Bharatiya Vidya Bhavan's

Sardar Patel Institute of Technology

(Autonomous Institute Affiliated to University of Mumbai)

Bachelor of Engineering/Technology (B.E./B.Tech)
in
Electronics Engineering

Final Year Engineering
(Sem. VII and Sem. VIII)
Effective from Academic Year 2017 -18

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Preamble:

Concept of academic autonomy is based on the argument that Institutions can undertake the work expected of them by all stakeholders such as Students , Parents , University , Industry , Society in general, only if they have freedom of choice and action.

We at S.P.I.T. would like to believe that this freedom of choice and action as far as academics is concerned will make us more Proactive in our offerings.

An academic autonomy is as good as its Curricula and execution of it is as well as its faculty. S.P.I.T. is confident of succeeding on both the fronts.

In the first offering we have tried to pro-actively bridge the ever discussed "Industry-academic gap" by way of our SCOPE program. The issue about sensitizing students to social needs is being addressed by special activity based courses. Liberal arts courses have been introduced to enhance functionality of both sides of brain. In all this the professional core has not been overlooked. Thus the curricula are designed to achieve multi dimensional outcomes.

The evaluation mechanism is tuned for assessing the attainment of the designed outcomes and is designed as a fair mechanism.

As our learning cycle begins from July 2017, I wish to place on record that entire S.P.I.T. staff and faculty will work with singular focus and commitment towards the success of this endeavour.

Dr. Prachi Gharpure
Principal, S.P.I.T.

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From the Desk of Dean Academics and Head of Electronics Engg. Dept.

Greetings and congratulations to all the students, teaching and supporting staff of Sardar Patel Institute of Technology for getting autonomous status to the institute from the year 2017-18. We look towards autonomy as a great opportunity to design and implement curriculum sensitive to needs of Indian Society and Industries.

In the proposed curriculum we have made an attempt to provide opportunity for students to develop themselves as competent engineering graduates with knowledge, skill and ethical behavior required for global career. Curriculum is designed to provide multiple learning opportunities for students to acquire and demonstrate competencies for rewarding careers. The curriculum model is outcome based that focuses on learning by doing. This is achieved through activity based learning, minor projects, problem solving and innovative styles of pedagogy. Various steps are taken to transform teaching-learning process to make learning a joyful experience for students. Special laboratory based courses are introduced to give more practical exposure to the students.

To create socially responsible citizen curriculum offers courses like Constitution of India, Environmental Studies and Human Health Systems Approach. Also various activity based learning modules like 'Building Automation, Fire Safety and Electronic Security', 'Occupational Safety & Legal Studies for Engineers', 'Technical Presentation Skills', 'Technical Paper and Patent Drafting', 'Engineering Solution for Environmental Problems' and 'Financial Planning, Taxation Policies and Investment' are introduced. For overall development of the learner, various elective courses like Yoga Vidya, Music Appreciation, Dramatics, Industrial and Organizational Psychology, Law for Engineers, French Language, German Language etc. are introduced. To encourage interdisciplinary studies institute level Open Elective courses are offered.

One of the special feature of this curriculum is Skill development programme called SCOPE (Skill Certification for Outcome-Based Professional Education) planned to enhance employability, innovation and research culture in the institute. Every department is offering six domain specific tracks, each track containing six courses. Student will have an opportunity to enroll for more than 140 courses in any of the department of his choice. Some of the courses under SCOPE will be delivered in co-ordination with industries.

We believe that this curriculum will raise the bar of academic standards with the active involvement and cooperation from students, academic and administrative units. Faculty of S.P.I.T. deserves a special appreciation for their relentless efforts in designing curriculum and assessment instruments which will bring transformation in the quality and transparency in assessment of learners.

Looking forward for your active cooperation and constructive feedback to create vibrant and joyful learning environment at Sardar Patel Institute of Technology.

Dr. Surendra Singh Rathod
Professor and Dean Academics

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Scheme for B.E./B.Tech Electronics Engineering (SEM VII)					
SEM VII					
Course Code	**Course Name**	**Teaching Scheme (Hrs/week)**			**Credits**
		L	**T**	**P**	**Total**
EXC701	Embedded System Design	4	--	--	4
EXC702	IC Technology	4	--	--	4
EXC703	Power Electronics –II	4	--	--	4
EXC704	Computer Communication Networks	4	--	--	4
EXC 705X	Elective - I	4	--	--	4
EXC 706	Project - I	--	--	4	2
EXL701	Embedded System Design Laboratory	--	--	2	1
EXL702	IC Technology Laboratory	--	--	2	1
EXL703	Power Electronics –II Laboratory	--	--	2	1
EXL704	Computer Communication Networks Laboratory	--	--	2	1
EXL 705X	Elective - I Laboratory	--	--	2	1
	Total	20	--	14	27

Elective – I

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

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Scheme for B.Tech./B.Tech Electronics Engineering (SEM VIII)					
SEM VIII					
Course Code	**Course Name**	**Teaching Scheme (Hrs/week)**			**Credits**
		L	**T**	**P**	**Total**
EXC801	CMOS VLSI Design	4	--	--	4
EXC802	Advanced Networking Technologies	4	--	--	4
EXC803	MEMS Technology	4	--	--	4
EXC804X	Elective -II	4	--	--	4
EXC806	Project (Stage II)	--	--	4	4
EXL801	CMOS VLSI Design Laboratory	--	--	2	1
EXL802	Advanced Networking Technologies Laboratory	--	--	2	1
EXL803	MEMS Technology Laboratory	--	--	2	1
EXL804X	Elective -II Laboratory	--	--	2	1
	Total	16	--	12	24

Elective – I

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

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Semester VII

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC701	Embedded System Design	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		
		10		30		100 (60% Weightage)		

Pre-requisite Course Codes		EXC403: Microprocessor and Peripherals EXC501: Microcontroller & Applications
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Discuss the fundamentals of embedded systems and communication protocols
	CO2	Decide the use of MSP430, ARM and Reconfigurable hardware for given applications
	CO3	Examine the working of Real time operating systems
	CO4	Compare Simulation, testing and debugging methods
	CO5	Design Embedded System for given application

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Fundamentals of Embedded System**		08
	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.	1,5	
	1.2	Characteristics and quality attributes (Design Metric) of embedded system. Real time system's requirements, real time issues, interrupt latency.	1,5	
	1.3	Embedded Product development life cycle, Program modeling concepts: DFG, FSM, Petri-net, UML	1,5,3	
2		**Embedded Serial Communication**		04
	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	1,5	
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).	11	
	3.2	Introduction to ARM-v7-M (Cortex-M3), Comparison of ARM-v7-A (CortexA8), ARM-v7-R (CortexR4), ARM-v7-M (Cortex-M3)	3,8,9	
	3.3	Direct digital solution using CPLD, FPGA, its advantages, and	3,8	

		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).	1,5	
	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.	1,5	
	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	
	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.	1,5	
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.	1,5,2	
			Total	**52**

References:

[1] Embedded Systems, Rajkamal , TMH, Edition 2008.

