UNIVERSITY OF MUMBAI

Bachelor of Engineering
Electronics Engineering

Final Year Engineering
(Sem. VII), Revised course
(REV- 2012) effective from Academic Year 2015 -16

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

Semester -VII

Sub Code	Subject Name	Teaching Scheme(Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC701	Embedded System Design	04	--	--	04	--	--	04
EXC702	IC Technology	04	--	--	04	--	--	04
EXC703	Power Electronics –II	04	--	--	04	--	--	04
EXC704	Computer Communication Networks	04	--	--	04	--	--	04
EXC 705X	Elective - I	04	--	--	04	--	--	04
EXC 706	Project - I					02		02
EXL701	Embedded System Design Laboratory	--	02	--	--	01	--	01
EXL702	IC Technology Laboratory	--	02	--	--	01	--	01
EXL703	Power Electronics –II Laboratory	--	02	--	--	01	--	01
EXL704	Computer Communication Networks Laboratory	--	02	--	--	01	--	01
EXL705X	Elective – I Laboratory	--	02	--	--	01		01
Total		**20**	**10**	**--**	**20**	**07**	**--**	**27**

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical & Oral.	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC701	Embedded System Design	20	20	20	80	-	--	--	100
EXC702	IC Technology	20	20	20	80	--	--	--	100
EXC703	Power Electronics –II	20	20	20	80	--	--	--	100
EXC704	Computer Communication Networks	20	20	20	80	--	--	--	100
EXC705X	Elective - I	20	20	20	80	--	--	--	100
EXC706	Project -I					25	--	25	50
EXL701	Embedded System Design Laboratory	--	--	--	--	25	--	25	50
EXL702	IC Technology Laboratory	--	--	--	--	25		25	50
EXL703	Power Electronics –II Laboratory	--	--	--	--	25	--	25	50
EXL704	Computer Communication Networks Laboratory	--	--	--	--	25	--	25	50
EXL705X	Elective – I Laboratory	--	--	--	--	25	--	25	50
Total		**--**	**--**	**100**	**400**	**150**	**00**	**150**	**800**

Elective – I

Code	Name of Elective
EXC7051	Digital Image Processing
EXC7052	Artificial Intelligence
EXC7053	ASIC Verification
EXC7054	Optical Fiber Communication

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC701	Embedded System Design	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC701	Embedded System Design	20	20	20	80	-	-	-	100

Course Pre-requisite:

- EXC403: Microprocessor and Peripherals
- EXC501: Microcontroller & Applications

Course Objectives:

1. To teach scope, usage, requirements, challenges and general design methodology of embedded system
2. To apply hardware and software knowledge to develop embedded system applications according to requirement and constraints

Course Outcomes:

After successful completion of the course student will be able to

1. interpret component's functional and electrical specifications and its implication and advantage in design.
2. develop their skill to select/choose proper components, approach, and method to develop optimal system.

