UNIVERSITY OF MUMBAI
SCHEME OF INSTRUCTION AND EVALUATION (R2007)
Programme: B.E. (ELECTRONICS ENGINEERING)

SEMESTER: VII

Sr. No	Subjects	No. of periods of 1Hour		Duration of Theory Paper in Hours	Marks			
		Lecture	Practical		Theory Paper	Term Work	Oral	Total
1	VLSI Design	4	2	3	100	25	25	150
2	Filter Design	4	2	3	100	25	25	150
3	Power Electronics and Drives	4	2	3	100	25	25	150
4	Communication Networks	4	2	3	100	25	25	150
5	**Elective-II** 1. Wireless communication 2. Advances in Biomedical Instrumentation 3. Micro computer system design 4. Digital Image Processing Design	4	2	3	100	25	25	150
6	**Project -I**		4			25	25	50
TOTAL		20	14	15	500	150	150	**800**

SEMESTER: VIII

Sr. No	Subjects	No. of periods of 1Hour		Duration of Theory Paper in Hours	Marks			
		Lecture	Practical		Theory Paper	Term Work	Oral	Total
1	Advance VLSI Design	4	2	3	100	25	25	150
2	Robotics and Automation	4	2	3	100	25	25	150
3	Embedded Systems and Real-Time Programming	4	2	3	100	25	25	150
4	**Elective-III** 1. Advanced Networking Technologies 2. DSP Processors and architectures 3. Neural Networks & Fuzzy Systems 4. Electronics Product Design	4	2	3	100	25	25	150
5	**Project -II**		8	--		50	100	150
TOTAL		16	16	12	400	150	200	**750**

University of Mumbai

CLASS: B.E. (Electronics Engineering)		Semester - VII	
SUBJECT: VLSI Design			
Periods per week	**Lecture**	**04**	
	Practical	**02**	
(each of 60 min.)	**Tutorial**	**-**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**3**	**100**
	Practical examination		
	Oral Examination	**-**	**25**
	Term Work	**-**	**25**
	Total		**150**

Module	Contents	Hours
Objective	To familiarize students with the different aspects of the VLSI field and to introduce important concepts that have industry value	**-**
Pre-requisite	Digital System Design I and II, BEC	**-**
1. Introduction to VLSI	Evolution of logical complexity in ICs as a function of time, VLSI design flow, Y-chart representation, design hierarchy/design abstraction levels in digital circuits, concepts of regularity, modularity and locality, Semi-custom & full custom devices	03
2. Physics of MOSFET	MOS capacitor, energy band diagrams, band bending, flat band voltage, threshold voltage calculation, threshold adjustment, MOSFET linear and saturated operation(GCA), MOSFET capacitance, channel length modulation. Types of scaling, functional limitations of scaling, short channel, narrow channel effects, hot electron effects.	13
3. Semiconductor manufacturing process	Wafer processing, mask generation, oxidation, epitaxy, ion implantation, diffusion, metallization, photolithography, process steps for NMOS & PMOS devices, CMOS inverters, latch-up in CMOS and its prevention. Process simulation using CAD tools Video of manufacturing process to be shown.	03
4.Design rules and layout	Need of design rules, NMOS, PMOS and CMOS design rules and layouts. Design of NMOS and CMOS Inverter, NAND and NOR gates. Interlayer contacts, Butting and Buried contacts. Stick diagrams, layout of integrated circuits. Realization of Boolean expressions in CMOS. Use of CAD tools for layout design and simulation.	10

5.MOS Inverters	MOS inverters - resistive load - NMOS load - pseudo NMOS (Qualitative) and CMOS inverters (quantitative) -calculation of noise margin, calculation of rise, fall and delay times for CMOS inverter, transistor sizing and power dissipation , series and parallel equivalency rules, equivalent inverter (numericals on noise margin calculations, timing calculations, power dissipation, equivalency expected)	12
6. Verilog	Basic concepts, structural gate level, switch level, behavior and RTL modeling. Arithmetic Circuits in CMOS VLSI – carry look ahead adder, high speed adders, subtractors, decoders, multiplexer and multipliers. Sequential circuits' implementation using verilog (Flip-Flop, registers and counters, state machines).	07

Text Books:

1. Sung-Mo Kang & Yusuf Leblebici, CMOS Digital Integrated Circuits - Analysis & Design, Second Ed., MGH

2. Jan M Rabaey, Digital Integrated Circuits - A Design Perspective, Prentice Hall

3. *Fabricius*, Eugene D, Introduction to VlSI Design. TMH

4. . Samir Palnitkar, Verilog HDL, A Guide to Digital Design and Synthesis, Pearson Education.