[2] Frank Vahid - Embedded Systems , Wiley India, Edition 2002

[3] ARM System-on-Chip Architecture, Steve Furber - Pearson Edition 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, Edition 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.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC702	IC Technology	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE	ESE			
		10		30	100 (60% Weightage)			

Pre-requisite Course Codes	EXC302: Electronic Devices EXC303: Digital Circuits and Design EXC402: Discrete Electronic Circuits EXC502: Design With Linear Integrated Circuits EXC601: VLSI Design
At the end of successful completion of the course, student will be able to	
Course Outcomes	CO1 Discuss integrated circuit fabrication processes
	CO2 Illustrate the sequence of process of semiconductor device fabrication
	CO3 Discuss the semiconductor parameter measurement techniques
	CO4 Interpret the physical mechanism of novel semiconductor devices
	CO5 Summarize features of novel semiconductor devices and justify use of these devices in an application

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Environment and Crystal Growth for VLSI Technology**		08
	1.1	**Environment:** Semiconductor technology trend, Clean rooms, Wafer cleaning	1,2,3,4	
	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	1,2,3,4	
2		**Fabrication Processes Part 1**		10
	2.1	**Deposition:** Evaporation, Sputtering and Chemical Vapor Deposition	1,2,3,4	
	2.2	**Epitaxy:** Molecular Beam Epitaxy, Vapor Phase Epitaxy, Liquid Phase Epitaxy, Evaluation of epitaxial layers	1,2,3,4	
	2.3	**Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality, high κ and low κ dielectrics	1,2,3,4	
	2.4	**Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, impurity behavior, diffusion systems, problems in diffusion, evaluation of diffused layers	1,2,3,4	
	2.5	**Ion Implantation:** Penetration range, ion implantation systems, process considerations, implantation damage and annealing	1,2,3,4	
3		**Fabrication Processess Part 2**		10
	3.1	**Etching:** Wet chemical etching, dry physical etching, dry chemical	1,2,3,4	

		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	1,2,3,4	
	3.3	**Device Isolation, Contacts and Metallization:** Junction and oxide isolation, LOCOS, trench isolation, Schottky contacts, Ohmic contacts, Metallization and Packaging	1,2,3,4	
	3.4	**CMOS Process Flow:** N well, P-well and Twin tub	1,2,3,4	
	3.5	Design rules, Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact	1,2,3,4	
4		**Measurements, Packaging and Testing**		**10**
	4.1	**Semiconductor Measurements:** Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility, Minority Carrier Lifetime and diffusion length	7	
	4.2	**Packaging:** Integrated circuit packages, Electronics package reliability	9	
	4.3	**Testing:** Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality	10	
5		**SOI, GaAs and Bipolar Technologies**		**8**
	5.1	**SOI Technology:** SOI fabrication using SIMOX, Bonded SOI and Smart Cut, PD SOI and FD SOI Device structure and their features	5	
	5.2	**GaAs Technologies:** MESFET Technology, Digital Technologies, MMIC technologies, MODFET and Optoelectronic Devices	8	
	5.3	**Silicon Bipolar Technologies:** Second order effects in bipolar transistor, Performance of BJT, Bipolar processes and BiCMOS	8	
6		**Novel Devices**		**6**
	6.1	**Multigate Device:** Various multigate device configurations (device structure and important features)	6	
	6.2	**Nanowire:** Fabrication and applications	8	
	6.3	**Graphene Device:** Carbon nanotube transistor fabrication, CNT applications	8	
			Total	**52**

References:

[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, Second 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, First edition.

[6] Jean-Pierre Colinge, "FinFETs and Other Multigate Transistors", Springer, First edition

[7] M. S. Tyagi, "Introduction to Semiconductor Materials and Devices", John Wiley and Sons, First 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

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC703	Power Electronics II	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		
		10		30		100 (60% Weightage)		

Pre-requisite Course Codes		EXC 604: Power Electronics – I EXC 404: Principles of Control Systems
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Analyze different methods of power converters.
	CO2	Describe power electronic applications.
	CO3	Analyze different power electronic application in DC Drives.
	CO4	Analyze different power electronic application in AC Drives.

Module No.	Unit No.	Topics	Ref.	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	3	
	1.2	PWM for 3-phase voltage source inverters, Space Vector Modulation (SVM) technique for 3-phase voltage source inverters, hysteresis control.	3	
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).	7	
3		**Power Electronic Applications**		6
	3.1	Use of power electronic systems in SMPS, Battery charging systems, UPS and Induction heating.	2	
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	1,4	
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.	1, 4	

Total	**52**

References:

[1] M. Rashid, Power Electronics: Circuits, Devices, and Applications, PHI, Third Edition.

[2]. By M. D. Singh, K. B. Khanchandani, Power Electronics, Tata McGraw Hill, Second Edition.

[3]. Mohan, Undeland and Riobbins, Power Electronics: Converters, Applications and Design, Wiley (Student Edition), Second Edition.

[4]. P. S. Bimbhra, Power Electronics, Khanna Publishers, Edition 2012.

[5]. R. W. Erickson, D. Maksimovic, Fundamentals of Power Electronics, Springer, Second Edition.

[6]. J. P. Agrawal, Power Electronics Systems: Theory and Design, Pearson Education, Edition 2002.

[7]. S. Bacha, I. Munteanu and A. Bratcu, Power Electronic Converters: Modeling and Control, Springer-Verlag, Edition 2014.

[8]. H. Sira-Ramírez, R. Silva-Ortigoza, Control Design Techniques in Power Electronics Devices, Springer-Verlag, Edition 2006

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC704	Computer Communication and Networks	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE	ESE			
		10		30	100 (60% Weightage)			

Pre-requisite Course Codes		EXC 405: Fundamentals of Communication Engineering EXC:504: Digital Communication
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Name different types of communication networks and modes of data transmission in digital transmission systems.
	CO2	Identify error control techniques and protocols associated with data link layer of the OSI model
	CO3	Summarize various routing and routed protocols associated with network layer
	CO4	Summarize congestion control mechanisms used in circuit and packet switched communication networks associated with transport layer.
	CO5	Demonstrate the significance of software layer protocols and IP addressing schemes used in networking using software tools

Module No.	Unit No.	Topics	Ref.	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	1,2,3	
	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**		8
	2.1	Introduction to physical media, Coax, fiber, twisted pair, DSL, HFC	1,2,3	
	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	1,2,3	
	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	1,2,3	

3		**Data Link Layer Protocol**		**10**
	3.1	PPP, HDLC, Stop and wait protocol	1,2,3	
4		**Network Layer Services and Protocols**		**10**
	4.1	Switching fabric, Routing and forwarding, Queues and buffering, Virtual-circuit and datagram networks, Internet protocol	1,2,3	
	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**		**8**
	5.1	GBN and SR. TCP and UDP. Port numbers, Multiplexing and de-multiplexing	1,2,3	
	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**.		**6**
	6.1	Application layer protocols such as HTTP, FTP, and SMTP,	1,2,3	
	6.2	Peer-to-Peer File Sharing Protocols and Architectures, ISPs and Domain name systems, Socket API and network socket programming	1,2,3	
			Total	**52**

References:

[1] B. A. Forouzan, "Data Communications and Networking", TMH, Fourth Edition.

[2] S. Tanenbaum, "Computer Networks", Pearson Education, Fourth Edition.

[3] Computer Networking: A Top-Down Approach, by J. F. Kurose and K. W. Ross, Addison Wesley, Fifth Edition.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC7051	Digital Image Processing	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		
		10		30		100 (60% Weightage)		

Pre-requisite Course Codes		EXS 401 : Applied Mathematics IV EXC 504 : Signal and Systems
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Discuss the fundamental concepts of digital image processing
	CO2	Discuss image enhancement and segmentation techniques
	CO3	Apply suitable operators for binary image processing
	CO4	Apply suitable transform techniques on digital image
	CO5	Discuss digital image compression and decompression techniques

Module No.	Unit No.	Topics	Ref.	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	1,2,3	
	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)	1,2,3	
2		**Image Enhancement**		08
	2.1	Spatial Domain Methods, Frequency Domain Methods, Some Simple Intensity Transformations, Histogram Processing, Image Subtraction, Image Averaging, Background	1,2,3	
	2.2	Smoothing Filters, Sharpening Filters, Lowpass Filtering, Highpass Filtering, Generation of Spatial Masks from Frequency Domain Specifications. Homomorphic Filtering.	1,2,3	
3		**Image Segmentation and Representation**		08
	3.1	Detection of Discontinuities, Edge Linking using Hough Transform, Thresholding, Region based Segmentation, Split and Merge Technique	1,2,3	
	3.2	Image Representation and Description, Chain Code, Polygonal, Representation, Shape Number, Moments.	1,2,3	
4		**Binary Image Processing**		06
	4.1	Binary Morphological Operators, Hit-or-Miss Transformation, Boundary Extraction, Region Filling, Thinning and Thickening,	1,2,3	

		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),	1,2,3	
	5.2	Discrete Hadamard Transform(DHT), Fast Hadamard Transform(FHT), Discrete Cosine Transform(DCT), Discrete Wavelet Transform(DWT),	1,2,3	
6		**Image Compression:**		**12**
	6.1	Fundamentals – Coding Redundancy, Interpixel Redundancy, Psychovisual Redundancy, Fidelity Criteria.	1,2,3	
	6.2	Image Compression Models – The Source Encoder and Decoder, Lossless Compression Techniques : Run Length Coding, Arithmetic Coding, Huffman Coding, Differential PCM,	1,2,3	
	6.3	Lossy Compression Techniques: Improved Gray Scale Quantization, Vector Quantization, JPEG, MPEG-1.	1,2,3	
			Total	**52**

References:

[1] Rafel C. Gonzalez and Richard E. Woods, 'Digital Image Processing', Pearson Education Asia, Third Edition.

