and interpret the concept of exploratory data science and processing of data. 4. Explain the concept of optimization methods 5. Interpret the concept of Data Mining 	

	6. Explain and judge the models for Data Analysis 7. Illustrate the concept of Time Series Models for data science
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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 Data Science And Python Programming	1. Introduction to Data Science - Why Python? - Essential Python libraries - Python Introduction-Features, Identifiers, Reserved words, Indentation, Comments	1	01	07
	2. Built-in Data types and their Methods: Strings, List, Tuples, Dictionary, Set - Type Conversion-Operators. Libraries for Data analysis using Machine Learning and Deep Learning.		02	
	3. Decision Making- Looping- Loop Control statement- Math and Random number functions.		02	
	4. User defined functions - function arguments & its types. Reading and Writing Data in Text Format.		02	
2. Data Manipulation With Pandas	1. Introduction to pandas Data Structures: Series, Data Frame	2	01	06
	2. Essential Functionality: Dropping Entries-Indexing, Selection, and Filtering- Function Application and Mapping- Sorting and Ranking.		03	
	3. Summarizing and Computing Descriptive Statistics-Unique Values, Value Counts, and Membership.		02	
3. Data Cleaning, Preparation And Visualization	1. Data Cleaning and Preparation: Handling Missing Data, Data Transformation: Removing Duplicates, Transforming Data Using a Function or Mapping, Replacing Values, Detecting and Filtering Outliers	3	02	06
	2. String Manipulation: Vectorized String Functions in pandas.		02	
	3. Plotting with pandas: Line Plots,		02	

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Bar Plots, Histograms and Density Plots, Scatter or Point Plots.			
4. Data Mining and Machine Learning	1. What is Data Mining, Evolution of Data Mining, Why Data Mining? Knowledge-Based System, Data Mining Process, Phases of Data Mining Process,	4	02	08
	2. KDD Process Model, CRISP - DM, CRISP-DM – Elaborate view		01	
	3. Data Mining – On what kinds of Data? DM Tasks and Components of DM methods, Data mining operations, Data mining techniques.		02	
	4. Industry examples of application of DM, Challenges of Data Mining, and Why Machine should “Learn”? What is Machine Learning? Growth of Machine Learning, Machine Learning types, Unsupervised learning, Reinforcement Learning.		03	
Model Development and Evaluation	1. Simple and Multiple Regression, Model Evaluation using Visualization, Residual Plot, Distribution Plot, Polynomial Regression and Pipelines	5	02	06
	2. Measures for In-sample Evaluation, Prediction and Decision Making. Generalization Error, Out-of-Sample Evaluation Metrics, Cross Validation, Over fitting, Under Fitting		02	
	3. Model Selection, Prediction by using Ridge Regression, Testing Multiple Parameters by using Grid Search.		02	
Time Series Models	1. Autoregressive with exogenous(ARX), Autoregressive moving average(ARMAX)	6	03	06
	2. Autoregressive integrated moving average(ARIM), Extended version of ARIMA models		03	
ii.	Recap of Modules, Outcomes,	-	01	01

Module No & Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
Course Conclusion	Applications and Summarization.			
1				Tota 42

Books:										
Text Books	<ol style="list-style-type: none"> 1. David Dietrich, Barry Heller, and Beibei Yang, “Data Science and Big data Analytics”, EMC Education Service, 2015 2. A. Agresti, C. Franklin, B. Klingenberg, “Statistics: The Art and Science of Learning from Data”, Pearson. 2017. 3. Y. Daniel Liang, “Introduction to Programming using Python.”, Pearson, 2012 									
Reference Books	<ol style="list-style-type: none"> 1. P. Bruce and A. Bruce, “Practical Statistics for Data Scientists: 50+ Essential Concepts Using R and Python”, 2nd Edition, O'Reilly Media, Inc. 2. W. Hines, D. Montgomery, D. Goldman, C. Borror, “Probability and Statistics in Engineering,”, 4th Edition, Wiley India Pvt. Ltd., 2003 									
Useful Links:										
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/111/104/111104147/ 2. https://nptel.ac.in/courses/111/104/111104146/ 3. https://nptel.ac.in/courses/108/104/108104174/ 										
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	Institute Level Optional Course -II	Credits (TH+P+TUT)
ILC8041	Project Management	3 + 0 + 0
Course	1. To familiarize the students with the use of a structured	

Objectives:	<p>methodology/approach for each and every unique project undertaken, including utilizing project management concepts, tools and techniques.</p> <p>2. To appraise the students with the project management life cycle and make them knowledgeable about the various phases from project initiation through closure.</p>
Course Outcomes:	<p>1. Apply selection criteria and select an appropriate project from different options.</p> <p>2. Write work breakdown structure for a project and develop a schedule based on it.</p> <p>3. Identify opportunities and threats to the project and decide an approach to deal with them strategically.</p> <p>4. Use Earned value technique and determine & predict status of the project.</p> <p>5. Capture lessons learned during project phases and document them for future reference</p> <p>6. Inculcate leadership qualities and ethics</p>

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. Project Management Foundation	Definition of a project, Project Vs Operations, Necessity of project management, Triple constraints, Project life cycles (typical & atypical) Project phases and stage gate process. Role of project manager. Negotiations and resolving conflicts. Project management in various organization structures. PM knowledge areas as per Project Management Institute (PMI).	1	05	05
2. Initiating Projects	How to get a project started, Selecting projects strategically, Project selection models (Numeric /Scoring Models and Non-numeric models), Project portfolio process, Project sponsor and creating charter; Project proposal. Effective project team, Stages of team development & growth (forming, storming, norming & performing), team dynamics.	2	06	06
3. Project Planning and Scheduling	Work Breakdown structure (WBS) and linear responsibility chart, Interface Coordination and concurrent engineering, Project cost estimation	3	08	08

Module No. Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	and budgeting, Top down and bottoms up budgeting, Networking and Scheduling techniques. PERT, CPM, GANTT chart. Introduction to Project Management Information System (PMIS)			
4. Planning Projects	Crashing project time, Resource loading and leveling, Goldratt's critical chain, Project Stakeholders and Communication plan. Risk Management in projects: Risk management planning, Risk identification and risk register. Qualitative and quantitative risk assessment, Probability and impact matrix. Risk response strategies for positive and negative risks	4	06	06
5. Projects	1. Executing Projects: Planning, monitoring and controlling the cycle. Information needs and reporting, engaging with all stakeholders of the projects. Team management, communication and project meetings.	5	03	08
	2. Monitoring and Controlling Projects: Earned Value Management techniques for measuring value of work completed; Using milestones for measurement; change requests and scope creep. Project audit.		03	
	3. Project Contracting Project procurement management, contracting and outsourcing,		02	
6. Project Leadership and Ethics	1. Project Leadership and Ethics: Introduction to project leadership, ethics in projects. Multicultural and virtual projects.	6	03	06