Module No.	Unit No.	Topics	Hrs.
1		**Fundamentals of Embedded System**	8
	1.1	Core of the embedded system, Memory, Sensors (resistive, optical, position, thermal) and Actuators (solenoid valves, relay/switch, opto-couplers), Communication Interface, Embedded firmware (RTOS, Drivers, Application programs), Power-supply (Battery technology, Solar), PCB and Passive components, Safety and reliability, environmental issues. Ethical practice.	
	1.2	Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency.	
	1.3	Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net, UML	
2		**Embedded Serial Communication**	4
	2.1	Study of basic communication protocols like SPI, SCI (RS232, RS485), I^2C, CAN, Field-bus (Profibus), USB (v2.0), Bluetooth, Zig-Bee, Wireless sensor network	
3		**Embedded Hardware and Design**	12
	3.1	Low power hardware design (MSP430 / Cortex-M3 based Real time clock and PWM dc motor control as a case study using on chip timers and watch-dog-timers).	
	3.2	Introduction to ARM-v7-M (Cortex-M3), Comparison of ARM-v7-A (CortexA8), ARM-v7-R (CortexR4), ARM-v7-M (Cortex-M3)	
	3.3	Direct digital solution using CPLD, FPGA, its advantages, and introduction to related development methodology	
4		**Embedded Software, Firmware Concepts and Design**	16
	4.1	Embedded C-programming concepts (from embedded system point of view): Optimizing for Speed/Memory needs, Interrupt service routines, macros, functions, modifiers, data types, device drivers, Multithreading programming. (Laboratory work on J2ME Java mobile application).	
	4.2	Basic embedded C programs/applications for ARM-v7, using ARM-GCC-tool-chain, Emulation of ARM-v7 (e.g. using QEMU), and Linux porting on ARM-v7 (emulation) board	
	4.3	Real time operating system: POSIX Compliance , Need of RTOS in Embedded system software, Foreground/Background systems, multitasking, context switching, IPC, Scheduler policies, Architecture of kernel, task scheduler, ISR, Semaphores, mailbox, message queues, pipes, events, timers, memory management, RTOS services in contrast with traditional OS.	
	4.4	Introduction to µCOS-II RTOS, study of kernel structure of µCOS-II, Synchronization in µCOS-II, Inter-task communication in µCOS-II, Memory management in µCOS-II, porting of RTOS on ARM-v7 (emulation) board, Application developments using µCOS-II.	
	4.5	Introduction Linux OS, Linux IPC usage, basic device (drivers) usage.	
5		**Simulation, Testing and Debugging Methodology and Tools**	04
	5.1	GNU Debugger (gdb), Boundary-Scan/JTAG interface concepts, Black-box, White-box testing, Hardware emulation, logic analyzer.	
6		**Embedded System Designing**	08
	6.1	Requirement analysis, Hardware blocks diagram, System model (like FSM, UML), Software architectures (modules, drivers), and Component/hardware selection, covering following cases: Hard real time/ Mission critical: Missile, Car cruise control, medical monitoring systems, process control system (temp, pressure) Soft real time: Automated vending machines, digital camera, media-player. Communication: Embedded web servers, routers, Wireless (sensor) networks.	
		Total	**52**

Recommended Books:

1. Embedded Systems, Rajkamal , TMH, 2008.
2. Frank Vahid - Embedded Systems , Wiley India, 2002
3. ARM System-on-Chip Architecture, Steve Furber - Pearson 2005
4. Jean J Labrose - MicroC / OS-II, Indian Low Price Edition 2002
5. DR.K.V.K.K. Prasad - Embedded / real time system, Dreamtech
6. Iyer, Gupta - Embedded real systems Programming , TMH
7. Embedded systems software primer, David Simon - Pearson
8. ARM System Developers Guide- Sloss, Symes, Wright, ElsevierMorgan Kaufman, 2005
9. LPC2148 Data Sheets www.arm.com
10. ARM Programers/architectural manual.
11. MSP430 architectural manual.
12. Embedded Microcomputer Systems – Real Time Interfacing – Jonathan W. Valvano; Cengage Learning; Third or later edition.

Internal Assessment (IA):
Two tests must be conducted which should cover at least 80% of syllabus. The average marks of both the test will be considered for final internal assessment.

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

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC702	IC Technology	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
EXC702	IC Technology	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXC302: Electronic Devices
- EXC303: Digital Circuits and Design
- EXC402: Discrete Electronic Circuits
- EXC502: Design With Linear Integrated Circuits
- EXC601: VLSI Design

Course Objectives:

1. To teach fundamental principles of fabrication of VLSI devices and circuits
2. To disseminate knowledge about novel VLSI devices

Course Outcomes:

After successful completion of the course student will be able to

1. demonstrate a clear understanding of CMOS fabrication flow and technology scaling
2. demonstrate a clear understanding of various MOS fabrication processes, semiconductor measurements, packaging, testing and advanced semiconductor technologies
3. discuss physical mechanism in novel devices
4. verify processes and device characteristics via simulations