[2] S. Jayaraman, E.Esakkirajan and T.Veerkumar, "Digital Image Processing" TataMcGraw Hill Education Private Ltd.

[3]. Anil K. Jain, "Fundamentals and Digital Image Processing", Prentice Hall of India Private Ltd, Third Edition.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC7052	Artificial Intelligence	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE	ESE			
		10		30	100 (60% Weightage)			

Pre-requisite Course Codes		Knowledge of linear algebra, multivariate calculus, and probability theory Knowledge of a programming language (MATLAB /C/C ++ recommended)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Classify different types of neural networks
	CO2	Identify type of neural network algorithm for given application
	CO3	Design a neural network for a given application
	CO4	Apply different fuzzy operations to design fuzzy controller

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Fundamental Concepts of Neural Networks**		08
	1.1	Difference between fuzzy and crisp sets and applications of fuzzy logic	4	
	1.2	Biological neurons, McCulloch and Pitts models *of* neuron, Important Terms of ANNs, McCulloch-Pitts Neuron, Hebb Network, Supervised learning	3,2	
	1.3	Applications and scope of Neural Network	3	
2		**Supervised Learning Networks**		12
	2.1	Perception Networks: Adaline, Madaline	3,2	
	2.2	Back Propagation Network	3	
	2.3	Function Network	3	
3		**Unsupervised learning network**		12
	3.1	Max Net, Mexican Hat, Kohonen Self-organizing Feature	3	
	3.2	Maps, Learning Vector Quantization, Adaptive Resonance Theory	3	
4		**Associative networks**		10
	4.1	Pattern Association, Auto-associative Memory Network, Hetero-associative Memory Network, Bidirectional Associative Memory, Discrete Hopfield Networks	3	
	4.2	**Special networks:** Simulated annealing neural networks, Boltzmann machine, Brain-in-a-Box	3	
5		**Fuzzy Logic**		10
	5.1	Fuzzy sets, Properties, Operations on fuzzy sets, Fuzzy relation Operations on fuzzy relations,	4,3	

	5.2	The extension principle, Fuzzy mean Membership functions, Fuzzification and defuzzification methods	4,3	
	5.3	Fuzzy controllers, Adaptive neuro-fuzzy information systems (ANFIS)		
			Total	**42**

References:

[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

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC7053	ASIC Verification	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		
		10		30		100 (60% Weightage)		

Pre-requisite Course Codes		EXL304: Object Oriented Programming Methodology Laboratory EXC303: Digital Circuits and Design
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Recognise trends in ASIC verification
	CO2	Apply SystemVerilog constructs for verification
	CO3	Create testbenches, threads and show interprocess communication
	CO4	Create test cases under constrained environment
	CO5	Validate design with SystemVerilog assertions and functional coverage
	CO6	Interface SystemVerilog with other languages

Module No.	Unit No.	Topics	Ref.	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	6	
	1.2	**Verilog HDL:** Data types, expressions, assignments, behavioral, gate and switch level modeling, tasks and functions	7	
	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	1,5	
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	1,2,4	
	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	1,2,4	
	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	1,2,4	

		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	1,2,4	
	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	1,2,4	
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	1,2,4	
	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	1,2,4	
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	3	
	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	1,2,4	
6		**Advanced interfaces and interfacing with C**		**06**
	6.1	**Advanced Interfaces:** Virtual interfaces with the ATM router, Connecting to multiple design configurations, procedural code in an interface	1,2,4	
	6.2	**A complete System Verilog Testbench:** Design blocks, testbench blocks, alternate tests	1,2,4	
	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	1,2,4	
			Total	**52**

References:

[1] Chris Spear, "System Verilog for Verification: A guide to learning the testbench language features", Springer, Second 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, Second Edition.

[3] Ben Cohen, Srinivasan Venkataramanan, Ajeetha Kumari and Lisa Piper, "SystemVerilog Assertions Handbook", VhdlCohen Publishing, Third 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, First Edition.

[6] Spartan and Virtex family user manuals from Xilinx

[7] Verilog Language Reference manual

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC7054	Optical Fiber Communication	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE	ESE			
		10		30	100 (60% Weightage)			

Pre-requisite Course Codes		EXC503: Electromagnetic Engineering EXC405: Fundamentals of Communication Engineering EXC505: Digital Communication.
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Discuss the fundamental principles of optics and light wave
	CO2	Describe construction and working principle of optical fiber communication system
	CO3	Outline transmission characteristics of optical fiber
	CO4	Discuss operational principle optical networks
	CO5	Calculate link budget parameters and list several optical network management functions

Module No.	Unit No.	Topics	Ref.	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	1,2,3	
	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	1,2,3	
	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	1,2,3	

	3.2	Couplers/splicer, wavelength division multiplexers and de-multiplexers	1,2,3	
	3.3	Filters, isolators and optical switches	1,2,3	
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,	1,2,3	
	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	1,2,3	
	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	1,2,3,4	
	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**

References:

[1] John M. Senior, "Optical Fiber Communication", Prentice Hall of India Publication, Chicago, Third Edition.

[2] Gred Keiser, "Optical Fiber Communication", Mc-Graw Hill Publication , Singapore, Fourth Edition.

[3] G Agarwal, "Fiber Optic Communication Systems", John Wiley and Sons, Third Edition.

[4] S.C. Gupta, "Optoelectronic Devices and Systems", Prentice Hall of India Publication, Chicago.

Sardar Patel Institute of Technology

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC706	Project (Stage I)	--	--	4	--	--	2	2
		Examination Scheme						
		Term Work		Practical		Oral		Total
		Phase-I:20 Phase-II:30		--		50		100

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.

Sardar Patel Institute of Technology

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL701	Embedded System Design Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE			ESE			Total
					Practical		Oral	
		40			--		20	60

Pre-requisite Course Codes		EXC701 (Embedded System Design)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Set-up simulation environment for programming several microcontroller architectures
	CO2	Interface various peripherals with the microcontrollers
	CO3	Compose procedure for initialization of internal peripherals of different microcontroller architectures
	CO4	Design and develop embedded system applications
	CO5	Test and debug embedded system applications
	CO6	Perform in a team to implement an embedded application

Exp. No.	Experiment Details	Ref.	Marks
1	Programming of NXP LPC11U24 using ARMmbed Compiler.(led blink, counter, Pot)	1	5
2	Interfacing of NXP LPC11U24 (7 segment display, traffic signal).	1	5
3	Programming of MSP430 Launchpad (led blink, counter, interrupt, and timer).	2	5
4	Programming of PSOC CY8CKIT- 030 PSOC 3 (Led blink, counter)	3	5
5	Programming of PSOC CY8CKIT- 050 PSOC 5 (LCD interfacing, ADC)	3	5
6	Programming of PSOC CY8CKIT- 050 PSOC 5 (Capsence)	3	5
7	RTOS Programming (Free RTOS).	4	5
8	Programming of C2000	5	5
		Total Marks	40

References:

[1] https://developer.mbed.org/
[2] MSP430 user Manual
[3] PSoC user Manual
[4] DR.K.V.K.K. Prasad - Embedded / real time system, Dreamtech
[5] C2000 user Manual

Sardar Patel Institute of Technology

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL702	IC Technology Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE			ESE			Total
					Practical		Oral	
		40			--		20	60

Pre-requisite Course Codes		EXC702 (IC Technology)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Make use of modern tools available for process and layout simulation
	CO2	Compose simulation program for a fabrication process to arrive at valid conclusion
	CO3	Draw layout and sketch characteristics of MOS circuit to arrive at valid conclusion
	CO4	Validate device characteristics via simulations to arrive at valid conclusion
	CO5	Build layout as per the design rules