Module No. Name	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	6.2 Closing the Project: Customer acceptance; Reasons of project termination, Various types of project terminations (Extinction, Addition, Integration, Starvation), Process of project termination, completing a final report; doing a lessons learned analysis; acknowledging successes and failures; Project management templates and other resources; Managing without authority; Areas of further study.		03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:										
Text Books	<ol style="list-style-type: none"> 1. Jack Meredith & Samuel Mantel, Project Management: A managerial approach, Wiley India, 7th Edition 2. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), 5th Ed, Project Management Institute PA, USA 									
Reference Books	<ol style="list-style-type: none"> 1. Gido Clements, Project Management, Cengage Learning. 2. Gopalan, Project Management, , Wiley India 3. Dennis Lock, Project Management, Gower Publishing England, 9th Edition 									
Useful Links:										
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/110/104/110104073/ 2. https://nptel.ac.in/courses/110/107/110107081/ 3. https://nptel.ac.in/noc/courses/noc19/SEM2/noc19-mg30/ 										
Continuous Assessment (CA):										
The distribution of Continuous Assessment marks will be as follows –										
<table border="1"> <tbody> <tr> <td>1.</td> <td>Class Test 1 (T-1)</td> <td>30 marks</td> </tr> <tr> <td>2.</td> <td>Class Test 2 (T-2)</td> <td>30 marks</td> </tr> <tr> <td>3.</td> <td>Internal Assessment</td> <td>10 marks</td> </tr> </tbody> </table>		1.	Class Test 1 (T-1)	30 marks	2.	Class Test 2 (T-2)	30 marks	3.	Internal Assessment	10 marks
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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 -II	Credits (TH+P+TUT)
ILC8042	Finance Management	3 + 0 + 0
Course Objectives:	1. To Overview of Indian financial system, instruments and market 2. To Understand Basic concepts of value of money, returns and risks, corporate finance working capital and its management 3. To gain Knowledge about sources of finance, capital structure, dividend policy	
Course Outcomes	1. Describe Indian financial system 2. Discuss basic concepts of returns and risks. 3. Use basic concepts of Time value of money. 4. Discuss sources of finance, capital structure, dividend policy 5 Discuss basic concepts of corporate finance 6 Use basic concepts of working capital management	

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 Indian Financial System	1 Characteristics, Components and Functions of Financial System.	1	01	06
	2 Financial Instruments: Meaning, Characteristics and Classification of Basic Financial Instruments — Equity Shares, Preference Shares, Bonds-Debentures, Certificates of Deposit, and Treasury Bills.		02	
	3 Financial Markets: Meaning, Characteristics and Classification of Financial Markets — Capital Market, Money Market and Foreign		02	

Module No. Name	Sub- Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	Currency Market			
	4 Financial Institutions: Meaning, Characteristics and Classification of Financial Institutions — Commercial Banks, Investment-Merchant Banks and Stock Exchanges		01	
2. Concepts of Returns and Risks & Time Value of Money	1 Measurement of Historical Returns and Expected Returns of a Single Security and a Two-security Portfolio; Measurement of Historical Risk and Expected Risk of a Single Security and a Two-security Portfolio.	2	03	06
	2 Future Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Present Value of a Lump Sum, Ordinary Annuity, and Annuity Due; Continuous Compounding and Continuous Discounting.		03	
3. Overview of Corporate Finance and Financial Ratio Analysis	1 Objectives of Corporate Finance; Functions of Corporate Finance— Investment Decision, Financing Decision, and Dividend Decision.	3	03	09
	2 Overview of Financial Statements— Balance Sheet, Profit and Loss Account, and Cash Flow Statement; Purpose of Financial Ratio Analysis; Liquidity Ratios; Efficiency or Activity Ratios; Profitability Ratios; Capital Structure Ratios; Stock Market Ratios; Limitations of Ratio Analysis.		06	
4. Capital Budgeting and Working Capital Management	1 Meaning and Importance of Capital Budgeting; Inputs for Capital Budgeting Decisions; Investment Appraisal Criterion—Accounting Rate of Return, Payback Period, Discounted Payback Period, Net Present Value (NPV), Profitability Index, Internal Rate of Return (IRR), and Modified Internal Rate	4	05	10

Module No. Name	Sub- Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs/ Module
	of Return (MIRR)			
	2 Concepts of Meaning Working Capital; Importance of Working Capital Management; Factors Affecting an Entity's Working Capital Needs; Estimation of Working Capital Requirements; Management of Inventories; Management of Receivables; and Management of Cash and Marketable Securities.		05	
5. Sources of Finance & Capital Structure	1 Long Term Sources—Equity, Debt, and Hybrids; Mezzanine Finance; Sources of Short-Term Finance—Trade Credit, Bank Finance, Commercial Paper; Project Finance.	5	02	05
	2 Factors Affecting an Entity's Capital Structure; Overview of Capital Structure Theories and Approaches— Net Income Approach, Net Operating Income Approach; Traditional Approach, and Modigliani-Miller Approach. Relation between Capital Structure and Corporate Value; Concept of Optimal Capital Structure		03	
6. Dividend Policy	Meaning and Importance of Dividend Policy; Factors Affecting an Entity's Dividend Decision; Overview of Dividend Policy Theories and Approaches—Gordon's Approach, Walter's Approach, and Modigliani-Miller Approach	6	03	03
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:	
Text Books	<ol style="list-style-type: none"> 1. Fundamentals of Fin Analysis for Financial Management, 10th Edition (2013) by Robert C. Higgins; Publishers: McGraw Hill Education, New Delhi. 2. Financial Management, 13th Edition (2015) by Eugene F. Brigham and

	Joel F. Houston; Publisher: Cengage Publications, New Delhi.									
References:	1. Indian Financial System, 9 th Edition (2015) by M. Y. Khan; Publisher: McGraw Hill Education, New Delhi. 2. Financial Management, 11 th Edition (2015) by I. M. Pandey; Publisher: S. Chand (G/L) & Company Limited, New Delhi.									
Useful Links:										
1. https://nptel.ac.in/courses/110/107/110107144/ 2. https://nptel.ac.in/courses/110/105/110105031/										
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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 -II	Credits (TH+P+TUT)
ILC8043	Entrepreneurship Development and Management	3 + 0 + 0
Prerequisites:	Fundamentals of Technology	
Course Objectives:	1. To Acquaint with Entrepreneurship and Management of Business. 2. To understand Indian environment for entrepreneurship. 3. To Ideate EDP, MSME. 4. To discuss the Government Plan for Start-up Business. 5. To analyze the Business Risk. 6. To discuss the Business Life Cycle.	
Course Outcomes:	Explain the concept of Business Plan and the Role of Money and Capital Markets in Entrepreneurial Development. Analyze Key regulations and legal aspects of entrepreneurship in India. Explain Government Policies for Start-up. Describe Different Government initiatives for Start-up. Explain Issues and Problems Faced by Micro and Small Enterprises. Describe Growth Strategies for small businesses.	

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topics	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Overview Of Entrepreneurship	1.1 Definitions, Roles and Functions/ Values of Entrepreneurship, History of Entrepreneurship Development.	1	01	04
	1.2 Role of Entrepreneurship in the National Economy, Functions of an Entrepreneur.	1	01	
	1.3 Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship.	1	02	
2. Business Plans and Importance of Capital to Entrepreneurship	2.1 Introduction: Preliminary and Marketing Plans, Management and Personnel.	2	02	09
	2.2 Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur.	2	03	
	2.3 Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business.	2	02	
	2.4 New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations.	2	02	
3. Entrepreneurship Development	Women's Entrepreneurship Development, Social Entrepreneurship-Role and Need, EDP Cell, Role of Sustainability and Sustainable Development for SMEs, Case	3	04	04

