UNIVERSITY OF MUMBAI

Bachelor of Engineering
Electronics Engineering

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

Under

FACULTY OF TECHNOLOGY

(As per Semester Based Credit and Grading System)

From Dean's Desk:

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

Faculty of Technology, University of Mumbai, in one of its meeting unanimously resolved that, each Board of Studies shall prepare some Program Educational Objectives (PEO's) and give freedom to affiliated Institutes to add few (PEO's) and course objectives and course outcomes to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. It was also resolved that, maximum senior faculty from colleges and experts from industry to be involved while revising the curriculum. I am happy to state that, each Board of studies has adhered to the resolutions passed by Faculty of Technology, and developed curriculum accordingly. In addition to outcome based education, semester based credit and grading system is also introduced to ensure quality of engineering education.

Semester based Credit and Grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. University of Mumbai has taken a lead in implementing the system through its affiliated Institutes and Faculty of Technology has devised a transparent credit assignment policy and adopted ten points scale to grade learner's performance. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 3-2 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

Credit and grading based system was implemented for First Year of Engineering from the academic year 2012-2013. Subsequently this system will be carried forward for Second Year Engineering in the academic year 2013-2014, for Third Year and Final Year Engineering in the academic years 2014-2015 and 2015-2016 respectively.

Dr. S. K. Ukarande
Dean,
Faculty of Technology,
Member - Management Council, Senate, Academic Council
University of Mumbai, Mumbai

Preamble:

In the process of change in the curriculum there is a limited scope to have major changes in the fundamental subjects which are mainly part of second year of engineering. The exposure to the latest technology and tools used all over the world is given by properly selecting subjects and their hierarchy in pre-final and final year. Thus this syllabus is made to groom the undergraduate students best suited and competent in all respect with best possible efforts put in by the experts in framing detail contents of individual subjects.

The engineering education in India is expanding in manifolds and the main challenge is the quality education. All the stakeholders are very much concerned about it.

The institution or program of study is committed and open to external review to meet certain minimum specified standards. The major emphasis of this process is to measure the outcomes of the program. Program outcomes are essentially a range of skills and knowledge that a student will have at the time of graduation.

So the curriculum must be constantly refined and updated to ensure that the defined objectives and outcomes are achieved. Students must be encouraged to comment on the objectives and outcomes and the role played by the individual courses in achieving them. In line with this Faculty of Technology of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

I, as Chairman, Board of Studies in Electronics Engineering University of Mumbai, happy to state here that, heads of the department and senior faculty from various institute took timely and valuable initiative to frame Program Educational Objectives as listed below.

1. To provide students with a strong foundation in the mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyze engineering problems and to prepare them for graduate studies.
2. To prepare students to demonstrate an ability to identify, formulate and solve electronics engineering problems.
3. To prepare students to demonstrate ability to design electrical and electronics systems and conduct experiments, analyze and interpret data.
4. To prepare students to demonstrate for successful career in industry to meet needs of Indian and multi-national companies.
5. To develop the ability among students to synthesize data and technical concepts from applications to product design.
6. To provide opportunity for students to work as part of teams on multidisciplinary projects.
7. To promote awareness among students for the life-long learning and to introduce them to professional ethics and codes of professional practice.

These are the suggested and expected main objectives and individual affiliated institute may add further in the list. In addition to Program Educational Objectives, for each course of undergraduate program, objectives and expected outcomes from learner's point of view are also included in the curriculum to support the philosophy of outcome based education. I believe strongly that small step taken in right direction will definitely help in providing quality education to the stake holders.

The subjects offered to undergraduate students in final year are at par to the requirement of industry. The students are also made competent to appear for various competitive examination conducted in India and abroad. The subjects offered are at enough level to

prepare a base of the students to understand and learn latest state of technology. The students are trained in such a way that they become versatile in hardware and software simulation. Some subjects offered upgrades them in the field of information and technology which is a need of today's' era.

At the end I must outset extend my gratitude to all experts who contributed to make curriculum competent at par with latest technological development in the field of electronics engineering.