Reference Books:

1. . Neil H.E. Weste, Kamran Eshraghian, *Principles of CMOS VLSI Design: A* system perspective, Addison Wesley publication.

2. Fundamentals of Modern VLSI Devices by Yuan Taur, Cambridge University Press

Proposed Practical list

Suggested list of experiments using CAD tools such as Magic, Microwind, Tanner tools, Xilinx ISE etc.

1. Spice simulation of NMOS(resistive load, enhancement load, depletion load) inverters, CMOS inverters
2. Fabrication process simulation using CAD tool
3. Layout design and simulation ,using CAD tools, of the following

    1. CMOS Inverter
    2. NAND/NOR gates
    3. Boolean expressions
    4. Mux/Decoder
    5. Logic expression using pass transistor/ transmission gate
    6. 6T RAM cell
4. Simulation and synthesis of Verilog code for
    1. Adder/subtractor
    2. Mux/decoder
    3. flip-flop/counters
    4. State machines

Term work:

The term work should contain at least 7 CAD programs and 2 assignments covering the whole syllabus, duly recorded and graded.

The distribution of marks for term work shall be as follows,

Laboratory work (Experiments and Journal) : 15 marks.

Test (at least one) : 10 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:
Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Theory Examination:

1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and will cover all modules.
4. Remaining questions will be from the same module or mixed in nature. (e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In the question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from pre-requisite module

University of Mumbai			
CLASS: B.E. (Electronics Engineering)		**Semester - VII**	
SUBJECT: Filter Design			
Periods per week (each of 60 min.)	**Lecture**	**4**	
	Practical	**2**	
	Tutorial	**-**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**3**	**100**
	Practical examination		
	Oral Examination	**-**	**25**
	Term Work	**-**	**25**
	Total		**150**

Objective	Filter is an important part of any electronic system. This course is to introduce the student the design of analog and digital filters ,adaptive filters and multirate signal processing	
Pre-requisite	Continuous and Discrete time signals and systems	
Module	**Contents**	**Hours**
1	**Analog filters** Filter specifications, Introduction to Butterworth Chebyshev, design (Derivation of T.F.), Elliptical filters, Frequency Transformations Low pass, high pass and band pass active filter realization, infinite gain single amplifier (LP,BP & HP) , positive and negative feedback infinite gain single amplifier filters, high order filters.	10
2	**Direct realization methods:** Active network elements for direct realization, inductance simulation frequency dependent negative resistors, leapfrog realization techniques, primary resonator block, switched capacitor filters.	10
3	**IIR filter design** IIR filter design methodology, Design of Butterworth and Chebyshev filters using Impulse/step invariant method, matched Z Transform method, Bilinear transform Technique. Spectral transformations Filter design by pole zero placements.	6
4	**FIR filter : Analysis and design** Linear phase FIR filter and its types, FIR filter design using windows and Frequency sampling method, Half Band FIR filter design.	6
5	**Adaptive Filters:** Concept of adaptive filter ,MMSE criterion ,LMS and RLS algorithms ,Basic Weiner filter and its applications	8
6	**Multirate Digital signal Processing** Concepts Decimation Interpolation ,sampling rate conversion by raional factor, polyphase structures ,multistage implementation ,applications like subband coding and Quadrature mirror filtering.	8

Text- Books:

- Principles of Active network synthesis and design: Govind Daryayani John Wiley publication
- Active and passive analoig filter design- Lawrence P Huelson Tata- Mc-Grawhill publication
- E.C.Ifeachor and B.W Jervis,Digital Signal Processing A Practical approach, Pearson Publication,second edition
- Ashok Ambardar, Digital Signal Processing, Cengeg Learning Publication,.