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topics	Total Hours
	Studies, Exercises.			
4. Indian Environment for Entrepreneurship	4.1 Key Regulations and Legal Aspects, MSMED Act 2006 and its Implications, Schemes and Policies of the Ministry of MSME, Role and Responsibilities of various Government Organisations, Departments, Banks etc.	4	03	09
	4.2 Role of State Governments in Terms of Infrastructure Developments and Support etc.	4	04	
	4.3 Public Private Partnerships, National Skill Development Mission, Credit Guarantee Fund, PMEGP, Discussions, Group Exercises etc.	4	02	
5. Effective Management of Business	5.1 Issues and Problems Faced by Micro and Small Enterprises and Effective Management of M and S Enterprises.	5	04	08
	5.2 Risk Management, Credit Availability, Technology Innovation, Supply Chain Management, Linkage with Large Industries, Exercises, E-Marketing.	5	04	
6. Achieving Success in The Small Business	Stages of the Small Business Life Cycle, Four Types of Firm-Level Growth Strategies, Options – Harvesting or Closing Small Business Critical Success Factors of Small Business.	6	05	05
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:										
Text Books:	<ol style="list-style-type: none"> 1. P Charantimath, Entrepreneurship Development- Small Business Enterprise, Pearson 2. R Hisrich and M Peters, Entrepreneurship, McGraw Hill Company. 3. D Kuratko, Entrepreneurship- Principles and Practices, Thomson Publication 									
Reference Books:	<ol style="list-style-type: none"> 1. Dr T Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi. 2. Law and Practice Relating to Micro, Small and Medium Enterprises, Taxmann Publication Ltd. 3. L Maddhurima, S Shikah, Entrepreneurship, Excel Books. 4. R Bansal ,STAY Hungry STAY Foolish, CIIE, IIM Ahmedabad 									
Useful Links:										
<ol style="list-style-type: none"> 1. www.msme.gov.in/ 2. www.dcmesme.gov.in/ 3. www.msmetraining.gov.in/ 										
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	Institute Level Optional Course -II	Credits (TH+P+TUT)
ILC8044	Human Resource Management	3 + 0 + 0
Prerequisites:	--	
Course Objectives:	<ol style="list-style-type: none"> 1. To introduce the students with basic concepts, techniques and practices of human resource management. 2. To provide an opportunity of learning Human resource management (HRM) processes, related with the functions, and challenges in the emerging perspective of today's organizations. 3. To familiarize the students about the latest developments, trends & 	

	<p>different aspects of HRM.</p> <p>4. To acquaint the student with the importance of inter-personal & inter-group behavioural skills in an organizational setting required for future stable engineers, leaders and managers.</p>
Course Outcomes:	<p>1. Describe the concepts, aspects, techniques and practices of human resource management.</p> <p>2. Describe the Human resource management (HRM) processes, functions, changes and challenges in today's emerging organizational perspective.</p> <p>3. Apply the knowledge about the latest developments and trends in HRM.</p> <p>4. Analyze the knowledge of Cross-cultural Leadership and Decision Making.</p> <p>5. Apply the knowledge of behavioural skills learnt and integrate it with in interpersonal and intergroup environment emerging as future stable engineers and managers.</p> <p>6. Apply the Labour Laws & Industrial Relations and various Act.</p>

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction Human Resource Management	1 Introduction to HR Human Resource Management-Concept, Scope and Importance, Interdisciplinary Approach Relationship with other Sciences, Competencies of HR Manager, HRM functions.	1	03	05
	2 Human resource development (HRD): changing role of HRM – Human resource Planning, Technological change, Restructuring and rightsizing, Empowerment, TQM, Managing ethical issues.	1	02	
2. Organizational Behaviour (OB)	1 Introduction to OB Origin, Nature and Scope of Organizational Behaviour, Relevance to Organizational Effectiveness and Contemporary issues.	2	02	07
	2 Personality: Meaning and Determinants of Personality, Personality development, Personality Types, Assessment of Personality Traits for Increasing Self Awareness.	2	01	
	3 Perception: Attitude and Value, Effect of perception on Individual	2	01	

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
	Decision-making, Attitude and Behavior.			
	4 Motivation: Theories of Motivation and their Applications for Behavioural Change (Maslow, Herzberg, McGregor);	2	01	
	5 Group Behaviour and Group Dynamics: Work groups formal and informal groups and stages of group development. Team Effectiveness: High performing teams, Team Roles, cross functional and self-directed team, Case study.	2	02	
3. Organizational Structure & Design	1 Structure, size, technology, Environment of organization; Organizational Roles & conflicts: Concept of roles; role dynamics; role conflicts and stress.	3	02	06
	2 Leadership: Concepts and skills of leadership, Leadership and managerial roles, Leadership styles and contemporary issues in leadership.	3	02	
	3 Power and Politics: Sources and uses of power; Politics at workplace, Tactics and strategies.	3	02	
4. Human resource Planning	1 Recruitment and Selection process, Job-enrichment, Empowerment - Job-Satisfaction, employee morale.	4	01	05
	2 Performance Appraisal Systems: Traditional & modern methods, Performance Counselling, Career Planning.	4 & 6	02	
	3 Training & Development: Identification of Training Needs, Training Methods.	4	02	
5. Emerging Trends in HR	1 Organizational development; Business Process Re-engineering (BPR), BPR as a tool for organizational development, managing processes & transformation in HR.	4	03	06

Module No. & Name	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
	Organizational Change, Culture, Environment.			
	2 Cross Cultural Leadership and Decision Making: Cross Cultural Communication and diversity at work, Causes of diversity, managing diversity with special reference to handicapped, women and ageing people, intra company cultural difference in employee motivation.	5	03	
6. Strategic HRM	1 HR & MIS: Need, purpose, objective and role of information system in HR, Applications in HRD in various industries (e.g. manufacturing R&D, Public Transport, Hospitals, Hotels and service industries.	6	04	10
	2 Strategic HRM: Role of Strategic HRM in the modern business world, Concept of Strategy, Strategic Management Process, Approaches to Strategic Decision Making; Strategic Intent – Corporate Mission, Vision, Objectives and Goals	6	03	
	3 Labour Laws & Industrial Relations: Evolution of IR, IR issues in organizations, Overview of Labour Laws in India; Industrial Disputes Act, Trade Unions Act, Shops and Establishments Act.	6	03	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:	
Text Books	<ol style="list-style-type: none"> 1. S. Robbins, Organizational Behaviour, Pearson Education Limited. 2. V.S.P. Rao, Human Resource Management, Excel publishing. 3. K. Aswathapa, Human resource management: Text & cases.
Reference Books	<ol style="list-style-type: none"> 1. C. B. Mamoria and S. V. Gankar, Dynamics of Industrial Relations in India, Himalaya Publishing. 2. P. Subba Rao, Essentials of Human Resource management and Industrial relations, Himalaya Publishing.

	3. L. Mullins, Management & Organizational Behaviour, Pearson Publications.									
Useful Links:										
1. https://www.nptel.ac.in/ 2. https://www.coursera.org/ 3. https://nptel.ac.in/courses/110/105/110105069/ 4. https://nptel.ac.in/courses/122/105/122105020/										
Continuous Assessment (CA):										
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Internal Assessment(IA):										
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End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.										

Course Code	Institute Level Elective Course -II	Credits (TH+P+TUT)
ILC8045	Professional Ethics and Corporate Social Responsibility (CSR)	3 + 0 + 0
Course Objectives:	1. To understand professional ethics in business 2. To recognized corporate social responsibility	
Course Outcomes:	Explain rights and duties of business Explain and understand the ethics in market and towards environment Solve the problems of consumers and job discrimination ethically Show corporate and social responsibility Distinguish different aspects of corporate social responsibility 6. Explain global aspects of corporate social responsibility	

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hours
i. Prerequisite and	Prerequisite Concepts and Course	-	02	02