Module No.	Unit No.	Topics	Hrs.
1. 0		**Environment and Crystal Growth for VLSI Technology**	8
	1.1	**Environment:** Semiconductor technology trend, Clean rooms, Wafer cleaning	
	1.2	**Semiconductor Substrate:** Phase diagram and solid solubility, Crystal structure, Crystal defects, Czochralski growth, Bridgman growth of GaAs, Float Zone growth, Wafer Preparation and specifications	
2.0		**Fabrication Processes Part 1**	10
	2.1	**Deposition:** Evaporation, Sputtering and Chemical Vapor Deposition	
	2.2	**Epitaxy:** Molecular Beam Epitaxy, Vapor Phase Epitaxy, Liquid Phase Epitaxy, Evaluation of epitaxial layers	
	2.3	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality, high κ and low κ dielectrics	
	2.4	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, impurity behavior, diffusion systems, problems in diffusion, evaluation of diffused layers	
	2.5	**Ion Implantation:** Penetration range, ion implantation systems, process considerations, implantation damage and annealing	
3.0		**Fabrication Processess Part 2**	10
	3.1	**Etching:** Wet chemical etching, dry physical etching, dry chemical etching, reactive ion etching, ion beam techniques	
	3.2	**Lithography:** Photoreactive materials, Pattern generation and mask making, pattern transfer, Electron beam, Ion beam and X-ray lithography	
	3.3	**Device Isolation, Contacts and Metallization:** Junction and oxide isolation, LOCOS, trench isolation, Schottky contacts, Ohmic contacts, Metallization and Packaging	
	3.4	**CMOS Process Flow:** N well, P-well and Twin tub	
	3.5	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact	
4.0		**Measurements, Packaging and Testing**	10
	4.1	**Semiconductor Measurements:** Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility, Minority Carrier Lifetime and diffusion length	
	4.2	**Packaging:** Integrated circuit packages, Electronics package reliability	
	4.3	**Testing:** Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality	
5.0		**SOI, GaAs and Bipolar Technologies**	08
	5.1	**SOI Technology:** SOI fabrication using SIMOX, Bonded SOI and Smart Cut, PD SOI and FD SOI Device structure and their features	
	5.2	**GaAs Technologies:** MESFET Technology, Digital Technologies, MMIC technologies, MODFET and Optoelectronic Devices	
	5.3	**Silicon Bipolar Technologies:** Second order effects in bipolar transistor, Performance of BJT, Bipolar processes and BiCMOS	
6.0		**Novel Devices**	06
	6.1	**Multigate Device:** Various multigate device configurations (device structure and important features)	
	6.2	**Nanowire:** Fabrication and applications	
	6.3	**Graphene Device:** Carbon nanotube transistor fabrication, CNT applications	
Total			52

Recommended Books:

1. James D. Plummer, Michael D. Deal and Peter B. Griffin, "*Silicon VLSI Technology*", Pearson, Indian Edition.
2. Stephen A. Campbell, "*The Science and Engineering of Microelectronic Fabrication"*, Oxford University Press, 2nd Edition.
3. Sorab K. Gandhi, "*VLSI Fabrication Principles*", Wiley, Student Edition.
4. G. S. May and S. M. Sze, "*Fundamentals of Semiconductor Fabrication*", Wiley, First Edition.
5. Kerry Bernstein and N. J. Rohrer, "*SOI Circuit Design Concepts"*, Kluwer Academic Publishers, 1st edition.
6. Jean-Pierre Colinge, "*FinFETs and Other Multigate Transistors"*, Springer, 1st edition
7. M. S. Tyagi, "*Introduction to Semiconductor Materials and Devices*", John Wiley and Sons, 1st edition.
8. James E. Morris and Krzysztol Iniewski, "*Nanoelectronic Device Applications Handbook*", CRC Press
9. Glenn R. Blackwell, "*The electronic packaging*", CRC Press
10. Michael L. Bushnell and Vishwani D. Agrawal, "*Essentials of Electronic Testing for digital, memory and mixed-signal VLSI circuits*", Springer

Internal Assessment (IA):

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

End Semester Examination:

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

Subject Code	Course Name	Teaching Scheme	Credits Assigned					
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
EXC703	Power Electronics II	04	--	--	04		--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
EXC703	Power Electronics II	20	20	20	80	--	--	--	100

Course Pre-requisites:

- EXC 604: Power Electronics – I
- EXC 404: Principles of Control Systems

Course Objectives:

1. To enhance and expand the ideas of students for more complex power electronic systems.
2. To teach the analytical methods in power electronic systems.
3. To expose the students to various applications of power electronics in various electronics equipments and drives.

Course Outcomes:

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

1. Thoroughly understand the modern methods of analysis and control of power electronic systems.
2. Carry out the theoretical analysis of the power electronic systems from the 'Systems Theory' point of view.
3. Appreciate the ubiquity of power electronics systems in engineering fields
4. Simulate and analyze power electronic systems