Exp. No.	Experiment Details	Ref.	Marks
1	Draw and simulate layout for the CMOS inverter. Carry out static as well as transient simulation. Analyze CMOS inverter for i) (W/L)pmos>(W/L)nmos ii) (W/L)pmos=(W/L)nmos iii) (W/L)pmos<(W/L)nmos. Do parasitic extraction. Feed these parasitic in circuit simulator and do layout versus schematic verification.	3,5	5
2	Draw and simulate layout for the following circuits. Size them with respect to reference inverter. a. CMOS NAND b. CMOS NOR Also observe the effect of different types of design rules on above circuits and tabulate the comparative results	3,5	5
3	Draw and simulate layout for the given equation (each student will get different equation [y= $\overline{A.B + C.D}$]) with the following design style a. Static CMOS b. Transmission gate c. Dynamic Logic	3,5	5
4	Simulate n type and p type MOSFETs (bulk, SOI and Double Gate) to obtain family of ID-VG and ID-VD characteristics. Compare the results obtained. (Tool: a TCAD lab on nanohub.org)	1,4	5
5	Simulate Carbon Nanotube MOSFET for different conditions (e.g. gate/drain voltage sweep, threshold voltage etc.) and comment on the	1,3	5

	1,3results obtained. (Tool: FETToy on nanohub.org)		
6	Simulate Silicon Nanowire MOSFET for different conditions (e.g. gate/drain voltage sweep, threshold voltage etc.) and comment on the results obtained. (Tool: FETToy on nanohub.org)	1,3	**5**
7	Simulate FinFET to plot energy band diagram and IV characteristics for different values of gate and drain bias. Comment on the results obtained. (Tool: MuGFET on nanohub.org)	4	**5**
8	Simulate SOI MOSFET and plot its characteristics. (Tool: Visual TCAD/Mentor)	2, 4	**5**
		Total Marks	**40**

References:

[1] *www.nanohub.org*

[2] Visual TCAD lab manual

[3] James D. Plummer, Michael D. Deal and Peter B. Griffin, "*Silicon VLSI Technology*", Pearson, Indian Edition

[4] Jean-Pierre Colinge, "*FinFETs and Other Multigate Transistors",* Springer, 1st edition

[5] Microwind User Manual

Sardar Patel Institute of Technology

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL703	Power Electronics –II Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE				Total
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC703 (Power Electronics - II)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Make use of simulation tool to simulate power electronic system and comment on its performance
	CO2	Analyze converters considering their practical issues
	CO3	Construct model of DC-DC converters using different techniques
	CO4	Analyze the given DC and AC drives

Exp. No.	Experiment Details	Ref.	Marks
1	Evaluation of the effect of source Inductance on performance of Half wave controlled rectifier.	3	5
2	Evaluation of the effect of source Inductance on performance of Full wave controlled rectifier.	3	5
3	Analysis of Space Vector Modulated 3 phase VSI using Simulation software.	3	5
4	Analysis of 3 phase PWM VSI using Simulation software.	3	5
5	Analysis of Semi-Converter Drive used for driving separately excited DC Shunt Motor	1	5
6	Analysis of Full-Converter Drive used for driving separately exciter DC Shunt Motor.	1	5
7	Speed control analysis of 3 phase induction motor using V/F method.	4	5
8	Feedback control of Buck/Boost converter using PMLK.	3	5
		Total Marks	40

References:

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

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL704	Computer Communication Networks Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE			Total	
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC704 (Computer Communication Networks)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Identify the scope of various networking commands in real time scenario
	CO2	Create socket programming for linux with a server and client
	CO3	Compose program to get logical results related to data link layer protocols
	CO4	Adapt open source packet analyzers for communication networks
	CO5	Implement secure client server environment

Exp. No.	Experiment Details	Ref.	Marks
1	Get acquainted with some commonly used networking commands	1	5
2	FTP Server Configuration	1	5
3	Web Server Configuration	1	5
4	Firewall Configuration	1	5
5	Simulate a network using Packet Tracer	2	5
6	Design Ethernet using opnet software	3	5
7	Design Token Ring using opnet software	3	5
8	Design Switched Lan using opnet software	3	5
		Total Marks	40

References:

[1] CCN Lab manual
[2] Packet Tracer software
[3] Opnet software and manual

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL7051	Digital Image Processing Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE			Total	
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC7051 (Digital Image Processing)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Discuss the fundamental concepts of digital image processing
	CO2	Discuss image enhancement and segmentation techniques
	CO3	Apply suitable operators for binary image processing
	CO4	Apply suitable transform techniques on digital image
	CO5	Discuss digital image compression and decompression techniques

Exp. No.	Experiment Details	Ref.	Marks
1	Image Enhancement [Any one Experiment] 1.To enhance image using Histogram Equalization 2. To enhance image using Contrast Stretching		5
2	Image Enhancement [Any one Experiment] 1. To enhance image using spatial filtering 2. To perform Colour Image Enhancement		5
3	Image Segmentation [Any one Experiment] 1. To find edges using LOG and DOG 2. To find Edges using Prewit/ Sobel/ Fri-chen / Robert operators.		5
4	Image Segmentation [Any one Experiment] 1. To find edges using canny Edge Detection. 2. To implement Morphological Operators		5
5	Image Compression [Any one Experiment] 1. To compress using Huffman coding 2. To compress DCT coefficient of Image		5
6	Image Compression [Any one Experiment] 1. To compress Wavelet Coefficient of Image. 2. To compress Binary Image using Run Length Coding		5
7	Digital Watermarking		5
8	Person Tracking using DWT		5
	Total Marks		**40**

References:
As recommended by faculty.

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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL7052	Artificial Intelligence	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE				Total
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC7052 (Artificial Intelligence)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Evaluate mathematical model of binary classification
	CO2	Validate training and testing of neural network algorithms
	CO3	Construct a model of fuzzy controller
	CO4	Develop neural network based application

Exp. No.	Experiment Details	Ref.	Marks
1	**Aim: Develop a Radial Basis Function Network (RBFN) for speech (gender) recognition** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) ii) Train RBFN network iii) Vary spread parameter iv) Calculate efficiency for different values of spread factor		5
2	**Aim: Develop a Generalized Regression Neural network for speech gender recognition** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) ii) Train GRN network iii) Vary spread parameter iv) Calculate efficiency for different values of spread factor		5
3	**Aim: Develop a Probabilistic Neural network for speech (gender) recognition** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) ii) Train PNN network iii) Vary spread parameter iv) Calculate efficiency for different values of spread factor		5

4	**Aim: Develop a Competitive layer Neural network for speech recognition for gender classification** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) ii) Train CLNN network iii) Vary learning rate for kohonen weights iv) Calculate efficiency for different values of learning rate		**5**
5	**Aim: Develop a Cascade Forward Neural network for speech recognition forgender classification** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) ii) Vary the hidden layer iii) Train CFNN network iv) Calculate efficiency for different values of hidden layer		**5**
6	**Aim: Develop a Linear Vector Quantization Neural network for speech recognition forgender classification** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) out of which 10 samples for testing and 10 samples for training. ii) Vary the hidden layer iii) Train LVQ network iv) Calculate efficiency for different values of hidden layer		**5**
7	**Aim: Develop a Feed Forward Neural Network for speech recognition for gender classification** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) out of which 10 samples for testing and 10 samples for training. ii) Vary the hidden layer iii) Train FFNN network iv) Calculate efficiency for different values of hidden layer		**5**
8	**Aim: Develop a Pattern recognition Neural Network for speech recognition for gender classification** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) out of which 10 samples for testing and 10 samples for training. ii) Vary the hidden layer		**5**

	iii) Train PRNN network iv) Calculate efficiency for different values of hidden layer		
9	**Aim: Develop a Support Vector Machine (SVM) model for speech (gender) recognition** **Problem definition:** i) Collect audio samples for different gender(20 for male & 20 for female) out of which 10 samples for testing and 10 samples for training. ii) Feature extraction of samples iii) Training & testing using SVM model **iv)** Calculate of efficiency		**5**
10	**Aim: To implement the working of Fuzzy logic** **Problem definition:** i) Initialize a fuzzy logic controller example ii) Observe the variations in the output for change in rules		**5**
		Total Marks	**40**