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hours
Course outline	Introduction			
1. Professional Ethics and Business	The Nature of Business Ethics; Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business	1	04	04
2. Professional Ethics in the Marketplace	Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy Professional Ethics and the Environment: Dimensions of Pollution and Resource Depletion; Ethics of Pollution Control; Ethics of Conserving Depletable Resources	3	08	08
3. Professional Ethics of Consumer Protection	Markets and Consumer Protection; Contract View of Business Firm's Duties to Consumers; Due Care Theory; Advertising Ethics; Consumer Privacy Professional Ethics of Job Discrimination: Nature of Job Discrimination; Extent of Discrimination; Reservation of Jobs.	3	06	06
4. Introduction to Corporate Social Responsibility:	Potential Business Benefits—Triple bottom line, Human resources, Risk management, Supplier relations; Criticisms and concerns—Nature of business; Motives; Misdirection. Trajectory of Corporate Social Responsibility in India	2	05	05
5. Corporate Social Responsibility	Articulation of Gandhian Trusteeship Corporate Social Responsibility and Small and Medium Enterprises (SMEs) in India, Corporate Social Responsibility and Public-Private Partnership (PPP) in India	2	08	08
6. Corporate Social Responsibility in Globalizing India	Corporate Social Responsibility Voluntary Guidelines, 2009 issued by the Ministry of Corporate Affairs, Government of India, Legal Aspects of Corporate Social Responsibility—Companies Act, 2013.	4	08	08

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hours
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:		
Text Books	1. Business Ethics: Texts and Cases from the Indian Perspective (2013) by Ananda Das Gupta; Publisher: Springer.	
Reference Books	1. Corporate Social Responsibility: Readings and Cases in a Global Context (2007) by Andrew Crane, Dirk Matten, Laura Spence; Publisher: Routledge. 2. Business Ethics: Concepts and Cases, 7th Edition (2011) by Manuel G. Velasquez; Publisher: Pearson, New Delhi. 3. Corporate Social Responsibility in India (2015) by Bidyut Chakrabarty, Routledge, New Delhi.	
Useful Links:		
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Continuous Assessment (CA):		
The distribution of Continuous Assessment marks will be as follows –		
	1. Class Test 1 (T-1)	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 -II	Credits (TH+P+TUT)
I LC8046	Research Methodology	3 + 0 + 0
Prerequisites:	Basic level knowledge of research	
Course Objectives:	1. To understand Research and Research Process 2. To acquaint students with identifying problems for research and develop	

	<p>research strategies</p> <p>3. To familiarize students with the techniques of data collection, analysis of data and interpretation.</p>
Course Outcomes:	<p>1. Describe about the methodologies in research</p> <p>2. Prepare a preliminary research design for projects in their subject matter areas.</p> <p>3. Accurately collect, analyze and report data.</p> <p>4. Present complex data or situations clearly.</p> <p>5. Review and analyze research findings.</p> <p>6. Summarize the different aspects and steps in conducting research.</p>

Module	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction and Basic Research Concepts	1 Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology	1	2	09
	2 Need of Research in Business and Social Sciences		2	
	3 Objectives of Research		1	
	4 Issues and Problems in Research		2	
	5 Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical		2	
2. Types of Research	1 Basic Research	2	1	07
	2 Applied Research		1	
	3 Descriptive Research		1	
	4 Analytical Research		1	
	5 Empirical Research		1	
	6 Qualitative and Quantitative Approaches		2	
3. Research Design and Sample Design	1 Research Design – Meaning, Types and Significance	1	4	07
	2 Sample Design – Meaning and Significance Essentials of a good sampling Stages in Sample Design Sampling methods/techniques Sampling Errors		3	
4. Research Methodology	1 Meaning of Research Methodology	2	1	08
	2 Stages in Scientific Research Process: a. Identification and Selection of		7	

Module	Sub Topics	COs Mapped	Hours/ Sub Topic	Total Hours
	Research Problem b. Formulation of Research Problem c. Review of Literature d. Formulation of Hypothesis e. Formulation of research Design f. Sample Design g. Data Collection h. Data Analysis i. Hypothesis testing and Interpretation of Data j. Preparation of Research Report			
5. Formulating Research Problem	Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis	4	4	04
6. Outcome of Research	1 Preparation of the report on conclusion reached	3	2	04
	2 Validity Testing & Ethical Issues		1	
	3 Suggestions and Recommendation		1	
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total	42

Books:		
Text Books	C. Kothari, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited, 1985.	
Reference Books	C. Dawson, Practical Research Methods, New Delhi, UBS Publishers Distributors, 2002. R. Kumar, Research Methodology-A Step-by-Step Guide for Beginners, 2nd edition, Singapore, Pearson Education, 2005.	
Useful Links:		
https://libguides.newcastle.edu.au/researchmethods https://nptel.ac.in/courses/121/106/121106007/		
Continuous Assessment (CA):		
The distribution of Continuous Assessment marks will be as follows –		
1.	Class Test 1 (T-1)	30 marks
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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 -II	Credits (TH+P+TUT)
ILC8047	IPR and Patenting	3 + 0 + 0
Course Objectives:	1. To understand intellectual property rights protection system 2. To promote the knowledge of Intellectual Property Laws of India as well as International treaty procedures 3. To get acquaintance with Patent search and patent filing procedure and applications	
Course Outcomes:	Explain Intellectual Property assets Explain the enforcements in IPR Investigate the issues in IPR. Illustrate basics of patent. Explain the patent rules 6. Apply the procedure of filing patent nationally and internationally	

Module No. & Name	Sub Topics	CO Mapped	Hour/ Sub Topic	Total Hours
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction to Intellectual Property Rights (IPR)	Meaning of IPR, Different categories of IPR instruments - Patents, Trademarks, Copyrights, Industrial Designs, Plant variety protection, Geographical indications, Transfer of technology etc. Importance of IPR in Modern Global Economic Environment: Theories of IPR, Philosophical aspects of IPR laws, Need for IPR, IPR as an instrument of development	1	05	05
2. Enforcement of Intellectual Property Rights	Introduction, Magnitude of problem, Factors that create and sustain counterfeiting/piracy, International agreements, International organizations (e.g. WIPO, WTO) active in IPR	2	07	07

Module No. & Name	Sub Topics	CO Mapped	Hour/ Sub Topic	Total Hours
	enforcement Indian Scenario of IPR: Introduction, History of IPR in India, Overview of IP laws in India, Indian IPR, Administrative Machinery, Major international treaties signed by India, Procedure for submitting patent and Enforcement of IPR at national level etc.			
3. Emerging Issues in IPR	Challenges for IP in digital economy, e-commerce, human genome, biodiversity and traditional knowledge etc.	2	05	05
4. Basics of Patents	Definition of Patents, Conditions of patentability, Patentable and non-patentable inventions, Types of patent applications (e.g. Patent of addition etc), Process Patent and Product Patent, Precautions while patenting, Patent specification Patent claims, Disclosures and non-disclosures, Patent rights and infringement, Method of getting a patent	3	07	07
5. Patent Rules	Indian patent act, European scenario, US scenario, Australia scenario, Japan scenario, Chinese scenario, Multilateral treaties where India is a member (TRIPS agreement, Paris convention etc.)	3	08	08
6. Procedure for Filing a Patent (National and International)	Legislation and Salient Features, Patent Search, Drafting and Filing Patent Applications, Processing of patent, Patent Litigation, Patent Publication, Time frame and cost, Patent Licensing, Patent Infringement Patent databases: Important websites, Searching international databases	3	07	07
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
			Total:	42

Books:	
Text Books	<ol style="list-style-type: none"> 1. Rajkumar S. Adukia, 2007, A Handbook on Laws Relating to Intellectual Property Rights in India, The Institute of Chartered Accountants of India 2. Keayla B K, Patent system and related issues at a glance, Published by National Working Group on Patent Laws 3. T Sengupta, 2011, Intellectual Property Law in India, Kluwer Law International