- J.G. Proakis, D. G. Manolakis, Digital Signal Processing: Principles, Algorithms and applications, Prentice Hall of India, 1995
- A.V. Oppenheim, Ronald W Schafer, Prentice Hall, 1983.
- A.Antoniou, Digital Filter analysis and applications. Tata McGraw-Hill Publication.
- Siman Hykin, Adaptive filters, PHI Publications
- S,Salivahanan, A. Vllaraja, C.Ganapriya Digital signal processing ,Mc Graw Hill ,second edition
- P.P.Vaidyanathan Multirate systems and Filter Banks Prentice Hall of india 2006
- Digital signal processing :system analysis and design .Diniz ,da sillva, Netto Cambridge university press

Reference Books:

- B.P.Lathi, linear systems and signals Oxford University Press second Indian Impression, 20007.
- S.K. Mitra, Digital Signal Processing, Tata McGraw-Hill Publication, 2001
- Chi-tsong Chen Digital signal processing, Oxford University Press
- P.P.Vaidyanathan Multirate systems and Filter Banks Prentice Hall of india 2006
- Digital signal processing:fundamentals and applications Li Tan Acadamic press

Suggested list of simulations
Matlab or C/C++ or Labview:

1. Analysis of analog filters in frequency domain
2. IIR filter design : Impulse invariant and Bilinear transform method
3. Linear phase filters: comparison of various types
4. FIR design using windows
5. FIR design using frequency sampling
6. Effect of quantization on filter design
7. Introduction to FTA tool for filter design
8. Application of adaptive signal processing to practical one dimensional signal e.g. speech signal ,ECG signal, music signal etc
9. Implementation of interpolation and decimation operation
10. implementation of filter on DSP processor

Term Work:

The term work shall consist of at least **two numerical assignments and six MATLAB Or C/C++ or Labview simulations** covering the whole of syllabus, duly recorded and graded.
The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) : 15 marks.

Test (at least one) : 10 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:
Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus

Theory Examination:

1. Question paper will be comprise of total 7 questions, each of 20 marks.

2. Only 5 questions need to be solved.

3. Question number 1 will be compulsory and will cover all modules.

4. Remaining questions will be mixed in nature. (e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)

5. In question paper weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.

6. No question should be asked from pre-requisite module.

University of Mumbai			
CLASS: B.E. (Electronics Engineering)		**Semester - VII**	
SUBJECT: Power Electronics and Drives			
Periods per week	**Lecture**	**4**	
	Practical	**2**	
(each of 60 min.)	**Tutorial**	**-**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**3**	**100**
	Practical /Oral examination		
	Oral Examination	**-**	**25**
	Term Work	**-**	**25**
	Total		**150**

Objective	To teach the applications of power electronics devices. Also to study Industrial Drives.	
Pre-requisite	Power Semiconductor devices, AC and DC machines	
Module	**Contents**	**Hours**
1	**Phase Controlled Converter:** Single phase bridge converter with effect of source impedance. Dual converter.	04
2	**Chopper:** Principle of chopper operation, step –up and step – down, one quadrant, two quadrant chopper (Type A and B). Thyristorised chopper circuits a) Voltage commutated chopper b) Current commutated chopper c) Load commutated chopper	10
3	**Inverter:** Classification of inverter , Analysis & Design: a) Series , Parallel and bridge (Mc Murray) b) Voltage and current source inverter c) PWM inverter Different methods for harmonic reduction in inverter output.	12
4	**DC Drives:** Concept of DC electric drive with respect to speed control. Single phase, half wave semi converter, full converter drive for separately excited dc motor. Dynamic and regenerative braking of DC motor. Methods used to adjust following parameters of a typical dc drive. 1) Speed 2) IR compensation 3) current limit 4) acceleration/de-acceleration	08
5	**AC Drives**: Induction motor fundamentals and speed control methods 1. Stator voltage 2. Variable frequency 3. Rotor resistance 4. Slip energy recovery scheme Drives related to V/F control and slip power recovery scheme.	08
6	**Applications:** SMPS and UPS:- Analysis of fly back, forward and half bridge converters	06

	for SMPS. Block diagram and configuration of UPS, salient features, selection of battery and charger ratings and sizing of UPS	

Text Books:

1) General Electric: SCR manual, USA.
2) M.H. Rashid, Power electronics, PHI India.
3) M.D. Singh and K.B. Khanchandani, power electronics, Tata McGraw Hill
4) Dr. P.S. Bimbhra, Power Electronics, Khanna Publications.
5) shepherd, Hulley, Liang power electronics and motor control second edition, Cambridge

Additional Reading:

1)Chute and Chute: Electronics in Industry; MGH
2)B.W. Williams: Power Electronics, Jhon Willey,1975.
3) P.C. Sen , Power Electronics, TMH.