Dr. D. G. Borse
Chairman, Board of Studies (Electronics Engineering)

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

Semester -VIII

Sub Code	Subject Name	Teaching Scheme(Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC801	CMOS VLSI Design	04	--	--	04	--	--	04
EXC802	Advanced Networking Technologies	04	--	--	04	--	--	04
EXC803	MEMS Technology	04	--	--	04	--	--	04
EXC804X	Elective -II	04	--	--	04	--	--	04
EXC806	Project - II		04			04	--	04
EXL801	CMOS VLSI Design Laboratory	--	02	--	--	01	--	01
EXL802	Advanced Networking Technologies Laboratory	--	02	--	--	01	--	01
EXL803	MEMS Laboratory	--	02	--	--	01	--	01
EXL804X	Elective –II Laboratory	--	02	--	--	01	--	01
Total		16	12	--	16	08	--	24

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					
EXC801	CMOS VLSI Design	20	20	20	80	-	--	--	100
EXC802	Advanced Networking Technologies	20	20	20	80	--	--	--	100
EXC803	MEMS Technology	20	20	20	80	--	--	--	100
EXC804X	Elective -II	20	20	20	80	--	--	--	100
EXC806	Project - II	--	--	--	--	50	--	50	100
EXL801	CMOS VLSI Design Laboratory	--	--	--	--	25	--	25	50
EXL802	Advanced Networking Technologies Laboratory	--	--	--	--	25		25	50
EXL803	MEMS Technology Laboratory	--	--	--	--	25	--	25	50
EXL804X	Elective –II Laboratory	--	--	--	--	25	--	25	50
Total		**--**	**--**	**80**	**320**	**150**	**--**	**150**	**700**

Elective –II

Code	Name of Elective
EXC8041	Robotics
EXC8042	Mobile Communication
EXC8043	Digital Control System
EXC8044	Biomedical Electronics

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.

Subject Code	Subject Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC801	CMOS VLSI Design	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					
EXC801	CMOS VLSI Design	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
- EXC702: IC Technology

Course Objectives:

1. To teach analysis and design of building blocks of CMOS Analog VLSI Circuits.
2. To highlight the issues associated with the CMOS analog VLSI circuit design.

Course Outcomes:

After successful completion of the course student will be able to

1. discuss tradeoffs involved in analog VLSI Circuits.
2. analyze building blocks of CMOS analog VLSI circuits.
3. design building blocks of CMOS analog VLSI circuits
4. carry out verifications of issues involved in analog circuits via simulations

Module No.	Unit No.	Topics	Hrs.
1. 0		**CMOS analog building blocks**	8
	1.1	**MOS Models:** Necessity of CMOS analog design, Review of characteristics of MOS device, MOS small signal model, MOS spice models	
	1.2	**Passive and Active Current Mirrors:** Basic current mirrors, Cascode current mirrors and Active current mirrors	
	1.3	**Band Gap References:** General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing	
2.0		**Single Stage Amplifiers**	10
	2.1	**Configurations:** Basic concepts, Common source stage, Source follower, Common gate stage, Cascode stage	
	2.2	**Frequency Response and Noise:** General considerations, Common-source stage, Source followers, Common-gate stage, Cascode stage and Noise in single stage amplifiers	
3.0		**Differential Amplifiers**	10
	3.1	**Configurations:** Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads, Gilbert cell	
	3.2	Frequency response and noise in differential pair	
4.0		**MOS Operational Amplifiers**	10
	4.1	**Op-amp Design:** General Considerations, performance parameters, One-stage op-amps, Two-stage op-amps, Gain Boosting, Common-mode feedback, Input range limitations, Slew Rate, Power supply rejection, Noise in op-amps	
	4.2	**Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps	
5.0		**Mixed Signal Circuits**	10
	5.1	**Switch Capacitor Circuits:** MOSFETs as switches, Speed considerations, Precision Considerations, Charge injection cancellation, Unity gain buffer, Non-inverting amplifier and integrator	
	5.2	**Oscillators:** General considerations, Ring oscillators, LC oscillators, VCO	
	5.3	**Phase-Locked Loop:** Simple PLL, Charge pump PLL, Nonideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	
6.0		**Analog Layout and other concepts**	04
	6.1	**Analog Layout Techniques:** Antenna effect, Resistor matching, capacitor matching, current mirror matching, floorplanning, shielding and guard rings	
	6.2	AMS design flow, ASIC, Full custom design, Semi custom design, System on Chip, System in package, Hardware software co-design	
		Total	**52**