References:
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL7053	ASIC Verification Lab	--	--	2	--	--	1	1
		Examination Scheme						
		ISE			ESE			Total
					Practical		Oral	
		40			--		20	60

Pre-requisite Course Codes		EXC7053 (ASIC Verification)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Install and use modern tools available for verification
	CO2	Compose the SystemVerilog code for verification
	CO3	Construct testbench for verification
	CO4	Investigate the given verification code
	CO5	Validate the code under constrained environments
	CO6	Debate the results of verification tool

Exp. No.	Experiment Details	Ref.	Marks
1	1. Simulate verilog code for a. D Flip-Flop (Using EDA Playground) b. 2:1 Mux : Using case Statement c. 4-bit Ripple Carry Full Adder by instantiating one bit full adder d. D Flip Flop using gates e. Example for blocking and non-blocking statements f. 8-Bit Up Counter With Load Do simulation, synthesis, implementation and physical verification of any one of above Verilog design of your choice on given CPLD/FPGA platform.	1,2	5
2	Complete the given task on literals and data types in SystemVerilog Also write the simulation output for the given Procedural Statements	3,4	5
3	Write the simulation output for the given Interprocess Communication	3,4	5
4	Write the simulation output for the given randomization code	3,4	5
5	Write the simulation output for the given Interfaces, Program and Clocking Blocks	3,4	5
6	Write the simulation output for the given Processes	3,4	5
7	Write the simulation output for the given Functional Coverage	3,4	5
8	Write the simulation output for the given Assertions	3,4	5
		Total Marks	40

References:

[1] Spartan and Virtex family user manuals from Xilinx
[2]Verilog Language Reference manual
[3]System Verilog Language Reference manual
[4] Chris Spear, "System Verilog for Verification: A guide to learning the testbench language features", Springer, 2nd Edition

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL7054	Optical Fiber Communication Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE				Total
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC7053 (Optical Fiber Communication)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Discuss the fundamental principles of optics and light wave
	CO2	Describe construction and working principle of optical fiber communication system
	CO3	Outline transmission characteristics of optical fiber
	CO4	Discuss operational principle optical networks
	CO5	Calculate link budget parameters and list several optical network management functions

Exp. No.	Experiment Details	Ref.	Marks
1	Measurement of Numerical Aperture of a given optical fiber.		5
2	Measurement of propagation loss and bending loss of two different wavelengths.		5
3	Study of characteristics of fiber optics LED and photo-detector.		5
4	Study the characteristics of LASER.		5
5	Study of Eye Pattern.		5
6	Study and measurement of bit error rate.		5
7	Fiber optic bi-directional communication		5
8	Wavelength Division Multiplexing		5
		Total Marks	40

References:
As recommended by faculty.

Sardar Patel Institute of Technology
Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Semester VII

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC801	CMOS VLSI Design	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		
		10		30		100 (60% Weightage)		

Pre-requisite Course Codes	EXC302: Electronic Devices EXC303: Digital Circuits and Design EXC402: Discrete Electronic Circuits EXC502: Design With Linear Integrated Circuits EXC601: VLSI Design EXC702: IC Technology	
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Recognize tradeoffs involved in analog VLSI Circuits
	CO2	Analyze basic building blocks of CMOS analog VLSI circuits
	CO3	Evaluate MOSFET based single stage and differential amplifiers
	CO4	Design MOSFET based operational amplifier
	CO5	Analyze mixed signal circuits
	CO6	Describe layout techniques for analog circuits

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**CMOS analog building blocks**		08
	1.1	**MOS Models:** Necessity of CMOS analog design, Review of characteristics of MOS device, MOS small signal model, MOS spice models	1	
	1.2	**Passive and Active Current Mirrors:** Basic current mirrors, Cascode current mirrors and Active current mirrors	1	
	1.3	**Band Gap References:** General Considerations, Supply-independent biasing, Temperature independent references, PTAT current generation and Constant Gm biasing	1	
2		**Single Stage Amplifiers**		10
	2.1	**Configurations:** Basic concepts, Common source stage, Source follower, Common gate stage, Cascode stage	1	
	2.2	**Frequency Response and Noise:** General considerations, Common-source stage, Source followers, Common-gate stage, Cascode stage and Noise in single stage amplifiers	1	
3		**Differential Amplifiers**		10
	3.1	**Configurations:** Single ended and differential operation, Basic differential pair, Common-mode response, Differential pair with MOS loads, Gilbert cell	1	
	3.2	Frequency response and noise in differential pair	1	

4		**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	1,3,5	
	4.2	**Stability and Frequency Compensation:** General Considerations, Multipole systems, Phase margin, Frequency compensation, compensation of two stage op-amps	1	
5		**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	1	
	5.2	**Oscillators:** General considerations, Ring oscillators, LC oscillators, VCO	1	
	5.3	**Phase-Locked Loop:** Simple PLL, Charge pump PLL, Nonideal effects in PLL, Delay locked loops and applications of PLL in integrated circuits	1	
6		**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	1,2	
	6.2	AMS design flow, ASIC, Full custom design, Semi custom design, System on Chip, System in package, Hardware software co-design	1	
			Total	**52**

References:

[1] B Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw Hill, First 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, Third Edition.

[4] Gray, Meyer, Lewis, Hurst, "Analysis and design of Analog Integrated Circuits", Willey, Fifth Edition

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC802	Advanced Networking Technologies	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE	ESE			
		10		30	100 (60% Weightage)			

Pre-requisite Course Codes		EXE704: Computer Communication Networks
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Identify the significance of WPAN standards
	CO2	Define the role of SONET, frame relay and ATM in efficient data transfer through the network
	CO3	Discuss issues related to network design, security threats and selection of appropriate tools and techniques to resolve the same.
	CO4	Illustrate the utility of various network management tools

Module No.	Unit No.	Topics	Ref.	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	7,8	
	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	7,8	
	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.	8	
2		**Optical Networking**		06
	2.1	ONET/SDH Standards, devices, DWDM, frame format, DWDM, Performance and design considerations.	3	
3		**WAN Technologies**		12
	3.1	**Frame:** FR concept, FR specifications, FR design and VoFR and Performance and design considerations	3,6	
	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	3,6	
	3.3	Traffic Descriptor and parameters, Traffic Congestion control defined, AAL Protocol model, Traffic contract and QoS, User Plane overview,	3,6	

		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.	1	
5		**Network Security**		**08**
	5.1	Security threats, safeguards and design for network security	2,3,4	
	5.2	**Enterprise Network Security:** DMZ, NAT, SNAT, DNAT, Port Forwarding, Proxy, Transparent Proxy, Packet Filtering and Layer 7 Filtering	2,3,4	
6		**Network Management and Control**		**08**
	6.1	Network management definitions, functional areas (FCAPS), SNMP, RMON	5,6,10	
	6.2	Designing a network management solutions, Monitoring and control of network activity and network project management	5,6,10	
			Total	**52**

References:

[1] Data Network Design by Darren Spohn, McGraw Hill publications, Third Edition.

[2] Data Communication and Network Security by Carr and Snyder, McGraw Hill Publications.

[3] Communication Networks by Leon-Garcia and Indra Widjaja, Tata McGraw-Hill Publications, Second Edition.

[4] Information Security by Mark Stamp and Deven Shah by Wiley Publications.

[5] Behrouz A Forouzan, Data communications and Networking, McGraw-Hill Publication, Forth Edition.

[6] William Stallings, Data Computer Communications, Pearson Education

[7] Wireless communication and Networking-Vijay Garg, ELSEVIER Inc

[8] Eldad Perahita ,Next Generation wireless LANS, Cambridge Publication

[9] Computer Networking by J. F. Kurose and K. W. Ross, Pearson Education

[10] Local Area Networks by Gerd Keiser, McGraw-Hill Publication.

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC803	MEMS Technology	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		
		10		30		100 (60% Weightage)		

Pre-requisite Course Codes		EXC 404: Basic VLSI Design EXC 604: IC Technology
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Discuss fundamental principles of MEMS devices including physical operation and mathematical modeling.
	CO2	Outline basic properties of MEMS materials and selection criteria of these materials for MEMS device fabrication.
	CO3	Apply various fabrication processes for MEMS devices.
	CO4	Develop different concepts of micro system sensors and actuators for real-world applications.