	<ol style="list-style-type: none"> 4. Tzen Wong and Graham Dutfield, 2010, Intellectual Property and Human Development: Current Trends and Future Scenario, Cambridge University Press 5. Cornish, William Rodolph & Llewelyn, David 2010, Intellectual Property: Patents, Copyrights, TradeMarks and Allied Right, 7th Edition, Sweet & Maxwell 									
Reference Books:	<ol style="list-style-type: none"> 1. Lous Harns, 2012, The enforcement of Intellectual Property Rights: A Case Book, 3rd Edition, WIPO 2. Prabhuddha Ganguli, 2012, Intellectual Property Rights, 1st Edition, TMH 3. R Radha Krishnan & S Balasubramanian, 2012, Intellectual Property Rights, 1st Edition, Excel Books 4. M Ashok Kumar and mohd Iqbal Ali, 2-11, Intellectual Property Rights, 2nd Edition, Serial Publications 5. Kompal Bansal and Praishit Bansal, 2012, Fundamentals of IPR for Engineers, 1st Edition, BS Publications 6. Entrepreneurship Development and IPR Unit, BITS Pilani, 2007, A Manual on Intellectual Property Rights, 7. Mathew Y Maa, 2009, Fundamentals of Patenting and Licensing for Scientists and Engineers, World Scientific Publishing Company 8. N S Rathore, S M Mathur, Priti Mathur, Anshul Rathi, IPR: Drafting, Interpretation of Patent Specifications and Claims, New India Publishing Agency 9. Vivien Irish, 2005, Intellectual Property Rights for Engineers, IET 10. Howard B Rockman, 2004, Intellectual Property Law for Engineers and scientists, Wiley- IEEE Press 									
Useful Links:										
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/110/105/110105139/ 2. https://nptel.ac.in/courses/109/105/109105112/ 										
Continuous Assessment (CA):										
The distribution of Continuous Assessment marks will be as follows –										
<table border="1"> <tr> <td>1.</td> <td>Class Test 1 (T-1)</td> <td>30 marks</td> </tr> <tr> <td>2.</td> <td>Class Test 2 (T-2)</td> <td>30 marks</td> </tr> <tr> <td>3.</td> <td>Internal Assessment</td> <td>10 marks</td> </tr> </table>		1.	Class Test 1 (T-1)	30 marks	2.	Class Test 2 (T-2)	30 marks	3.	Internal Assessment	10 marks
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 -II	Credits (TH+P+TUT)
ILC8048	Digital Business Management	3 + 0+ 0
Prerequisite:	Business Intelligence	
Course Objectives:	<ol style="list-style-type: none"> 1. To familiarize with digital business concept 2. To acquaint with E-commerce 3. To give insights in to E-business and its strategies 	
Course Outcomes:	<ol style="list-style-type: none"> 1. Identify drivers of digital business 2. Reviewing the concepts of E-commerce 3. Devise the services of Digital Business 4. Illustrate various techniques of managing E-business 5. Illustrate various approaches of E-business Strategy 6. Prepare E-business Plan 	

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 Digital Business	<p>Introduction to Digital Business Introduction, Background and current status, E-market places, structures, mechanisms, economics and impacts Difference between physical economy and digital economy. Drivers of digital business- Big Data & Analytics, Mobile, Cloud Computing, Social media, BYOD, and Internet of Things (digitally intelligent machines/services) Opportunities and Challenges in Digital Business.</p>	1	09	09
2. Overview of E-Commerce	<p>Meaning, Retailing in e-commerce-products and services, consumer behaviour, market research and advertisement B2B-E-commerce-selling and buying in private e-markets, public B2B exchanges and support services, e-supply chains, Collaborative Commerce, Intra business EC and Corporate portals Other E-C models and applications, innovative EC System-From E-government and learning to C2C, mobile</p>	2	06	06

Module No. & Name	Sub Topics	CO Mapped	Hrs./ Sub Topic	Total Hrs/ Module
	commerce and pervasive computing EC Strategy and Implementation-EC strategy and global EC, Economics and Justification of EC, Using Affiliate marketing to promote your e-commerce business, Launching a successful online business and EC project, Legal, Ethics and Societal impacts of EC.			
3. Digital Business Support services	ERP as e –business backbone, knowledge Tope Apps, Information and referral system Application Development: Building Digital business Applications and Infrastructure.	3	06	06
4. Managing E-Business	Managing Knowledge, Management skills for e-business, Managing Risks in e –business Security Threats to e-business - Security Overview, Electronic Commerce Threats, Encryption, Cryptography, Public Key and Private Key Cryptography, Digital Signatures, Digital Certificates, Security Protocols over Public Networks: HTTP, SSL, Firewall as Security Control, Public Key Infrastructure (PKI) for Security, Prominent Cryptographic Applications.	4	06	06
5. E-Business Strategy	E-business Strategic formulation-Analysis of Company’s Internal and external environment, Selection of strategy, E-business strategy into Action, challenges and E-Transition (Process of Digital Transformation).	5	04	04
6. Materializing e-business	From Idea to Realization-Business plan preparation Case Studies and presentations	6	08	08
ii. Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	-	01	01
Total:				42

Books:	
Text Books	<ol style="list-style-type: none"> 1. A textbook on E-commerce, Er. Arunrajan Mishra, Dr. W K Sarwade, Neha Publishers & Distributors, 2011 2. Digital Business and E-Commerce Management, 6th Ed, Dave Chaffey, Pearson, August 2014 3. Digital Business Concepts and Strategy, Eloise Coupey, 2nd Edition, Pearson 4. Perspectives the Digital Enterprise –A framework for Transformation, TCS consulting journal Vol.5 5. Measuring Digital Economy-A new perspective DoI:10.1787/9789264221796-enOECD Publishing
Reference Books	<ol style="list-style-type: none"> 1. E-commerce from vision to fulfilment, Elias M. Awad, PHI-Restricted, 2002 2. Introduction to E-business-Management and Strategy, Colin Combe, ELSEVIER, 2006 3. Trend and Challenges in Digital Business Innovation, Vincenzo Morabito, Springer. 4. Digital Business Discourse Erika Darics, April 2015, Palgrave Macmillan. 5. 5. E-Governance-Challenges and Opportunities in : Proceedings in 2nd International Conference theory and practice of Electronic Governance
Useful Links:	
<ol style="list-style-type: none"> 1. https://nptel.ac.in/courses/110/105/110105083/ 2. https://onlinecourses.nptel.ac.in/noc19_mg54/preview 	

<p>Continuous Assessment (CA): The distribution of Continuous Assessment marks will be as follows –</p> <table border="1" data-bbox="566 1371 1053 1486"> <tbody> <tr> <td>1.</td> <td>Class Test 1 (T-1)</td> <td>30 marks</td> </tr> <tr> <td>2.</td> <td>Class Test 2 (T-2)</td> <td>30 marks</td> </tr> <tr> <td>3.</td> <td>Internal Assessment</td> <td>10 marks</td> </tr> </tbody> </table> <p>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.</p> <p>Internal Assessment(IA): Marks will be allotted as per designed rubrics.</p> <p>End Semester Theory Examination will be of 60 Marks with Two Hours and 30 Minutes duration.</p>	1.	Class Test 1 (T-1)	30 marks	2.	Class Test 2 (T-2)	30 marks	3.	Internal Assessment	10 marks
1.	Class Test 1 (T-1)	30 marks							
2.	Class Test 2 (T-2)	30 marks							
3.	Internal Assessment	10 marks							

Course Code	Institute Level Optional Course -II	Credits (TH+P+TUT)
ILC8049	Environmental Management	3 + 0 + 0
Prerequisites:	General Awareness of environment and factors affecting the environment.	
Course Objectives:	<ol style="list-style-type: none"> 1. To understand and identify environmental issues relevant to India and global concerns 2. To learn concepts of ecology 3. To familiarise environment related legislations 4. To understand to protect and sustain our natural resources of land, water, air, and vegetation. 	
Course Outcomes:	<ol style="list-style-type: none"> 1. Interpret the concept of environmental management 2. Learn the ecosystem and interdependence, food chain etc. and interpret environment related legislations 3. Identify the environmental issues important to India 4. Learn the regulating policies of Government in environmental management 5. Identify solutions to protect the environment from pollution 6. Examine the quality environmental management 	