Module No.	Unit No.	Topics	Hrs.
1		**Rectifiers and Inverters:**	12
	1.1	Effect of source inductance in 1-phase and 3-phase rectifiers, distortion in line current waveforms, voltage distortion for diode and SCR based rectifiers	
	1.2	PWM for 3-phase voltage source inverters, Space Vector Modulation (SVM) technique for 3-phase voltage source inverters, hysteresis control.	
2		**DC-DC Converters:**	10
	2.1	Average model, linearized and transfer function models, state-space average models of basic buck, boost and buck-boost converters, Feedback control of these converters (PI and PID).	
3		**Power Electronic Applications**	06
	3.1	Use of power electronic systems in SMPS, Battery charging systems, UPS and Induction heating.	
4		**Power Electronic Applications in DC Drives**	10
	4.1	Various schemes of DC motor speed control, single-phase half-wave semi converter & full converter drive for separately excited DC motor, Dynamic and Regenerative braking of DC motor	
5		**Power Electronic Applications in AC Drives**	14
	5.1	Introduction to speed control of three-phase induction motor methods: i) Stator voltage ii) Variable frequency iii) Rotor resistance iv) V/f control v) Regenerative braking**.**	
		Total	**52**

Recommended Books:

1. M. Rashid, Power Electronics: Circuits, Devices, and Applications, PHI, 3rd Edition.
2. By M. D. Singh, K. B. Khanchandani, Power Electronics, Tata McGraw Hill, 2nd Edition.
3. Mohan, Undeland and Riobbins, Power Electronics: Converters, Applications and Design, Wiley (Student Edition), 2nd Edition.
4. P. S. Bimbhra, Power Electronics, Khanna Publishers, 2012.
5. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer, 2nd Edition.
6. J. P. Agrawal, Power Electronics Systems: Theory and Design, Pearson Education, 2002.
7. S. Bacha, I. Munteanu and A. Bratcu, Power Electronic Converters: Modeling and Control, Springer-Verlag, 2014.
8. H. Sira-Ramírez, R. Silva-Ortigoza, Control Design Techniques in Power Electronics Devices, Springer-Verlag, 2006

Internal Assessment (IA):

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

End Semester Examination:

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

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC704	Computer Communication and Networks	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC704	Computer Communication and Networks	20	20	20	80	-	-	-	100

Pre requisite :

- EXC 405: Fundamentals of Communication Engineering
- EXC:504: Digital Communication

Course Objective:

1. To ensure that students have the necessary networking skills to design, implement and analyze communication networks.
2. Students will be able to design, implement, and analyze communication networks**.**

Course Outcome: After Completing this course student will be able to

1. Understand the fundamentals of communication and Computer networks.
2. Have the capability of designing and analyzing data transmission protocols and data link control protocols.
3. Able to discuss major trends in industry and current research activities within the discipline.
4. Able to implement networking protocols using TCP/IP based on socket programming**.**

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to Network Architectures, Protocol Layers, and Service models**	10
	1.1	Network Hardware: Topologies, LAN, MAN, WAN, Wireless network, Home Network, Internetworks, Virtual LANs	
	1.2	Network Software: Protocol Hierarchies, Design Issues for the layers, Connection oriented and connectionless Services	
	1.3	Reference Models: Layers details of OSI, TCP/IP Models, Protocol Layers and Their Service Models	
2		**Physical-layer Services and Systems**	08
	2.1	Introduction to physical media, Coax, fiber, twisted pair, DSL, HFC	
	2.2	Data link layer services and protocols**:** Link-layer and its services, Ethernet, hubs, bridges, and switches, Link- layer addressing, Error-detection and error-correction. Parity, check-summing, CRC, Manchester encoding. Aloha protocols, Control Access Protocol, Carrier Sense	
	2.3	Multiple Access (CSMA), Local Area Networks - Ethernet, Token ring, FDDI. WiMax, cellular, satellite, and telephone networks, Bit transmission, Frequency division multiplexing. Time division multiplexing	
3		**Data Link Layer Protocol**	10
	3.1	PPP, HDLC, Stop and wait protocol	
4		**Network Layer Services and Protocols**	10
	4.1	Switching fabric, Routing and forwarding, Queues and buffering, Virtual-circuit and datagram networks, Internet protocol	
	4.2	IPv4 and IPv6, Tunneling, LS and DV algorithms. Routing in the Internet, RIP, OSPF, and BGP	
	4.3	Broadcast and multicast, Handling mobility	
5		**Reliable and Unreliable Transport-layer Protocols**	08
	5.1	GBN and SR. TCP and UDP. Port numbers, Multiplexing and de-multiplexing	
	5.2	Flow control and congestion control. Fairness, Delay, jitter, and loss in packet-switched networks	
	5.3	Bandwidth, throughput, and quality-of-service	
6		**Principles of Network Applications**.	06
	6.1	Application layer protocols such as HTTP, FTP, and SMTP,	
	6.2	Peer-to-Peer File Sharing Protocols and Architectures, ISPs and Domain name systems, Socket API and network socket programming	
		Total	**52**

Recommended Books:

1. B. A. Forouzan, “Data Communications and Networking”, TMH, Fourth Edition.
2. S. Tanenbaum, “Computer Networks”, Pearson Education, Fourth Edition.
1. Computer Networking: A Top-Down Approach, by J. F. Kurose and K. W. Ross, Addison Wesley, 5th Edition, March 2009, ISBN-13: 978-0136079675.