Module No.	Unit No.	Topics	Ref.	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	1,3,6	
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.	6	
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	3,6	
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	3,6	
5		**MEMS Devices**		11
	5.1	Architecture, working and basic quantitative behaviour of Cantilevers, Microheaters, Accelerometers, Pressure Sensors, Micromirrors in	1,2,3	

		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	6	
			Total	**52**

References:

[1] N. Maluf, K Williams,"An Introduction to Microelectromechanical Systems Engineering" Artech House Inc, Second Edition.

[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; Second edition

[6] Micro Electro Mechanical System Design - by J. Allen; Publisher: CRC Press

[7] Micromachined Transducers Sourcebook - by G. Kovacs; Publisher: McGraw-Hill

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC8041	Robotics	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		
		10		30		100 (60% Weightage)		

Pre-requisite Course Codes		EXS 301 : Applied Mathematics III EXS 401 : Applied Mathematics IV EXC 404 : Principles of Control Systems
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Discuss the fundamentals of robotics.
	CO2	Apply the direct and inverse kinematics algorithm for robotic arm manipulation
	CO3	Analyse the equations for velocity kinematics and Dynamics.
	CO4	Discuss the concept of robot motion planning using different algorithms.
	CO5	Justify the need of trajectory planning and robot vision algorithms for robotic arm manipulation

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Fundamentals of Robotics**		03
	1.1	Robot Classification, Robot Components, Degrees of freedom, Joints, Coordinates, Coordinate frames, workspace, applications	1	
2		**Forward & Inverse Kinematics of Robots**		09
	2.1	Homogeneous transformation matrices, Inverse transformation matrices, Forward and inverse kinematic equations – position and orientation	2	
	2.2	Denavit-Hatenberg representation of forward kinematics, Inverse kinematic solutions, Case studies	2	
3		**Velocity Kinematics & Dynamics**		14
	3.1	**Differential motions and velocities :** Differential relationship, Jacobian, Differential motion of a frame and robot, Inverse Jacobian,Singularities.	2	
	3.2	**Dynamic Analysis of Forces :** Lagrangian mechanics, Newton Euler formulation, Dynamic equations of robots, Transformation of forces and moment between coordinate frames	2	
4		**Robot Motion Planning**		04
	4.1	Concept of motion planning, Bug Algorithms – Bug1, Bug2, Tangent Bug	3	
5		**Potential Functions and Visibility Graphs**		08
	5.1	Attractive/Repulsive potential, Gradient descent, wave-front planner, navigation potential functions, Visibility map, Generalized Voronoi	3	

		diagrams and graphs, Silhouette methods		
6		**Trajectory Planning**		**08**
	6.1	Trajectory planning, Joint-space trajectory planning, Cartesian-space trajectories	2	
7		**Robot Vision**		**06**
	7.1	Image representation, Template matching, Polyhedral objects, Shape analysis, Segmentation, Iterative processing, Perspective transform.	1	
			Total	**52**

References:

[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.

[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.

[4] Mark W. Spong , Seth Hutchinson, M. Vidyasagar, "Robot Modeling & Control ", Wiley India Pvt. Ltd.

[5] John J. Craig, "Introduction to Robotics – Mechanics & Control", Third Edition, Pearson Education, India.

[6] Aaron Martinez & Enrique Fernandez, "Learning ROS for Robotics Programming", Shroff Publishers, First Edition.

[7] Mikell P. Groover et.al, "Industrial Robots-Technology, Programming & applications" ,McGraw Hill , New York.

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC8042	Mobile Communication	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE	ESE			
		10		30	100 (60% Weightage)			

Pre-requisite Course Codes		EXC 704: Computer Communication Networks EXC: Digital Communication
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Identify the blocks of cellular communication system
	CO2	Compare GSM and CDMA standards
	CO3	Explain 3G mobile communication system
	CO4	Identify the requirements of 4G standards
	CO5	Discuss emerging technologies

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Cellular Communication System**		10
	1.1	**I**ntroduction to Cellular Communications, Frequency reuse, Multiple Access Technologies	1,2	
	1.2	**Cellular Processes:** Channel assignment, Call Setup, Handoff strategies, interferences and system capacity	1	
	1.3	**Traffic Theory:** Trunking and grade of service, improving system capacity	1	
2		**GSM**		08
	2.1	GSM Network architecture, signaling protocol architecture, identifiers, channels, Frame structure, speech coding, authentication and security, call procedure, handoff procedure, services and features	1	
3		**CDMA digital cellular standard (1S-95).**		08
	3.1	Frequency and channel specifications of IS-95, forward and reverse CDMA channel, packet and frame formats, mobility and radio resource management	1	
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	4	
5		**4G Wireless Standards**		08
	5.1	Need for 4G network, difference between 3G and 4G, LTE, WiMAX	4	
6		**Emerging Technologies**		08
	6.1	Mobile Adhoc Network, Mobile IP and Mobility Management, Mobile TCP, Wireless Sensor Networks, RFID Technology	4	
			Total	52

References:

[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.

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC8043	Digital Control System	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE		ESE		
		10		30		100 (60% Weightage)		

Pre-requisite Course Codes		EXC404: Principles of Control System EXC504: Signals and Systems
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Differentiate between analog and digital control and importance of digital control
	CO2	Analyze the model of digital control system
	CO3	Analyze the digital control systems
	CO4	Design digital controllers

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Introduction**		12
	1.1	Why digital control system? Advantages and limitations, comparison of continuous and discrete data control, block diagram of digital control system	1,2,3	
	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		**Modeling of Digital Control System**		04
	2.1	Linear difference equation, pulse transfer function, input output model	1,2,3	
	2.2	Examples of first order continuous and discrete time systems		
	2.3	Signal flow graph applied to digital control system		
3		**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	1,2,3	
	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		**State Space Analysis**		08
	4.1	Discrete time state equation in standard canonical form, similarity transformation	1,2,3	
	4.2	State transition matrix, solution of discrete time state equation		
	4.3	Discretization of continuous state space model and its solution.		
5		**Pole Placement and Observer Design**		10
	5.1	Concept of reachability, controllability, constructability and observability	2,4	

	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		**Transfer Function Approach to Controller Design**		**10**
	6.1	Control structures, internal stability	1,3	
	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**

References:

[1] M. Gopal, "Digital Control and State Variable Methods", McGraw Hill companies, 3rd edition, 2009.

[2] K. Ogata, "Discrete-Time Control Systems", PHI, Second Edition.

[3] B. C. Kuo, "Digital Control Systems", Oxford University press, Second Edition.

[4] K. M. Moudgalya, "Digital Control", Wiley India.

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC8044	Biomedical Electronics	4	--	--	4	--	--	4
		Examination Scheme						
		ISE		MSE	ESE			
		10		30	100 (60% Weightage)			

Pre-requisite Course Codes		EXC305:Electronic Instruments and Measurements FEC102,202: Applied Physics I and II
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Describe anatomy of human body and interpret bioelectric signals
	CO2	Analyze physiological systems, measurement of related bio-signals and its instrumentation
	CO3	Analyze cardiovascular system related measurement techniques
	CO4	Analyze building blocks of life support instruments and imaging techniques
	CO5	Justify the importance of patient safety and hospital management system
	CO6	Adapt the norms related to biomedical electronics

Module No.	Unit No.	Topics	Ref.	Hrs.
1		**Bio-Potential and Measurement**		08
	1.1	Structure of Cell, Origin of Bio-potential, electrical activity of cell their characteristic and specifications.	1,3	
	1.2	Measurement of RMP and AP. Electrode-Electrolyte interface and types of bio-potential electrodes.	1,3	
2		**Physiological Systems and Related Measurement**		14
	2.1	Respiratory system- Physiology of respiration and measurements of respiratory related parameters	2,3	
	2.2	Cardiovascular system- Structure of Heart, Electrical and Mechanical activity of Heart, ECG measurements and Cardiac arrhythmias	2,3	
	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	2,3	
	2.4	Muscular system- Generation of EMG signal, specification and measurement.	2,3	
	2.5	Design of ECG amplifier (Pre-amplifier)	2	
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.	2,3	

		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	2,3	
5		**Imaging Techniques**		**10**
	5.1	X-Ray- Generation, X-ray tube and its control, X-ray machine and its application	2,3	
	5.2	CT Scan- CT Number, Block Diagram, scanning system and application. Ultrasound Imaging- Modes of scanning and their application	2,3	
	5.3	MRI- Concepts and image generation, block diagram and its application	2,3	
6		**Significance of Electrical Safety**		**04**
	6.1	Physiological effects of electrical current, Shock Hazards from electrical equipments and methods of accident prevention.	1,2,3	
			Total	**52**

References:

[1] Leslie Cromwell, "Biomedical Instrumentation and Measurements", Second Edition, Pearson Education, 1980.