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs
i. Prerequisite and Course outline	Prerequisite Concepts and Course Introduction	-	02	02
1. Introduction and Definition of Environment	1 Significance of Environment Management for contemporary managers	1	02	10
	2 Career opportunities		01	
	3 Environmental issues relevant to India		02	
	4 Sustainable Development		03	
	5 The Energy scenario		02	
2. Global Environmental concerns	1 Global Warming	4	01	06
	2 Acid Rain		01	
	3 Ozone Depletion		01	
	4 Hazardous Wastes		30 min	
	5 Loss of Biodiversity		30 min	
	6 Industrial/Man-made		01	
	7 Industrial/Man-made disasters / Atomic / Biomedical hazards, etc		01	
3. Concepts of Ecology	1 Ecosystems and interdependence between living organisms	2	01	05
	2 Habitats		30 min	
	3 Limiting factors		30 min	

Module	Sub Topics	CO Mapped	Hrs/ Sub Topic	Total Hrs
	4 Carrying capacity		01	
	5 Food chain		01	
	5 Ecology		01	
4. Scope of Environment Management	1 Scope of Environment Management	5	03	10
	2 Role and functions of Government as a planning and regulating agency		03	
	3 Environment Quality Management and Corporate Environmental		04	
5. Quality Environmental Management	1 Total Quality Environmental Management	1	02	05
	2 ISO-14000		02	
	3 EMS certification		01	
6. General overview of major legislations	Environment Protection Act, Air (P & CP) Act, Water (P & CP) Act, Wildlife Protection Act, Forest Act, Factories Act	3	03	03
Course Conclusion	Recap of Modules, Outcomes, Applications and Summarization.	0	01	01
			Total	42

Books:	
Text Books	<ol style="list-style-type: none"> 1. Environmental Management: Principles and Practice, C J Barrow, Routledge Publishers London, 1999 2. A Handbook of Environmental Management Edited by Jon C. Lovett and David G. Ockwell, Edward Elgar Publishing 3. Environmental Management V Ramachandra and Vijay Kulkarni, TERI Press
Reference Books	<ol style="list-style-type: none"> 1. Indian Standard Environmental Management Systems — Requirements With Guidance For Use, Bureau Of Indian Standards, February 2005 2. Introduction to Environmental Management, Mary K Theodore and Louise Theodore, CRC 3. Environment and Ecology, Majid Hussain, 3rd Ed. Access Publishing.2015 4. Environmental Management: An Indian Perspective, S N Chary and Vinod Vyasulu, Macmillan India, 2000
Useful Links:	
<ol style="list-style-type: none"> 1. https://libguides.library.qut.edu.au/EVB302_Environmental_pollution/links 2. https://www.epd.gov.hk/epd/epic/english/epichome.html 3. http://www.ecovacservices.com/Useful-Links-6-5511.html 	
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 (P+TUT)
EXL801	Optical Communication Network Laboratory	1+0

Lab Prerequisite:	<ol style="list-style-type: none"> Principles of Communication Engineering Electromagnetics and Antenna Digital Communication
Lab Objectives:	<ol style="list-style-type: none"> To understand the optical fiber communication concepts, essentials, structures wave guide, and signal degradation in fiber. To understand the characteristics of optical sources and detectors. To understand Link budget and optical networks, design and management. To Study the multiplexing schemes.
Lab Outcomes:	<ol style="list-style-type: none"> Analyze Performance of Optical Link Calculate dispersion, NA for given fiber Calculate link Loss for given link Analyze optical component performance Write 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	To perform analog and digital link with different source and receiver.	1,5,6	02
2	Calculation of Numerical aperture	2,5,6	02
3	To Measure bending loss	3,5,6	01

Lab No.	Experiment Title	LO Mapped	Hrs/ Lab
4	To Measure transmission loss.	3,5,6	01
5	Performance Analysis of Optical Amplifier.	4,5,6	02
6	Performance Analysis of Optical Link with Different source	4,5,6	02
7	Performance Analysis of Optical Link with Different Detectors	4,5,6	02
8	Calculation of link Loss for given link with nonlinearities	3,5,6	02
9	Performance analysis of WDM system using EDF amplifier	4,5,6	02
10	Performance Analysis of OTDM	4,5,6	02
11	Average soliton regime	1	02
12	System Design – Power Budget	3,5,6	02
13	Observe performance of Broadcast Star Coupler	4,5,6	02
14	Optical cross-connect (OXC)	4,5,6	02
15	To perform analog and digital link with different source and receiver.	1,5,6	02
Total			28

<p>Suggested Software List:</p> <ol style="list-style-type: none"> 1. Matlab 2. OptiPerformer (Student version) 3. Comsol 	
<p>Term work:</p> <ol style="list-style-type: none"> 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) 	
<p>Oral/Practical/P&O :</p> <p>Oral examination will be based on entire theory syllabus and carries 25 Marks.</p>	

Course Code	Department Level Elective Course – V Laboratory	Credits (P+TUT)
EXDLL8021	Augmented Reality & Virtual Reality Laboratory	1+0

Lab Prerequisite:	Image Processing and Machine Vision
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Lab Objectives:	<p>To learn the background of VR including a brief history of VR, different forms of VR and related technologies, and a broad overview of some of the most important concepts.</p> <p>To provide background in perception to educate VR creators on concepts and theories of how we perceive and interact with the world around us.</p> <p>To make learners aware of high-level concepts for designing/building assets and how subtle design choices can influence user behaviour.</p> <p>Learning about art for VR and AR should be optimized for spatial displays with spatially aware input devices to interact with digital objects in true 3D.</p>
Lab Outcomes:	<p>To design small ARVR system applications.</p> <p>Gain insights into AR/VR industrial applications and future technologies like mixed reality.</p> <p>Setup development Environment for projects.</p> <p>Discuss Resources of ARVR system.</p> <p>5. Write accurate documentation for experiments performed.</p> <p>Apply ethical principles like timeliness and adhere to the rules of the laboratory.</p>

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Setup development environment for projects using Unity	3,5,6	02
2	Study of Sensors and actuators in AR/VR system	4,5,6	02
3	Write a Script code using Unity	3,5,6	02
4	Use of Graphics in 2D/3D using Unity	1, 5, 6	02
5	Create various Joints/ Colliders using Unity	1,5,6	02
6	Use of navigation and path finding feature in Unity	1,5,6	02
7	Unity with C# to code 2D / 3D games for computers/ mobile	1,5,6	02
8	Building a project using IL2CPP	1,5,6	02
9	Case Study/Mini Project	1 to 6	10
Total			28

<p>Virtual Lab Links:</p> <p>1. Download and Install Unity-</p>
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<https://docs.unity3d.com/560/Documentation/Manual/InstallingUnity.html>

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.