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

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

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC7051	Digital Image Processing	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC7051	Digital Image Processing	20	20	20	80	-	-	-	100

Course Pre-requisite:

- EXS 401 : Applied Mathematics IV
- EXC 504 : Signal and Systems

Course Objectives:

1. To develop an overview of the field of image processing
2. To learn the fundamental concepts of Digital Image Processing .
3. To understand basic image enhancement and segmentation techniques.
4. To illustrate Image Transform calculations mathematically and develop fast transform algorithm
5. To learn Image Compression and Decompression Techniques

Course Outcomes:

After successful completion of the course student will be able to

1. Understand the concept of Digital Image processing.
2. Explain image enhancement and Segmentation technique.
3. Understand Digital Image compression and decompression techniques
4. Perform Binary Image Processing Operations

Module No.	Unit No.	Topics	Hrs.
1		**Digital Image Processing Fundamentals**	06
	1.1	**Introduction:** Background, Digital Image Representation, Fundamental Steps in Image Processing, Elements of a Digital Image Processing System	
	1.2	**Digital Image Fundamentals:** Elements of Visual Perception, A Simple Image Model, Sampling and Quantization, Some Basic Relationships between Pixels, Imagining Geometry. Image File Formats : BMP, TIFF and JPEG. Colour Models (RGB, HSI, YUV)	
2		**Image Enhancement**	08
	2.1	Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background	
	2.2	Smoothing Filters, Sharpening Filters, Lowpass Filtering, Highpass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. Homomorphic Filtering.	
3		**Image Segmentation and Representation**	08
	3.1	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique,	
	3.2	Image Representation and Description, Chain Code, Polygonal, Representation, Shape Number, Moments.	
4		**Binary Image Processing**	06
	4.1	Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening, Connected Component Labeling, Iterative Algorithm and Classical Algorithm	
5		**Image Transform**	12
	5.1	Introduction to the Fourier Transform, The Discrete Fourier Transform, Some Properties of the Two-Dimensional Fourier Transform Fast Fourier Transform(FFT),	
	5.2	Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT),	
6		**Image Compression:**	12
		Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria.	
	6.1	Image Compression Models – The Source Encoder and Decoder, Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM,	
	6.2	Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.	
		Total	**52**

Recommended Books:

1. Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition, 2009,
2. S. Jayaraman, E.Esakkirajan and T.Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd, 2009,
3. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition

Internal Assessment (IA):

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

End Semester Examination:

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

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC7052	Artificial Intelligence	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC7052	Artificial Intelligence	20	20	20	80	-	-	-	100

Course Prerequisite:

- Knowledge of linear algebra, multivariate calculus, and probability theory
- Knowledge of a programming language (MATLAB /C/C ++ recommended)

Course Objective:

1. To study basics of biological Neural Network.
2. To understand the different types of Artificial Neural Networks
3. To know the applications of ANN
4. To study fuzzy logic and fuzzy systems

Course Outcome: At the end of completing the course of Artificial Neural Networks, a student will be able to:

1. Choose between different types of neural networks
2. Design a neural network for a particular application
3. Understand the applications of neural networks
4. Appreciate the need for fuzzy logic and control