Suggested Laboratory Experiments

Minimum Six experiments on

- Various types of Inverters
- Various types of Choppers
- Speed Control of DC Motor and Induction Motor

Term work:

Term work shall consist of minimum six experiments, Two Assignments and a written test.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) : 15 marks.

Test (at least one) : 10 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Theory Examination:

1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and will cover all modules.
4. Remaining questions will be from the same module or mixed in nature. (e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In the question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from pre-requisite module

University of Mumbai			
CLASS: B.E. (Electronics Engineering)		**Semester – VII**	
SUBJECT: Communication Networks			
Periods per week (Each of 60 min.)	Lecture	4	
	Practical	2	
	Tutorial	-	
		Hours	Marks
Evaluation System	Theory Examination	3	100
	Practical examination	-	-
	Oral Examination	-	25
	Term Work	-	25
	Total		150

Objectives:

Interconnecting hardware, configuring network systems, measuring performance, observing protocols in action, and creating client-server programs that communicate over a network all help sharpen students's understanding and appreciation.

Module	Contents	Hours
1	**Introduction to Communication Networks** Communications Model, Data Communication Networks- Public Switched Telephone Network (PSTN), Leased Line, Local Area Networks (LAN), Public Switched Data Network (PSDN), and Integrated Services Digital Network (ISDN). Communication Architectures, Protocol Layer Concepts, OSI Layer, Standard Organizations. Transmission Media**:** Twisted pair, STP, UTP, Coaxial cable, Fiber Optics, Wireless, Microwave, Satellite, Radio, and Media Properties.	**06**
2	**Data Transmission and Digital Carrier Systems** Simplex, Half-Duplex, Full-Duplex, Serial and Parallel Transmission, Synchronous and	**08**

	Asynchronous Transmission, Bit Oriented Synchronous Transmission, Byte Oriented Synchronous. Modem functions, Standard V Series. **Digital Carrier Systems:** T-carrier, Super frame, Extended Superframe, (ESF), XDSL. E-carrier, PDH, Synchonouse Digital Hierarchy, Synchronous Optical Network, concept of SONET/SDH, and Digital Multiplexing Hierarchy,	
3	**Data Link Control** Flow Control, Framing, Sliding-Window, Error Detection, Parity Check, Cyclic Redundant Check (CRC), Error Control Techniques, Stop-and-Wait ARQ, Go-back-N ARQ, Selective-repeat ARQ. HDLC Frame Format .	**08**
4	**Switching Network** Switching technology, Circuit switching, Packet switching, Virtual Circuits and Datagram. Routing in Packet Networks, Network Algorithms and Shortest Path Routing, Congestion Control in Switched Data Networks.	**08**
5	**Local Area Networks and High-Speed LANs** LAN characteristics, Topology, Bus, Ring, Star, LAN Media, Data Link Layers, MAC Address, Logical Link Control, LAN Standard, IEEE 802.2, IEEE 802.3- CSMA/CD, CSMA/CA Ethernet architecture, IEEE 802.3 specifications, Hub, 10Base5, 10Base5, 10BaseT, 10BaseF, Concept of bridge LAN., Ethernet Frame, Binary Back off, Inter-frame Gap, Ethernet Performance, Ethernet Switching. IEEE 802.4, IEEE 802.5, Gigabit Ethernet and FDDI .	**10**
6	**Applications and Layered Architectures** Examples of Protocols, Services (HTTP, DNS and SMTP etc), and Layering, TCP/IP Architecture. TCP/IP Protocol, IP Addressing, The Berkeley API, Application Layer Protocols and TCP/IP Utilities	**08**

Text Books:

1. William Stallings, Data Computer Communications, Pearson Education
2. A. Leon-Garcia and Indra Widjaja, Communication Networks, Tata McGraw-Hill Publication
3. Behrouz A Forouzan, Data communications and Networking 4th Edition, McGraw-Hill Publication.
4. J. F. Kurose and K. W. Ross, Computer Networking, Pearson Education
5. D. Bertsekas and Gallager, Data Networks, 2nd Edition, Prentice-Hall of India

Reference Books:

1. Gerd Keiser, Local Area Networks, McGraw-Hill Publication.

2. Dayanand Ambawade and Deven Shah, Linux Lab, Wiley-Dreamtech Publication.
3. Behrouz A Forouzan, Local Area Network 4th Edition, McGraw-Hill Publication
4. Youlu Zheng, Networks for computer scientists and engineers OXFORD Publication
5. Natalia olifer Victor olifer, Computer Networks Wiley- Publication

Proposed Practical list:

1. Study of Hardware and Software Components of Computer Communication and Networking
2. Network Installation & Configuration of Network OS : ***GNU/Linux***
3. IP Networking & Network Commands: *ifconfig , ping, traceroute , netstat, arp ,nslookup dig & route etc.*
4. Study of Modem Commands, Queries
5. Study of Serial Communication (RS-232)
6. Study of Network topology and flow control techniques.
7. Simulation of Shortest path routing algorithms.
8. Installation and Configuration of Telnet & FTP Server/Client
9. Installation and Configuration of DNS & Web Server/Client
10. Network Protocol Analyzers : *TCPDUMP & ETHEREAL*
11. Implementation of CSMA/CD and Stop-n-Wait Protocols using Network Simulator (ns-2)
12. Study of Wireless LAN *(WLAN): Adhoc & Infrastructure Network* Mode
13. Implementation of Socket Programming

Term work:

Term work shall consist of minimum six experiments, 2 Assignments and a written test.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) : 15 marks.

Test (at least one) : 10 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus

Theory Examination:

1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and will cover all modules.
4. Remaining questions will be from the same module or mixed in nature.

(e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any

module other than module 3.)

5. In the question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from pre-requisite module

University of Mumbai			
CLASS: B.E. (Electronics Engineering)		**Semester – VII (Elective)**	
SUBJECT: WIRELESS COMMUNICATION (Elective)			
Periods per week (each of 60 min.)	**Lecture**	**4**	
	Practical	**2**	
	Tutorial	**-**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**3**	**100**
	Practical examination		
	Oral Examination	**-**	**25**
	Term Work	**-**	**25**
	Total		**150**

Module	Contents	Hours
Objective	The objective of the course is to introduce the Concepts of basic wireless mobile communication systems.	-
Pre-requisite	Fundamentals of Digital Communication	-
1	**Introduction and Cellular Concept** Existing technology, Evolution in wireless systems, Trends in cellular system Frequency Reuse channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Cellular System, Design in worst case with an omni Directional Antenna, Co-Channel Interference Reduction with use of Directional Antenna, Improving Coverage and Capacity in Cellular systems, Trunking and Grade of service	08
2	**WIRELESS COMMUNIACTION SYSTEMS GSM** GS Services and features , GSM Architecture and interfaces, GSM Radio Sub System , GSM Channel Types , Traffic Channels, Control Channels, Example of a GSM call, Frame structure for GSM , Signal Processing in GSM, GPRS.	10
3	**Wideband Modulation Techniques –OFDM** Basic Principles ,OFDM Signal Mathematical	12

	representation , Block Diagram , Selection Parameters for modulation , Pulse shaping, Windowing, Spectral Efficiency , Synchronization	
4	**WIRELESS COMMUNIACTION SYSTEMS CDMA IS95** **Direct** sequence Spread Spectrum , Spreading codes, Multipath Signal Propagation and RAKE receiver, Frame Quality and BER Requirements, Critical challenges of CDMA,TIA IS95 System, Physical and Logical Channels of IS95, CDMA IS95 call processing, soft hand off and power control in CDMA,Access and Paging Channel Capacity, Reverse and Forward Link Capacity of a CDMA System.	08
5	**WIRELESS COMMUNIACTION SYSTEMS** **CDMA 2000** : CDMA layering structure, CDMA 2000 channels, logical channels , forward link physical ,forward link features ,reverse physical channels , CDMA 2000 Media Access control and LAC sub layer, Data services , Data services in CDMA 2000 , mapping of logical channels to physicals, evolution of CDMA IS95 to CDMA 2000.	10
6	**More WIRELESS COMMUNIACTION SYSTEMS** Bluetooth , Wi Fi Standards, WIMAX, Wireless Sensor Networks, Zigbee , UWB, IEEE 802.20 and Beyond.	04

Text Books:

1) Wireless Communication : Principles and Practice – Theodare . S. Rappaport- Pearson Education
2) Wireless Communication :- Upena Dalal – Oxford Higher Education
3) Wireless Network Evolution : 2G to 3G – Vijay . K. Garg – Pearson Education