Course Code	Department Level Elective Course – V Laboratory	Credits (P+TUT)
EXDLL8022	5G Technology Laboratory	1+0

Lab Prerequisite:	Wireless Networks Lab
Lab Objectives:	<ol style="list-style-type: none"> 1. To Implement basic multiple access techniques used in 5G technology. 2 To Simulate 5G Network Model. 3. To Implement basic beamforming in 5G technology 4.To detect signal in 5G technology
Lab Outcomes:	<ol style="list-style-type: none"> 1. Implement basic multiple access techniques used in 5G technology. 2 Simulate 5G Network Model. 3. Implement basic beamforming in 5G technology 4.Detect signal in 5G technology 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 find Antenna diversity in 5G	1,5,6	02
2	Implement MIMO system	1,5,6	02
3	Implement SU Massive MIMO	4,5,6	02
4	Find Spatial Diversity, Spatial Multiplexing	3,5,6	02
5	Implement Beamforming in 5G	3,5,6	02
6	Implement Channel Estimation IN wireless communication	2,5,6	02
7	Write a program Signal Detection in 5G	4,5,6	02
8	Wire a program for LDPC	2,5,6	02

9	Perform simulation of 5G network	4,5,6	02
10	Mini project performance can be based on different basic modulation schemes used, coding techniques, propagation parameters	2,5,6	08
Total			28

Virtual Lab Links:	
1. http://simu5g.org/	
2. https://ourtechplanet.com/5g-rf-design-planning-fundamentals/	
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.	

Course Code	Department Level Elective Course – V Laboratory	Credits (P+TUT)
EXDLL8023	System on Chip Laboratory	1+0

Lab Prerequisite:	1. Digital VLSI 2. Project Based Learning II
Lab Objectives:	1. To design digital systems using SoC 2. To analyze the performance of digital systems implemented using different design methodologies
Lab Outcomes:	After taking the course students will be able to, 1. Design and implement systems with RTL design using verilog. 2. Design and implement systems software logic on the 3. Design digital systems with software- hardware co-design. 4. Interface Peripherals to the PL and PS of SoC. 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 an application to blink an LED.	2,4,5,6	02
2	Write an application to display different values on LEDs and verify it to be working	2,4,5,6	02
3	Write a software application to add 2 numbers and display their sum	2,4,5,6	02
4	Develop an accelerator which accepts start address, num of words as inputs and reads corresponding number of data from BRAM, adds them and displays on LED	3,4,5,6	02
5	Design a 4-bit wrap-around counter that increments every one second. The counter value is shown on the LEDS	1,4,5,6	02
6	Design a debouncer circuit switch	1,4,5,6	02
7	Design a counter with a button parser	1,5,6	02
8	Design an accumulator with memory block	1,5,6	02
9	Design a calculator that can perform some basic functionalities such as load, store, and sum of two operands	1,5,6	02
10	Design an UART transmitter	1,5,6	02
11	Design an UART receiver	1,5,6	02
12	Design a module that interfaces with Digi-lent video IP to draw a triangle to a monitor	1,4,5,6	02
13	Interfacing between PS and PL	3,5,6	02
14	Flash LED using timer	3,4,5,6	02
15	Design a system that will light an LED in response to a user input, but at the same time flash another LED at a frequency of 1Hz	3,4,5,6	02
16	Implement an interrupt based design to send and receive data from the external board via SPI	3,4,5,6	02
Total			34*
*Minimum 28 Hrs. Lab / Mini Project to be conducted			

<p>Term work:</p> <ol style="list-style-type: none"> 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)
<p>Oral/Practical/P&O :</p> <p>Oral examination will be based on entire theory syllabus and carries 25 Marks.</p>

Course Code	Department Level Elective Course – V Laboratory	Credits (P+TUT)
EXDLL8024	Web Designing Laboratory	1+0

Lab Prerequisite:	1. Data Structures 2. Basics of Programming Languages
Lab Objectives:	1. To design and create web pages using HTML5 and CSS3 2. To Create web pages and provide client side validation 3. To create dynamic web pages using server side scripting 4. To use MVC framework for web application development
Lab Outcomes:	Apply the concept of client side validation and design static web pages using 1. HTML5 and CSS3 and dynamic web pages using JavaScript and JQuery. 2. Evaluate client and server side technologies and create Interactive web pages using PHP, AJAX with database connectivity using MySQL. 3. Apply the basics of XML, DTD and XSL and develop web pages using XML/ XSLT. 4. Analyze end user requirements and Create web application using appropriate web technologies and web development framework 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the 7. Laboratory.

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Installation and Setting of LAMP / WAMP / XAMP	1,5,6	02
2	Create Simple web page using HTML5	1,5,6	02
3	Design and Implement web page using CSS3 and HTML5	1,5,6	02
4	Form Design and Client Side Validation using: a. Javascript and HTML5 b. Javascript and JQuery	1,2,5,6	02
5	Develop simple web page using PHP	2,5,6	02
6	Develop interactive web pages using PHP with database connectivity MYSQL	3,5,6	02
7	Develop XML web page using DTD, XSL	3,5,6	02
8	To implement MVC architecture	4,5,6	02
9	Implement a webpage using Ajax and PHP	2,5,6	02
10	Hosting the website with Domain Registration Process	4,5,6	02

11	Design a Web application using Laravel Framework	4,5,6	02
12	Case Study / Mini Project	1 to 6	04
Total			28

Mini Project:

Setting up /buying the web host management system for hosting of mini project is recommended

Virtual Lab Links:

1. www.nptelvideos.in
2. www.w3schools.com
3. <http://spoken-tutorial.org>

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 – VI Laboratory	Credits (P+TUT)
EXDLL8031	Natural Language Processing Laboratory	1+0
Lab Prerequisite:	<ol style="list-style-type: none"> 1. Python 2. R Language 	
Lab Objectives:	<ol style="list-style-type: none"> 1. To implement basic algorithms of NLP. 2. To apply N Gram to the Text. 3. To implement Semantics of the Text using NLP algorithms 4. To apply different NLP techniques to the Indian Languages 	
Lab Outcomes:	<ol style="list-style-type: none"> 1. Apply the basic algorithms using Python. 2. Implement the grammar rules of NLP to the text and test the results 3. Implement the error free Language reading by applying suitable algorithms 4. Implement the NLP techniques to real life applications. 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	Pre-processing of Text (Tokenization,), filtration, Script Validation, Stop word removal, Stemming	1,5,6	02
2	Morphological Analysis	2,5,6	02
3	N-Gram Model	2,5,6	02
4	POS Tagging	2,5,6	02
5	Chunking	3,5,6	02
6	Named Entity Recognition	4,5,6	02
7	Case Studies (Proposed case studies)	4,5,6	14
	a) Sentiment Analysis / Opinion Mining Gauge attitude / sentiments / evaluations / emotions of a speaker or chat		
	b) CV parsing Shortlisting Candidate Automated Interview		
	c) Clause classification in legal contracts Contract Making		
	d) Automate response to RFP Tender Filing		
	e) Concept extraction from legal / lease documents Risk Analysis		
	f) Text summarization Evaluation, Automated Paper Correction		
	g) Meeting analyzer / Meeting notes summary generation MOM		
h) Automatic email response, Office Efficiency			
Total			28

Virtual Lab Links:
http://cse24-iiith.virtual-labs.ac.in/#
Term Work:
<ol style="list-style-type: none"> 1. Term work should consist of a minimum of 6 experiments and a Case Study 2. Journal must include contents on practical performance and a report on case study 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. Total 25 Marks (Experiments: 15-marks, Assignments/Case study/demo/presentation: 10-marks) 4. A practical/Oral exam of 25 marks will be conducted at the end of the semester.

Oral/Practical/P&O :

Practical examination will be based on experiment list and performance of experiment.