Recommended Books:

1. B Razavi, "*Design of Analog CMOS Integrated Circuits*", Tata McGraw Hill, 1st Edition.
2. R. Jacaob Baker, Harry W. Li, David E. Boyce, "*CMOS Circuit Design, Layout,and Stimulation*", Wiley, Student Edition
3. P. E. Allen and D. R. Holberg, "*CMOS Analog Circuit Design*", Oxford University Press, 3rd Edition.
4. Gray, Meyer, Lewis, Hurst, "*Analysis and design of Analog Integrated Circuits*", Willey, 5th 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
EXC 802	Advanced Networking Technologies	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					
EXC 802	Advanced Networking Technologies	20	20	20	80	-	-	-	100

Course Pre-requisite:

- EXE704: Computer Communication Networks

Course Objectives:

1. To make students familiar with data communication technologies and how to use them to: Design, Implement, Operate, Manage enterprise networks.
2. To introduce the concept of wireless WAN,WAP and different IEEE standards.

Course Outcomes:

Upon completion of the course, students should be able to:

1. Analyze the performance of networks.
2. Determine the network performance using monitor tools..
3. Set up WLAN,PAN
4. Explain optical networking technology

Module No.	Unit No.	Topics	Hrs.
1		**Emerging Wireless Technologies**	10
	1.1	**Wireless Personal Area Network** – Bluetooth Bluetooth (IEEE 802.15.1),Definitions of the Terms Used in Bluetooth, Bluetooth Protocol Stack, Bluetooth Link Types, Bluetooth Security, Network Connection Establishment in Bluetooth, Network Topology in Bluetooth, Bluetooth Usage Models	
	1.2	Bluetooth Applications, WAP and Bluetooth Wireless Personal Area Networks (WPAN):Low Rate (LR) and High Rate (HR)Wireless Sensor Network, Usage of Wireless Sensor Networks, Wireless Sensor Network	
	1.3	Model, Sensor Network Protocol Stack, ZigBee Technology, IEEE 802.15.4 LR-WPAN Device Architecture, IEEE 802.15.3a Ultra WideBand, Radio Frequency Identification.	
2		**Optical Networking**	06
	2.1	ONET/SDH Standards, devices, DWDM, frame format, DWDM, Performance and design considerations.	
3		**WAN Technologies**	12
	3.1	**Frame:** FR concept, FR specifications, FR design and VoFR and Performance and design considerations	
	3.2	**ATM:** The WAN Protocol: Faces of ATM, ATM Protocol operations. (ATM cell and Transmission) ATM Networking basics, Theory of Operations, B-ISDN reference model, PHY layer, ATM Layer (Protocol model), ATM layer and cell	
	3.3	Traffic Descriptor and parameters, Traffic Congestion control defined, AAL Protocol model, Traffic contract and QoS, User Plane overview, Control Plane AAL, Management Plane, Sub S3 ATM,ATM public services	
4		**Network Design**	08
	4.1	Network layer design, access layer design, access network capacity, network topology and Hardware and completing the access network design.	
5		**Network Security**	08
	5.1	Security threats, safeguards and design for network security	
	5.2	**Enterprise Network Security:** DMZ, NAT, SNAT, DNAT, Port Forwarding, Proxy, Transparent Proxy, Packet Filtering and Layer 7 Filtering	
6		**Network Management and Control**	
	6.1	Network management definitions, functional areas (FCAPS), SNMP, RMON,	08
	6.2	Designing a network management solutions, Monitoring and control of network activity and network project management	
		Total	52

Recommended Books:

1. Data Network Design by Darren Spohn, 3e McGraw Hill publications
2. Data Communication and Network Security by Carr and Snyder, McGraw Hill Publications.
3. Communication Networks by Leon-Garcia and Indra Widjaja, 2e, Tata McGraw-Hill Publications.
4. Information Security by Mark Stamp and Deven Shah by Wiley Publications.
5. Behrouz A Forouzan, Data communications and Networking 4th Edition,
6. McGraw-Hill Publication.
7. William Stallings, Data Computer Communications, Pearson Education
8. Wireless communication and Networking-Vijay Garg, ELSEVIER Inc
9. Eldad Perahita ,Next Generation wireless LANS, Cambridge Publication
10. Computer Networking by J. F. Kurose and K. W. Ross, Pearson Education
11. Local Area Networks by Gerd Keiser, McGraw-Hill Publication.