Module No.	Unit No.	Topics	Hrs.
1.		**Fundamental Concepts of Neural Networks**	8
	1.1	Difference between fuzzy and crisp sets and applications of fuzzy logic and	
	1.2	Biological neurons, McCulloch and Pitts models *of* neuron, Important Terms of ANNs, McCulloch-Pitts Neuron, Hebb Network, Supervised learning,	
	1.3	Applications and scope of Neural Network	
2		**Supervised Learning Networks**	12
	2.1	Perception Networks: Adaline, Madaline	
	2.2	Back Propagation Network	
	2.3	Function Network	
3		**Unsupervised learning network**	12
	3.1	Max Net, Mexican Hat, Kohonen Self-organizing Feature	
	3.2	Maps, Learning Vector Quantization, Adaptive Resonance Theory	
4		**Associative networks**	10
	4.1	Pattern Association, Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory, Discrete Hopfield Networks	
	4.2	**Special networks:** Simulated annealing neural networks, Boltzmann machine, Brain-in-a-Box	
5		**Fuzzy logic**	10
	5.1	Fuzzy sets, Properties, Operations on fuzzy sets, Fuzzy relation Operations on fuzzy relations,	
	5.2	The extension principle, Fuzzy mean Membership functions, Fuzzification and defuzzification methods	
	5.3	Fuzzy controllers, Adaptive neuro-fuzzy information systems (ANFIS)	
		Total	**52**

Recommended Books:

1. Simon Haykin, "Neural Network a - Comprehensive Foundation", Pearson Education
2. Dr.S.N.Sivanandam,Mrs S.N. Deepa Introduction to Soft computing tool Wiley Publication
3. Satish Kumar Neural Networks:A classroom Approach Tata McGraw-Hill
4. Thimothv J. Ross, "Fuzz V Logic with Engineering Applications", McGraw -Hill
5. Rajsekaran S, Vijaylakshmi Pai, Neural Networks, Fuzzy Logic, andGenetic Algorithms, PHI
6. Hagan, Demuth, Beale, 'Neural Network Design', Thomson Learning
7. Christopher M Bishop Neural Networks For Pattern Recognition ,Oxford Publication
8. William W Hsieh Machine Learning Methods in the Environmental Sciences Neural Network and Kernels Cambridge Publication
9. Dr.S.N.Sivanandam, Dr.S.Sumathi Introduction to Neural Network Using Matlab Tata McGraw-Hill

Internal Assessment (IA):

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

End Semester Examination:

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

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC7053	ASIC Verification	04	--	--	04	--	--	04

Subject Code	Subject Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Avg. of Test 1 and Test 2					
EXC7053	ASIC Verification	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXL304: Object Oriented Programming Methodology Laboratory
- EXC303: Digital Circuits and Design

Course Objectives:

1. To teach ASIC Verification fundamentals
2. To highlight the significance of verification in VLSI industry

Course Outcomes:

After successful completion of the course student will be able to

1. demonstrate an understanding of programmable devices and languages
2. demonstrate an understanding of verification process in VLSI systems
3. write system verilog code for VLSI systems
4. carry out verification of design successfully using simulators

Module No.	Unit No.	Topics	Hrs.
1		**Programmable Devices and Verilog**	08
	1.1	**Programmable Devices:** Architecture of FPGA, CPLD with an example of Virtex-7 and Spartan -6 family devices	
	1.2	**Verilog HDL:** Data types, expressions, assignments, behavioral, gate and switch level modeling, tasks and functions	
	1.3	**Verification Basics:** Technology challenges, Verification methodology options, Verification methodology, Testbench creation, testbench migration, Verification languages, Verification IP reuse, Verification approaches, Verification and device test, Verification plans, reference design of Bluetooth SoC, Verification Guidelines	
2		**Data types, procedural statements and testbench**	08
	2.1	**Data Types:** Built in, Fixed size array, dynamic array, queues, associative array, linked list, array methods, choosing a storage type, creating new types with typedef, creating user-defined structures, type conversion, enumerated types, constants, strings, expression width	
	2.2	**Procedural Statements and Routines:** Procedural statements, tasks, functions and void functions, task and function overview, routine arguments, returning from a routine, local data storage, time values	
	2.3	**Connecting the Testbench and Design:** Separating the testbench and design, the interface construct, stimulus timing, interface driving and sampling, connecting it all together, top-level scope, program-module interactions, system verilog assertions, the four port ATM router, the ref port direction, the end of simulation, directed test for the LC3 fetch block	
3		**OOP and Randomization**	10
	3.1	**Basic OOP:** Class, Creating new objects, Object deallocation, using objects, variables, class methods, defining methods outside class, scoping rules, using one class inside another, understanding dynamic objects, copying objects, public vs. local, building a testbench	
	3.2	**Randomization:** Randomization in system Verilog, constraint details, solution probabilities, controlling multiple constraint blocks, valid constraints, In-line constraints, The pre-randomize and post-randomize functions, Random number functions, Constraints tips and techniques, common randomization problems, Iterative and array constraints, Atomic stimulus generation vs. scenario generation, random control, random number generators, random device configuration	
4		**IPC and advanced OOP**	08
	4.1	**Threads and Interprocess Communication:** working with threads, disabling threads, interprocess communication, events, semaphores, mailboxes, building a testbench with threads and IPC	
	4.2	**Advanced OOP and Testbench Guidelines:** Inheritance, Blueprint pattern, downcasting and virtual methods, composition, inheritance and alternatives, copying an object, abstract classes and pure virtual methods, callbacks, parameterized classes	
5		**Assertions and Functional Coverage**	12
	5.1	**System Verilog Assertions:** Assertions in verification methodology, Understanding sequences and properties, SystemVerilog Assertions in the Design Process, Formal Verification Using Assertions and SystemVerilog Assertions Guidelines	
	5.2	**Functional Coverage:** Coverage types, strategies, examples, anatomy of a cover group, triggering a cover group, data sampling, cross coverage, generic cover groups, coverage options, analyzing coverage data, measuring coverage statistics during simulation	
6		**Advanced interfaces and interfacing with C**	6
	6.1	**Advanced Interfaces:** Virtual interfaces with the ATM router, Connecting to multiple design configurations, procedural code in an interface	
	6.2	**A complete System Verilog Testbench:** Design blocks, testbench blocks, alternate tests	
	6.3	**Interfacing with C:** Passing simple values, connecting to a simple C routine, connecting to C++, simple array sharing, open arrays, sharing composite types, pure and context imported methods, communicating from C to system verilog, connecting other languages	
		Total	**52**