Course Code	Department Level Elective Course – VI Laboratory	Credits (P+TUT)
EXDLL8032	RF Design Laboratory	1+0

Lab Prerequisite:	<ol style="list-style-type: none"> 1. Electromagnetic and Antenna Laboratory 2. Principles of Communication Engineering Laboratory 3. Microwave Engineering Laboratory
Lab Objectives:	<ol style="list-style-type: none"> 1. To learn the concept of impedance matching and RF filters. 2. To learn Microwave amplifiers. 3. To learn RF and Microwave oscillators. 4. To learn of the RF mixer. 5. To learn of the EMI/EMC.
Lab Outcomes:	<p>Analyze impedance matching networks using any simulation software. Analyze RF filters, amplifiers and oscillators using any simulation software. Analyze RF mixer using any simulation software. Explain the concept of EMI/EMC. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory.</p>

Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	To Study the non-ideal characteristics of Lumped elements using spectrum/network analyser.	1,5,6	02
2	Analysis of the Low-Pass and High pass composite filter design using simulation software.	1,2,5,6	02
3	Analysis of the filter design by Insertion Loss method using simulation software.	1, 2,5,6	02
4	Study the impedance matching in case of real and imaginary loads using simulation software.	1,5,6	02
5	Analysis of a Low Noise Amplifier (LNA) using simulation software.	2,5,6	02
6	Analysis of Microwave Oscillator using simulation software and its demonstration using spectrum analyser.	2,5,6	02
7	Measurement of gain factor & tunable bandwidth of voltage control oscillator (VCO) using spectrum analyser.	2,5,6	02

8	Analysis of a simple mixer using time domain and frequency domain response using simulation software.	3,5,6	02
9	Demonstrate the different stages of microwave amplifiers using a spectrum analyser.	2,5,6	02
10	Common-Mode Currents and Radiated Emissions of Cables.	4,5,6	02
11	Mini Project with Case Study	1 to 6	02
12	Assignment 1	-	02
13	Assignment 2	-	02
Total			28

Virtual Lab Links:

1. http://www.iitk.ac.in/mimt_lab/vlab/index.php
2. <https://nptel.ac.in/courses/108/101/108101112/>

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 :

Practical examination will be based on experiment list and performance of experiment.

Course Code	Department Level Elective Course – VI Laboratory	Credits (P+TUT)
EXDLL8033	Autonomous Vehicle Laboratory	1+0

Lab Prerequisite:	<ol style="list-style-type: none"> 1. Octave 2. Control lab 3. Basics of FFT 4. Robotic lab
Software Requirements:	<ol style="list-style-type: none"> 1. Windows / Linux Desktop OS 2. Matlab/Octave 3. Colab, Keras
Lab Objectives:	<ol style="list-style-type: none"> 1. To provide Introduction to open cv libraries programs/API for computer vision of AV 2. To provide exposure of open source architecture model for Autonomous driving 3. To provide foundational knowledge in motion/trajectory control of AV

Lab Outcomes:	<ol style="list-style-type: none"> 1. Implement sensors/ actuators in Octave/Matlab 2. Implement algorithm to control motion of vehicle 3. Train a model for image/traffic sign identification 4. Analyze the large set of data generated from vehicle using data analytics technique 5. Write accurate documentation for experiments performed. 6. Apply ethical principles like timeliness and adhere to the rules of the laboratory
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Lab No	Experiment Title	LO Mapped	Hrs/ Lab
0	Lab Prerequisites	-	02
1	Python introduction	2,3,5,6	02
2	Numpy Library usage for data analytics	3,5,6	02
3	Finding lanes- Image processing	3,5,6	02
4	Introduction to Perceptron	4,5,6	02
5	Introduction to keras	3,5,6	02
6	Deep learning for Binary data classification, multiclass classification, Amnist datasets	4,5,6	02
7	CNN algorithm for amnist data set	4,5,6	02
8	Classifying traffic sign data sets-48 classes	3,4,6	02
9	Polynomial regression: NVIDIA architecture model	4,5,6	02
10	Behavioral cloning	3,4,5,6	04
11	Radar measurement (range and Velocity) in octave	1,5,6	02
12	PID controller for speed control	1,2,5,6	02
13	Mini Project with Case Study	1 to 6	02
Total			28

<p>Virtual Lab Links:</p> <ol style="list-style-type: none"> 1. https://github.com/udacity/self-driving-car-sim 2. https://www.kaggle.com/account/login?phase=startSignInTab&returnUrl=%2Fdatasets 3. https://uwaterloo.ca/autonomous-vehicle-research-intelligence-lab/about

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 :

Practical examination will be based on experiment list and performance of experiment.

Lab Code	Department Level Elective Course – VI Laboratory	Credits (P+TUT)
EXDLL8034	Fundamental of Data Science Laboratory	1+0
Lab Prerequisite:	<ol style="list-style-type: none"> 1. Knowledge of python programming 2. Linear Algebra 3. Statistical Techniques 	
Lab Objectives:	<ol style="list-style-type: none"> 1. To understand the concept of Data Science. 2. To verify the procedures involved in the processing of data. 3. To develop models for the Analysis of data. 4. To Evaluate and test the models developed. 	
Lab Outcomes :	<ol style="list-style-type: none"> 1. Develop an in-depth understanding of popular methods like regression, clustering using tools in python for Data Science. 2. Learn optimisation formulations to minimise errors and build accurate models 3. Gain hands-on experience and Build statistical, predictive models and time series data forecasting Models 4. Analyze the Data Mining algorithm using machine learning 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.	Python Programming refresher download sample data set from repository	1	02
2.	Perform Reading and Writing Data in Text Format.	1	02
3.	Perform using Pandas Indexing, Selection, Filtering, and Mapping.	2	02
4	Perform using Pandas Summarizing, Computing Descriptive Statistics-Unique Values, Value Counts, and Membership.	2, 5	02
5	Perform Data Cleaning, Preparation, String Manipulation and	3, 5	02

	plotting with pandas on Sample Data on sample data		
6	Optimize the sample data making use of Machine Learning	5	02
7	Perform Data mining using Machine learning	6	02
8	Develop a model using regression, validate it and test for multiple parameters	4,5	02
9	Implementation of ARX and ARMX models	4	02
10	Implementation of ARIM and ARIMA models	4	02
11	Mini Project with Case Study	1 to 6	06
Total			28

Virtual Lab Links:
http://vlabs.iitb.ac.in/vlabs-dev/labs/machine_learning/labs/index.php https://vlab.spit.ac.in/ai/#/experiments
Term work:
<ol style="list-style-type: none"> 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 :
Practical examination will be based on experiment list and performance of experiment.

Lab Code	Project Based Learning	Credits (TH+P+TUT)
EXPR86	Major Project – B	(0+6+0)
Lab Prerequisite:	Major Project – A	
Lab Objectives:	<ol style="list-style-type: none"> 1. To meet the milestones formed in the overall project plan decided in Major Project-A. 2. To implement idea presented in Major Project -A with results, conclusion, and future work. 3. To culminate the production of a thesis by each individual student. 	
Lab Outcomes:	<ol style="list-style-type: none"> 1. Identify, formulate, review research literature, and analyse complex engineering problems 2. Design solutions, components, or processes for complex 	

	<p>engineering problems.</p> <ol style="list-style-type: none"> 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.
<p>Guidelines:</p>	
<p>Project Report Format: At the end of the semester the student needs to prepare a project report which should be prepared. Along with the project report a CD containing: project documentation, Implementation code, required utilities, softwares and user Manuals need to be attached.</p>	
<p>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:</p> <ol style="list-style-type: none"> e. Weekly Attendance on Project Day f. Project work contributions as per objective g. Project Report (Hard Bound) h. Term End Presentation (Internal) <p>The final certification and acceptance of Term Work ensures the satisfactory performance on the above aspects which carries 50 Marks.</p>	
<p>Practical & Oral (P&O): Practical examination of Major Project-B should be conducted by Internal and External examiners. Students must give a presentation and demonstration on the Major Project-B. Oral and Practical will carry 100 Marks.</p>	
<p>Useful Links:</p>	
<ol style="list-style-type: none"> 1. https://ieeexplore.ieee.org/ 2. https://www.electronicsforu.com/ 	