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	Course Name	Teaching Scheme	Credits Assigned					
		Theory	Practical	Tutorial	Theory	TW/ Practical	Tutorial	Total
EXC803	MEMS 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	Ave. Of Test 1 and Test 2					
EXC803	MEMS Technology	20	20	20	80	-	-	-	100

Course Pre –requisite:

- EXC 404: Basic VLSI Design
- EXC 604: IC Technology

Course Objective:

- To provide a basic knowledge of MEMS processing steps and processing modules.
- To demonstrate the use of semiconductor based processing modules used in the fabrication of variety of sensors and actuators (e.g. pressure sensors, accelerometers, etc.) at the micro-scale.
- To provide an understanding of basic design and operation of MEMS sensors and transducers.

Course Outcome:

On Completion of this course Student will be able to

- Understand the underlying fundamental principles of MEMS devices including physical operation, mathematical modeling and fabrication.
- Design and simulate MEMS devices and system using standard simulation tools.
- Develop different concepts of micro system sensors and actuators for real-world applications.

Module No.	Unit No.	Topics	Hrs.
1.		**Introduction to MEMS**	04
	1.1	Introduction to MEMS & Real world Sensor/Actuator examples (DMD, Air-bag, pressure sensors). MEMS Sensors in Internet of Things (IoT), BioMedical Applications	
2		**MEMS Materials and Their Properties**	10
	2.1	Materials (eg. Si, SiO2, SiN, Cr, Au, Ti, SU8, PMMA, Pt); Important properties: Young modulus, Poisson's ratio, density, piezoresistive coefficients, TCR, Thermal Conductivity, Material Structure. Understanding Selection of materials based on applications.	
3		**MEMS Fab Processes – 1**	11
	3.1	Understanding MEMS Processes & Process parameters for: Cleaning, Growth & Deposition, Ion Implantation & Diffusion, Annealing, Lithography. Understanding selection of Fab processes based on Applications	
4		**MEMS Fab Processes – 2**	10
	4.1	Understanding MEMS Processes & Process parameters for: Wet & Dry etching, Bulk & Surface Micromachining, Die, Wire & Wafer Bonding, Dicing, Packaging. Understanding selection of Fab processes based on Applications	
5		**MEMS Devices**	11
	5.1	Architecture, working and basic quantitative behaviour of Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in DMD, Inkjet printer-head. Understanding steps involved in Fabricating above devices	
6		**MEMS Device Characterization**	06
	6.1	Piezoresistance, TCR, Stiffness, Adhesion, Vibration, Resonant frequency, & importance of these measurements in studying device behavior, MEMS Reliability	
		Total	52

Recommended Books:

1. An Introduction to Microelectromechanical Systems Engineering; 2nd Ed - by N. Maluf, K Williams; Publisher: Artech House Inc
2. Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing
3. Microsystem Design - by S. Senturia; Publisher: Springer
4. Analysis and Design Principles of MEMS Devices - Minhang Bao; Publisher: Elsevier Science
5. Fundamentals of Microfabrication - by M. Madou; Publisher: CRC Press; 2 edition
6. Micro Electro Mechanical System Design - by J. Allen; Publisher: CRC Press
7. Micromachined Transducers Sourcebook - by G. Kovacs; Publisher: 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
EXC8041	Robotics	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					
EXC8041	Robotics	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXS 301 : Applied Mathematics III
- EXS 401 : Applied Mathematics IV
- EXC 404 : Principles of Control Systems

Course Objectives:

1. To prepare students with basics of robotics
2. To familiarize students with kinematics & dynamics of robots
3. To familiarize students with path & Trajectory planning of robots
4. To familiarize students with robot vision

Course Outcomes:

After successful completion of the course student will be able to

1. Describe kinematics and dynamics of stationary and mobile robots
2. Describe trajectory planning for robots
3. Implement trajectory generation and path planning various algorithms
4. Work in interdisciplinary projects