Recommended Books:

1. Chris Spear, "*System Verilog for Verification: A guide to learning the testbench language features*", Springer, 2nd Edition
2. Stuart Sutherland, Simon Davidmann, and Peter Flake, "*System Verilog for Design: A guide to using system verilog for hardware design and modeling*", Springer, 2nd Edition.
3. Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, "*SystemVerilog Assertions Handbook*", VhdlCohen Publishing, 3rd edition
4. *System Verilog Language* Reference manual
5. S Prakash Rashinkar, Peter Paterson and Leena Singh, "*System on Chip Verification Methodologies and Techniques*", Kluwer Academic, 1st Edition.
6. *Spartan and Virtex family* user manuals from Xilinx
7. *Verilog Language* Reference manual

Internal Assessment (IA):

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

End Semester Examination:

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

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC7054	Optical Fiber Communication	04	--	--	04	--	--	04

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXC7054	Optical Fiber Communication	20	20	20	80	-	-	-	100

Pre requisites:

- EXC503: Electromagnetic Engineering
- EXC405: Fundamentals of Communication Engineering
- EXC505: Digital Communication.

Course Objective: To teach students

1. Optical fiber wave guide structures, fabrication and signal degradation in fiber
2. The characteristics and working of various components used in optical link
3. Design and management of optical networks

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

1. understand light wave propagation through fiber
2. identify structures, materials, and components used in optical link
3. analyze transmission characteristics of fiber
4. design and management of optical fiber links

Module No.	Unit No.	Topics	Hrs.
1.		**Overview of Optical Fiber Communication**	10
	1.1	The evolution of fiber optic systems, elements of an optical fiber transmission link, block diagram, advantages of optical fiber communication, applications	
	1.2	Ray theory transmission, total internal reflection, acceptance angle, numerical aperture and skew rays	
	1.3	Modes, electromagnetic mode theory and propagation, single mode and multimode fibers, linearly polarized modes	
	1.4	Fiber material, fiber cables and fiber fabrication, fiber joints, fiber connectors, splicer	
2		**Optical Sources and Detectors**	10
	2.1	Coherent and non-coherent sources, quantum efficiency, modulation capability of optical sources	
	2.2	LEDs: Working principle and **c**haracteristics	
	2.3	Laser diodes: Working principle and **c**haracteristics	
	2.4	Working principle and characteristics of detectors: PIN and APD, noise analysis in detectors, coherent and non-coherent detection, receiver structure, bit error rate of optical receivers, and receiver performance	
3		**Components of Optical Fiber Networks**	08
	3.1	Overview of fiber optic networks, trans-receiver, semiconductor optical amplifiers	
	3.2	Couplers/splicer, wavelength division multiplexers and de-multiplexers	
	3.3	Filters, isolators and optical switches	
4		**Transmission Characteristic of Optical Fiber**	08
	4.1	Attenuation, absorption, linear and nonlinear scattering losses, bending losses, modal dispersion, waveguide dispersion and pulse broadening,	
	4.2	Dispersion shifted and dispersion flattened fibers, and non linear effects	
	4.3	Measurement of optical parameters, attenuation and dispersion, OTDR	
5		**Optical Networks**	08
	5.1	SONET and SDH standards, architecture of optical transport networks (OTNs), network topologies	
	5.2	Operational principle of WDM, WDM network elements and Architectures, Introduction to DWDM, Solitons.	
6		**Network Design and Management**	08
	6.1	Point to point links system considerations, link power budget, and rise time budget	
	6.2	Transmission system model, power penalty-transmitter, receiver optical amplifiers, crosstalk, dispersion, wavelength stabilization.	
	6.3	Network management functions, configuration management, performance management, fault management, optical safety and service interface	
		Total	52