[2] John G. Webster, "Medical Instrumentation", John Wiley and Sons, Fourth 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, Fourth Edition, 2001.

[6] John E Hall, Gyton's Medical Physiology, Twelfth Edition, 2011

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC806	Project (Stage II)	--	--	4	--	--	4	4
		Examination Scheme						
		Term Work		Practical		Oral		Total
		Phase-III:50 Phase-IV:50 TPP:25 PE:25		--		50		200

TPP: Technical Paper Presentation; PE: Project Exhibition

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.

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL801	CMOS VLSI Design Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE				Total
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC801 (CMOS VLSI Design)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Analyze tradeoffs in CMOS analog circuits after successful simulations
	CO2	Compose SPICE code and simulate MOSFET based analog circuits
	CO3	Validate characteristics of MOSFET based analog circuits via simulations
	CO4	Solve the issues via troubleshooting the CMOS analog circuit

Exp. No.	Experiment Details	Ref.	Marks
1	Analysis of MOSFETs for analog performance	1,3	05
2	Design and simulate various types of current mirror circuits	1,3	05
3	Design and simulate various types of single stage amplifiers	1,3	05
4	Design and simulate differential amplifier	1,3	05
5	Design and simulate operational transconductance amplifier	2,3	05
6	Design and simulate switch capacitor circuits	1,3	05
7	Design and simulate various types of oscillators	1,3	05
8	Generate layout for the simple and cascode current mirror	1,3	05
		Total Marks	40

References:

[1] R. Jacaob Baker, Harry W. Li, David E. Boyce, "CMOS Circuit Design, Layout,and Stimulation", Wiley, Student Edition.

[2] P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design", Oxford University Press, Third Edition

[3] LTSPICE Manual.

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL802	Advanced Networking Technologies Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE				Total
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC802 (Advanced Networking Technologies)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Understand specification of Bluetooth and its various profiles through FOSS and command prompt.
	CO2	Understand system utilities for network management using various open source networking tools.
	CO3	Perform a Vulnerability Analysis using security network analyzer.

Exp. No.	Experiment Details	Ref.	Marks
1	Identify the specifications of Bluetooth through command prompt and GUI.	2,3	05
2	Understand the system utilities for network management.	2,3	05
3	To perform network audit of a LAN.	2,3	05
4	To observe the statistics of application and service based network management protocols	2,3	05
5	Test a host to determine potential security vulnerabilities.	2,3	05
6	Virtual Lab on identifying the different issues related to hidden terminal problem and exposed terminal problem; also they can solve and simulate with the open source network simulator NS2/NS3	1	05
7	Virtual Lab on evaluating the network performance by using performance evaluation matrix and NS2	1	05
8	Case Study on Network Design and Management.	2,3	05
		Total Marks	40

References/Online Resources:

1. http://iitkgp.vlab.co.in/index.php?sub=38&brch=121
2. Wireless communication and Networking-Vijay Garg, ELSEVIER Inc
3. Computer Networking by J. F. Kurose and K. W. Ross, Pearson Education

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
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Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL803	MEMS Technology Laboratory	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE				Total
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC803 (MEMS Technology)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Design and simulate MEMS devices and system using Industry graded simulation tools like COMSOL and Coventorware.
	CO2	Determine characteristics of given MEMS device using Hardware setup.
	CO3	Design and simulate MEMS devices and system using open source simulation tools like sugar.
	CO4	Relate the given literature with the studied concepts of MEMS.

Exp. No.	Experiment Details	Ref.	Marks
1	**Aim:** To analyze MEMS cantilever in Matlab. **Problem Statement:** For the given MEMS cantilever with given dimensions and uniformly distributed load a) To plot the variation in stiffness constant (K) for varying length (L) keeping its width (W), thickness (h) constant and different values of effective length (λr=L/Lc) of uniformly distributed load. b) To plot the variation in stiffness constant (K) for varying width (W) keeping its length (L), thickness (h) constant and different values of effective length (λr=L/Lc) of uniformly distributed load. c) To plot the variation in stiffness constant (K) for varying thickness (h) keeping its width (W), length (L) constant and different values of effective length (λr=L/Lc) of uniformly distributed load	1,2,4	**05**
2	**Aim:** To model MEMS cantilever in COMSOL Multiphysics. **Problem Statement:** For the given dimensions and material create MEMS cantilever model in COMSOL and observe the dependence of resonance frequency of the cantilever on material.	1,2,4	**05**

3	**Aim:** To analyze MEMS cantilever in COMSOL Multiphysics. **Problem Statement:** For the cantilever model analyze dependence of fundamental resonance frequency on varying length (given range), plot the result and also compare the result with analytical expression of resonance frequency.	1,2,4	**05**
4	**Aim:** To analyze MEMS Piezoelectric Harvester model. **Problem Statement:** Choose the proper configuration, dimensions and the method of conversion (converter) for obtaining dc voltage from ac voltage generated by the MEMS Piezoelectric Harvester. Obtain the output voltage graph for any two different substrates materials against Silicon as a substrate material.	1,2,3	**05**
5	**Aim:** To analyze MEMS cantilever in Sugar Tool. **Problem Statement:** Choose the proper dimensions of MEMS cantilever modeled in Sugar. Choose the proper co-ordinate and node for applied point contact force. Observe and tabulate the maximum displacement of the cantilever for at least three different values of point contact load, verify one of the readings with given analytical expression of maximum displacement of the cantilever.	1,2,3	**05**
6	**Aim:** To model and analyze Piezoresitive Pressure Sensor in MEMS Design and Simulation FEM Tool (CoventorWare). **Problem Statement:** a) Choose the proper substrate; define the process flow and Layout of Piezoresitive pressure sensor in MEMS Design and Simulation FEM Tool (CoventorWare) and create a its 3 D Layout. b) Observe the change in resistance of piezoresistance for given input pressure. Compare this reading with the given analytical expression of the change in resistance of the piezoresistace.	1,2,4	**05**
7	**Aim:** To evaluate the performance of the fabricated MEMS micro-heater. **Problem Statement:** For the given fabricated MEMS micro-heater,	1,2,4	**05**

	a) To measure the temperature of the heated membrane for the input excitation voltage and compare it with the given analytical expression. b) To plot the temperature response of heated membrane to standard test voltages like square, Ramp, and sinusoidal.		
8	**Aim:** To model and analyze the Hot Arm actuator in COMSOL Multiphysiscs. **Problem Statement:** For the given model of Hot Arm actuator in COMSOL Multiphysiscs, a) Describe the complete process flow, schematic representation of the mask layout and draw the final structure. c) Observe the spatial variation of electric potential, temperature of the Hot Arm actuator before and after the deflection of the Hot Arm actuator. b) Observe and draw the effect of change in width of flexures on the deflection of the Hot Arm actuator.	1,2,4	**05**
		Total Marks	**40**

References:

[1] Practical MEMS - by Ville Kaajakari; Publisher: Small Gear Publishing

[2] Microsystem Design - by S. Senturia; Publisher: Springer

[3] www.nanohub.org

[4] MEMS Technology Laboratory Manual

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC8041	Robotics	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE				Total
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC8041 (Robotics)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Develop inverse and direct kinematics algorithm for robotic arm manipulation using suitable platform
	CO2	Differentiate the performance of motion planning algorithms
	CO3	Develop image processing algorithm for robotic arm manipulation
	CO4	Operate the robotic arm manipulator and verify its specifications
	CO5	Perform in a team to execute a given robotic task

Exp. No.	Experiment Details	Ref.	Marks
1	Generation of PWM Signal for motor control	1	05
2	Digital control algorithm for self-balance ROBOT	1	05
3	Simulation of CTM in MATLAB	2	05
4	Implement Bug 0 Algorithm	2,3	05
5	Implement Bug 2 Algorithm	2,3	05
6	Control Algorithm 6 DOF Robot	1	05
7	Thresholding, Histogram and Edge detection of Digital Image	2	05
8	Position control of DC motor using NI Elvis	1	05
	Total Marks		40

References:

[1] LabVIEW & myRIO user manual

[2] www.mathworks.com

[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.