Module No.	Unit No.	Topics	Hrs.
1		**Fundamentals of Robotics**	03
	1.1	Robot Classification, Robot Components, Degrees of freedom, Joints, Coordinates, Coordinate frames, workspace, applications	
2		**Forward & Inverse Kinematics of Robots**	09
	2.1	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation	
	2.2	Denavit-Hatenberg representation of forward kinematics, Inverse kinematic solutions, Case studies	
3		**Velocity Kinematics & Dynamics**	14
	3.1	**Differential motions and velocities :** Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian,Singularities.	
	3.2	**Dynamic Analysis of Forces :** Lagrangian mechanics, Newton Euler formulation, Dynamic equations of robots, Transformation of forces and moment between coordinate frames	
4		**Robot Motion Planning**	04
	4.1	Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug	
5		**Potential Functions and Visibility Graphs**	08
	5.1	Attractive/Repulsive potential, Gradient descent, wave-front planner, navigation potential functions, Visibility map, Generalized Voronoi diagrams and graphs, Silhouette methods	
6		**Trajectory planning**	08
	6.1	Trajectory planning , Joint-space trajectory planning, Cartesian-space trajectories	
7		**Robot Vision**	06
	7.1	Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform.	
		Total	52

Recommended Books:

1. Robert Shilling, Fundamentals of Robotics - Analysis and control, Prentice Hall of India
2. Saeed Benjamin Niku, "Introduction to Robotics – Analysis, Control, Applications", Wiley India Pvt. Ltd., Second Edition, 2011
3. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, "Principles of Robot Motion – Theory, Algorithms and Implementations", Prentice-Hall of India, 2005.
4. Mark W. Spong , Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control ", Wiley India Pvt. Ltd., 2006
5. John J. Craig, "Introduction to Robotics – Mechanics & Control", Third Edition, Pearson Education, India, 2009
6. Aaron Martinez & Enrique Fernandez, "Learning ROS for Robotics Programming", Shroff Publishers, First Edition, 2013.
7. Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications" ,McGraw Hill , New York, 2008

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 (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC 8042	Mobile Communication	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	Ave. Of Test 1 and Test 2					
EXC 8042	Mobile Communication	20	20	20	80	--	--	--	100

Course Pre-requisite:

- EXC 704: Computer Communication Networks
- EXC: Digital Communication

Course Objectives:

To enable the student to study, understand and appreciate the concepts of mobile communication technology.

Course Outcomes:

After successful completion of the course student will be able to

1. Understand the fundamentals of mobile communications
2. Differentiate between GSM and CDMA
3. Understand the evolving wireless communication technologies.
4. Understand the requirement of 4 G technology

Module No.	Unit No.	Topics	Hrs.
1		**Cellular Communication System**	10
	1.1	**I**ntroduction to Cellular Communications, Frequency reuse, Multiple Access Technologies	
	1.2	**Cellular Processes:** Channel assignment, Call Setup, Handoff strategies, interferences and system capacity	
	1.3	**Traffic Theory:** Trunking and grade of service, improving system capacity	
2		**GSM**	8
	2.1	GSM Network architecture, signaling protocol architecture, identifiers, channels, Frame structure, speech coding, authentication and security, call procedure, handoff procedure, services and features	
3		**CDMA digital cellular standard (1S-95)**.	8
	3.1	Frequency and channel specifications of IS-95, forward and reverse CDMA channel, packet and frame formats, mobility and radio resource management	
4		**3 G Mobile Communication System**	10
	4.1	2.5 G TDMA Evolution Path, GPRS, EDGE , 2.5G CDMA one cellular N/W, Need of 3G Cellular N/w, IMT 2000 Global Standard, UMTS Technology, W-CDMA Air interface, TD-SCDMA Technology, CDMA 2000 Cellular Technology	
5		**4G Wireless Standards**	8
	5.1	Need for 4G network, difference between 3G and 4G, LTE, WiMAX	
6		**Emerging Technologies**	8
	6.1	Mobile Adhoc Network, Mobile IP and Mobility Management, Mobile TCP, Wireless Sensor Networks, RFID Technology	
		Total	52

Recommended Books:

1. Wireless Communications - Theodore S. Rappaport, Prentice Hall of India, PTR publication
2. Mobile & Personal Communication system & Services by Raj Pandya , Prentice –Hall of India (PHI) Private Limited
3. Principles of Wireless Networks-KavehPahlavan, Prashant Krishnamurthy, PHI
4. Wireless communication and Networking-Vijay Garg, ELSEVIER Inc
5. Wireless communication- Singhal_TMH
6. Fundamentals of Wireless Communications, "David Tse and Pramod Viswanath, Publisher, Cambridge University Press.
7. Wireless Communications: Andrea Goldsmith, Cambridge University Press.