Recommended Books:

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. G Agarwal, "*Fiber Optic Communication Systems*", John Wiley and Sons, 3rd Edition, New York 2014
4. S.C. Gupta, "*Optoelectronic Devices and Systems*", Prentice Hall of India Publication, Chicago, 2005.

Internal Assessment (IA):

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

End Semester Examination:

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

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL701	Embedded System Design Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL701	Embedded System Design Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC701** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.
The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
Practical and oral exam will be based on the entire syllabus of **EXC701**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL702	IC Technology Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL702	IC Technology Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC702** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.
The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
Practical and oral exam will be based on the entire syllabus of **EXC702**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL703	Power Electronics –II Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL703	Power Electronics –II Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC703** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.
The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
Practical and oral exam will be based on the entire syllabus of **EXC703**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL704	Computer Communication Networks Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL704	Computer Communication Networks Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC704** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.
The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
Practical and oral exam will be based on the entire syllabus of **EXC704**

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL705X	Elective I Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme						
		Theory Marks				Term Work	Oral	Total
		Internal assessment			End Sem. Exam			
		Test 1	Test 2	Ave. Of Test 1 and Test 2				
EXL705X	Elective I Laboratory	--	--	--	--	25	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC705X** should be set to have well predefined inference and conclusion. Computation/simulation based experiments are encouraged. The attempt should be made to make experiments more meaningful, interesting and innovative. Term work assessment must be based on the **overall performance** of the student with **every experiment graded from time to time**. The grades should be converted into marks as per the **Credit and Grading System** manual and should be **added and averaged**. The grading and term work assessment should be done based on this scheme.
The final certification and acceptance of term work ensures satisfactory performance of laboratory work and minimum passing marks in term work.
Practical and oral exam will be based on the entire syllabus of **EXC705X**

Elective – I

Code	Name of Elective
EXC7051	Digital Image Processing
EXC7052	Artificial Intelligence
EXC7053	ASIC Verification
EXC7054	Optical Fiber Communication

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC706	Project - I)	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXc706	Project -I	--	--	--	--	25	-	25	50

Term Work:

The final year students have already under gone project assignment in their pre-final year in Mini Project I and II. In final year group of maximum **four** students will be completing a comprehensive project work based on the courses studied. The project work may be internally assigned or may be externally assigned by the research institutes, industry etc. Each group will be assigned one faculty as a supervisor. This project work in final year may be extension of the Mini Project work done in pre-final year.

The main intention of Project work is to enable students to apply the knowledge and skills learned out of courses studied to solve/implement predefined practical problem. The Project work may be beyond the scope of curriculum of courses taken or may be based on the courses but thrust should be

- Learning additional skills
- Development of ability to define, design, analysis and implementation of the problem and lead to its accomplishment with proper planning
- Learn the behavioral science by working in a group
- The project area may be selected in which the student intend to do further education and/or may be either intend to have employment or self employment
- The topic of project should be different and / or may be advancement in the same topic of Mini Project
- The students may use this opportunity to learn different computational techniques as well as some model development. This they can achieve by making proper selection of Project work.

The college should keep proper assessment record of the progress of project and at the end of the semester it should be assessed for awarding TW marks. The TW should be examined by approved internal faculty appointed by the head of the institute on the basis of following:

- Scope and objective of the project work.
- Extensive Literature survey.
- Progress of the work (Continuous assessment)
- Report in prescribed University format.

An approved external examiner and internal examiner appointed by the head of the institute together will assess during oral examination. The oral examination is a presentation by the group members on the project along with demonstration of the work done. In the examination each individual student should be assessed for his/her contribution, understanding and knowledge gained.