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXC8042	Mobile Communication	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		Practical		Oral		Total
		40		--		20		60

Pre-requisite Course Codes		EXC8042 (Mobile Communication)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Explain basic building block of mobile communication system
	CO2	Illustrate Mobile information using android applications
	CO3	Analyze the Virtual Lab for different mobile communication technologies.

Exp. No.	Experiment Details	Ref.	Marks
1	**AIM:** List Hardware Components of Mobile Communication Networks. (Mobile Phone, Antenna, BTS,PSTN) List Software Components of Mobile Communication Networks. (Bluetooth Protocol Stack,WML, HTML, Browsers)	5	**05**
2	**AIM:** Find mobile specifications and signal specifications using different android applications.(G-Net Track Lite, Network Cell)	1	**05**
3	**AIM:** WAP to implement cell splitting method to improve coverage area of cellular system. Simulation to implement capacity of cellular system. (Scilab or Matlab)	4	**05**
4	**AIM:** To understand the cellular frequency reuse concept fulfilling the following objectives I. finding the co-channel cells for a particular cell. II. Finding the cell clusters within certain geographic area.	2	**05**
5	**AIM:** To understand the handover mechanism. Objectives: To study the effect of handover threshold and margin on SINR and call drop probability and handover probability.	2	**05**
6	**AIM:** Understand about WiMAX networks, standards, limitations. Get familiar with adaptive modulation techniques used with WiMAX.	3	**05**
7	**AIM:** Understand about the basics of Mobile Ad-hoc Networks (MANETs) and different routing protocols. Setup a network with wireless nodes using ns2. Get familiar with the different characteristics of MANET through simulations	3	**05**

8	Understand basic concepts about Wireless Sensor Networks (WSNs), types, applications of WSN. Gain familiarity with LEACH, a cluster based routing protocol for WSNs.	3	**05**
		Total Marks	**40**

References:

[1] G-NetTrack Lite Android application.

[2] Fading Channels and Mobile Communications Virtual Lab

[3] IIT Khargpur Virtual Lab http://vlabs.iitkgp.ernet.in/ant

[4] Matlab / Scilab

[5] Internet

Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India
(Autonomous Institute Affiliated to University of Mumbai)

Course Code	Course Name	Teaching Scheme (Hrs/week)			Credits Assigned			
		L	T	P	L	T	P	Total
EXL8044	Biomedical Electronics	--	--	2	--	--	1	1
		Examination Scheme						
		ISE		ESE				Total
				Practical		Oral		
		40		--		20		60

Pre-requisite Course Codes		EXC8044 (Biomedical Electronics)
After successful completion of the course, student will be able to		
Course Outcomes	CO1	Evaluate design of building blocks for various medical instruments
	CO2	Measure various bioelectric signals using advanced electronics techniques
	CO3	Justify the necessity and principle of operation of health related medical instruments used in hospital
	CO4	Justify the importance of patient safety
	CO5	Check biomedical equipment related standards

Exp. No.	Experiment Details	Ref.	Marks
1	**Aim:** Simulate the instrumentation amplifier with TINA SPICE and plot frequency response. Implement the instrumentation amplifier with Texas Instruments ALSK or on bread board. Compare and discuss the simulation and experimental results. **Objective:** In this experiment student should understand the need of instrumentation amplifier in biomedical instrumentation. Also should able to design and implement IA with high value of gain (>1000) and CMRR. **Tasks:** i) Simulate IA for high value of gain and CMRR & obtain frequency response. ii) Implement IA using hardware components with same values & plot frequency response. iii) Verify simulation and hardware results.	1,2	**05**
2	**Aim:** To design, simulate and implement notch filter (50Hz). Plot the frequency response and compare experimental results with simulation results. **Objective:** In this experiment student should understand the need of Notch filter in biomedical instrumentation. Also should able to design and implement notch filter.	1,2	**05**

	Tasks: i) Simulate notch filter & obtain frequency response ii) Implement notch filter using hardware components with same values & plot frequency response. iii) Verify simulation and hardware results.		
3	**Aim:** To obtain, measure and analyze simulated and real time ECG waveforms using simulator board ST2351 and ST2352. **Objective:** In this experiment student should understand the measurement procedure for ECG using ST2351 and ST2352 boards. Also student should understand various lead configurations and their importance and able to analyze the recorded ECG's. Depending on the nature of ECGgraph and measured values student should able to identify the abnormalities if any. **Tasks:** i) Record simulated ECG using ST2351 board. ii) Record real time ECG using ST2352 board for different lead configurations. iii) Compare simulated & real time ECG and note down values of amplitude, time duration, etc; for P, QRS, T & U segments. iv) Note down the value of heart rate for real time ECG and identify abnormalities if any.	3	**05**
4	**Aim:** To record and analyze real time ECG waveform using ECG sensor, Ni-Elvis and LabView. **Objective:** In this experiment student should understand the recording procedure for ECG using biomedical electronics toolbox of Labview and NI-Elvis kit. Also student should understand the interfacing of hardware components electrodes-protoboard-NI-Elvis-PC with Labview. **Tasks:** i) Develop a VI to plot real time ECG graph using Labview and NI-Elvis. ii) Using Biomedical electronics toolbox plot ECG graphs for various abnormalities. iii) Compare normal and abnormal ECG graphs.	4	**05**
5	**Aim:** To record and analyze real time EEG waveform using EEG sensor, Ni-Elvis and LabView. **Objective:** In this experiment student should understand the recording procedure for EEG using biomedical electronics toolbox of Labview and NI-Elvis kit. Also student should understand the interfacing of hardware components electrodes-protoboard-NI-Elvis-PC with Labview. **Tasks:** i) Develop a VI to plot real time EEG graph using Labview	4	**05**

	and NI-Elvis. ii) Using Biomedical electronics toolbox plot EEG graphs for various abnormalities. iii) Compare normal and abnormal EEG graphs.		
6	**Aim:** To record and analyze real time EMG waveform using EMG sensor, Ni-Elvis and Labview. **Objective:** In this experiment student should understand the recording procedure for EMG using biomedical electronics toolbox of Labview and NI-Elvis kit. Also student should understand the interfacing of hardware components electrodes-protoboard-NI-Elvis-PC with Labview. **Tasks:** i) Develop a VI to plot real time EMG graph using Labview and NI-Elvis. ii) Using Biomedical electronics toolbox plot EMG graphs for various abnormalities. iii) Compare normal and abnormal EMG graphs.	4	**05**
7	**Aim:** Design, implement and demonstrate various circuits for implementation of biomedical data acquisition/ instrumentation system (Innovative – Application/Project based learning)		**05**
8	**Aim:** To demonstrate Medical instruments X-ray machine, CT machine, MRI machine, Defibrillator, Pacemaker, Bedside monitor, Dialysis machine, Anesthesia machine and electrosurgical unit **Objective:** In this experiment students will understand the working principle of imaging instruments. Also students should able to differentiate between X-ray machine, CT machine and MRI machine. **Tasks:** Draft a detailed report on imaging instruments mentioning model number of the instruments, name of the company, specifications, working principle, procedure, safety & precautions.	Based on hospital visit	**05**
		Total Marks	**40**

References:

1. John G. Webster, "Medical Instrumentation", John Wiley and Sons, 4th edition, 2010.
2. R. S. Khandpur, "Biomedical Instrumentation", TMH, 2004.
3. ST2351 & ST2352 Manual
4. www.ni.com