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 (Hrs.)			Credits Assigned			
		Theory	Practical	Tutorial	Theory	TW/Practical	Tutorial	Total
EXC 8043	Digital Control System	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	Ave. Of Test 1 and Test 2					
EXC 8043	Digital Control System	20	20	20	80	--	--	--	100

Course Prerequisites:

- EXC404: Principles of Control System
- EXC504: Signals and Systems

Course Objective:

1. To study the importance of digital control
2. To study stability analysis of digital control systems
3. To study the design of digital control systems

Course Outcomes:

1. Students will be able to differentiate between analog and digital control and importance of digital control
2. Student will be able to analyze the digital control systems
3. Students will be able to design digital controllers

Module No.	Unit No.	Topics	Hrs.
1.0		**Introduction**	
	1.1	Why digital control system? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system	**12**
	1.2	Data conversion and quantization, sampling and reconstruction of analog signal, zero and first order hold	
	1.3	Impulse invariance, bilinear transformation, finite difference approximation of derivatives	
2.0		**Modeling of Digital Control System**	**04**
	2.1	Linear difference equation, pulse transfer function, input output model	
	2.2	Examples of first order continuous and discrete time systems	
	2.3	Signal flow graph applied to digital control system	
3.0		**Time Domain Analysis and Stability of Digital Control System**	**08**
	3.1	Mapping between s plane and Z plane, Jury's method, R. H. criteria	
	3.2	Comparison of time response of continuous and digital control system	
	3.3	Steady state analysis of digital control system, effect of sampling on transient response	
4.0		**State Space Analysis**	**08**
	4.1	Discrete time state equation in standard canonical form, similarity transformation	
	4.2	State transition matrix, solution of discrete time state equation	
	4.3	Discretization of continuous state space model and its solution.	
5.0		**Pole Placement and Observer Design**	**10**
	5.1	Concept of reachability, controllability, constructability and observability	
	5.2	Design of controller using pole placement method, dead beat controller design	
	5.3	Concept of duality, state observer design, concept of multi rate output feedback based state estimation	
6.0		**Transfer Function Approach to Controller Design**	**10**
	6.1	Control structures, internal stability,	
	6.2	Internal model principle and system type, well behaved signals	
	6.3	Discretization of PID controllers, pole placement controllers with performance specifications	
		Total	**52**

Recommended Books:

1. M. Gopal, "Digital Control and State Variable Methods", McGraw Hill companies, 3rd edition, 2009.
2. K. Ogata, "Discrete-Time Control Systems", PHI, 2nd edition, 2009.
3. B. C. Kuo, "Digital Control Systems", Oxford University press, 2nd edition, 2007.
4. K. M. Moudgalya, "Digital Control", Wiley India, 2012.

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 (Hrs)			Credit Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tut.	Total
EXC8044	**Biomedical Electronics**	4						**4**

Course code	Course Name	Examination Scheme							
		Theory (out of 100)				Term Work	Practical and oral	Oral	Total
		Internal Assessment (out of 20)			End Sem. Exam				
		Test 1	Test 2	Avg.					
EXC8044	**Biomedical Electronics**	20	20	20	80	--	--	--	**150**

Course Pre-requisites:

- EXC305:Electronic Instruments and Measurements
- FEC102,202: Applied Physics I and II

Course Objective:

1. To make students understand the Identification, classification, and working principle of various Biomedical Instruments used for Bio-potential measurement
2. Application of these instruments in diagnosis, therapeutic treatment and imaging fields

Course Outcome:

The Students will be able to

1. Identify various Bio-potential and their specifications in terms of amplitude and frequency.
2. Understand principle and working of various Biomedical Instruments for diagnosis applications.
3. Decide the applications of therapeutic instruments for treatment purpose.
4. Understand applications of imaging instruments and the modalities involved in each technique.

Module No.	Unit No.	Topics	Hrs.
1		**Bio-Potential and Measurement**	08
	1.1	Structure of Cell, Origin of Bio-potential, electrical activity of cell their characteristic and specifications.	
	1.2	Measurement of RMP and AP. Electrode-Electrolyte interface and types of bio-potential electrodes.	
2		**Physiological Systems and Related Measurement**	14
	2.1	Respiratory system- Physiology of respiration and measurements of respiratory related parameters	
	2.2	Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias	
	2.3	Nervous system- Nerve cell, neuronal communication, nerve-muscle physiology, CNS, PNS. Generation of EEG and its measurement. Normal and abnormal EEG, evoked potential and epilepsy	
	2.4	Muscular system- Generation of EMG signal, specification and measurement.	
		Design of ECG amplifier	
3		**Cardiovascular Measurement**	08
	3.1	Blood Pressure- Direct and Indirect types. Blood Flow- Electromagnetic and Ultrasonic types. Blood Volume- Types of Plethysmography. (Impedance, Capacitive and Photoelectric) Cardiac Output- Flicks method, Dye-dilution and Thermo-dilution type. Heart sound measurement	
4		**Life support Instruments**	08
	4.1	Pacemaker- Types of Pacemaker, mode of pacing and its application. Defibrillator- AC and DC Defibrillators and their application. Heart Lung machine and its application during surgery. Haemodialysis system and the precautions to be taken during dialysis. Baby Incubator and its application	
5		**Imaging Techniques**	10
	5.1	X-Ray- Generation, X-ray tube and its control, X-ray machine and its application	
	5.2	CT Scan- CT Number, Block Diagram, scanning system and application. Ultrasound Imaging- Modes of scanning and their application	
	5.3	MRI- Concepts and image generation, block diagram and its application	
6		**Significance of Electrical Safety**	04
	6.1	Physiological effects of electrical current, Shock Hazards from electrical equipments and methods of accident prevention.	
		Total	52

Recommended Books:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education, 1980.
2. John G. Webster, "Medical Instrumentation", John Wiley and Sons, 4th edition, 2010.
3. R. S. Khandpur, "Biomedical Instrumentation", TMH, 2004
4. Richard Aston, "Principles of Biomedical Instrumentation and Instruments", PH, 1991.
5. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", PHI/Pearson Education, 4th edition, 2001.
6. John E Hall, Gyton's Medical Physiology, 12th edition, 2011

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	Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL 801	CMOS VLSI Design Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXL801	CMOS VLSI Design Laboratory	--	--	--	--	25	--	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC801** 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 **EXC801**.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL 802	Advanced Networking Technologies Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXL802	Advanced Networking Technologies Laboratory	--	--	--	--	25	--	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC802** 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 **EXC802**.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL 803	MEMS Technology Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXL803	MEMS Technology Laboratory	--	--	--	--	25	--	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXC803** 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 **EXC803**.

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXL 804X	Elective –II Laboratory	--	02	--	--	01	--	01

Course Code	Course Name	Examination Scheme							
		Theory Marks				Term Work	Practical and Oral	Oral	Total
		Internal assessment			End Sem. Exam				
		Test 1	Test 2	Ave. Of Test 1 and Test 2					
EXL 804X	Elective –II Laboratory	--	--	--	--	25	--	25	50

Term Work:
At least 10 experiments based on the entire syllabus of Subject **EXE804X** 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 **EXE804X**.

Elective –II

Code	Name of Elective
EXC8041	Robotics
EXC8042	Mobile Communication
EXC8043	Digital Control System
EXC8044	Biomedical Electronics

Course Code	Course Name	Teaching Scheme			Credits Assigned			
		Theory	Practical	Tutorial	Theory	Practical	Tutorial	Total
EXC806	Project - II	--	04	--	--	02	--	02

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					
EXC806	Project - II	--	--	--	--	50	-	50	100

Term Work:

The final year students have already under gone project assignment in their seventh semester and in this semester the students are expected to continue the project work of stage I.

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)
- Design, implementation, and analysis of the project work.
- Results, conclusions and future scope.
- 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.