Additional Reading:

1) Principles and Application of GSM – Vijay Garg , Joseph . E. Wilkes – Pearson Education
2) Mobile Cellular Telecommunications : Analog and Digital Systems , William C. Y. Lee, Tata McGraw – Hill Edition
3) Introduction to Wireless Telecommunication Systems and Networks- Gary . J. Mullet, DELMAR CENGAGE Learning
4) Wireless Communications and Networks : 3G and Beyond, ITI Saha Misra, Tata McGraw – Hill Edition
5) Fundamentals of Wireless Communication: David Tse, Pramod Viswanath, CAMBRIDGE University Press
6) Mobile Wireless communications, Mischa Schwartz, CAMBRIDGE University Press

7) Wireless Communications : Andreas F. Molisch , Wiley Student Edition

Proposed Practical list

Hardware setups or simulation experiments on the following

1. OFDM (2 expts),
2. GSM (2 expts),
3. CDMA (2 expts),
4. One seminar per student on related latest technology in wireless systems (outside syllabus)

Term work:

Term work shall consist of minimum six experiments, Two Assignments and a written test.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) : 15 marks.

Test (at least one) : 10 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:
Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus

Theory Examination:
1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and will cover all modules.
4. Remaining questions will be from the same module or mixed in nature.
(e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In the question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from pre-requisite module

University of Mumbai	
CLASS: B.E. (Electronics Engineering)	**Semester – VII (Elective)**
SUBJECT: Advances in Biomedical Instrumentation (Elective)	

Periods per week (each of 60 min.)	**Lecture**	**4**	
	Practical	**2**	
	Tutorial	**-**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**3**	**100**
	Practical examination	**-**	
	Oral Examination	**-**	**25**
	Term Work	**-**	**25**
	Total		**150**

Module	**Contents**	**Hours**
Objective	To understand .importance of pathological and diagnostic equipments in Medical Electronics. The material and working of prosthetic and intensive care unit. Different imaging techniques in detail and Drug Delivery and Hospital Information System	
Pre-requisite	Knowledge of generation of electrical signal after studying anatomy and physiology of human body and different systems. Basic working and design of biomedical instruments.	
1	**Basic principle of Photometry :** • Beer Lambertz's Law, • Photoelectric Colorimeter • Spectrophotometer • Flame photometer • Autoanalyzer	06
2	**Blood Gas Analyzers:** Blood PO2, PCO2 and PH measurement; Complete Blood Gas Analyzer; Blood cell Counter : ▪ Methods of Cell counting-Coulter Counters; ▪ Automatic recognition and ▪ Differential counting of cells.	08
3	**Foetal Monitoring Instruments:** • Cardiotocograph • Foetal heart rate measurements • Foetal scalp pH monitoring	06
4	**Orthotic and Prosthetic Engg.** Definition, Need and Classification Normal Human Locomotion – Gait Cycle Biomaterials : Definition, Need and Classification Biological Testing and Biocompatibility Upper and Lower limb Prosthetic devices Upper and Lower limb Orthotic devices Study of various biomaterials and applications • Metallic Implants • Composites • Ceramics • Polymers Heart Lung Bypass machine and artificial heart valves	10

5	**Fundamentals of medical imaging:** X-ray computed Tomography, Spiral or Helical C T: Slip Ring Technology, C T Angiography. Clinical use & Biological effects and safety, Magnetic resonance imaging Biological effects and safety. Nuclear medical imaging Biological effects and safety., Infrared imaging, Liquid crystal thermography. Microwave thermography. Endoscopy, gastroscope, bronchoscope, cystoscope, colonoscope, Enteroscope Lithotripsy.	10
6	**Advances in Biomedical Systems:** Introduction to Nanotechnology and its use in Drug Delivery System, Hospital Information system: Role of database in HIS. Need of Networking in HIS. Overview of Networking, topologies and its configuration. Structuring medical record to carry out functions like admissions, discharges, treatment history etc. Computerization in pharmacy & billing. Automated clinical laboratory systems & radiology information system.	08

Text Books:

1. Khandpur R. S., Handbook of Biomedical Instrumentation, Tata McGraw Hill, second edition, 2003
2. Carr and Brown, Introduction to biomedical equipment technology, fourth edition, Pearson press, 2003
3. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
4. W.R.Hendee & E.R.Ritenour, Medical Imaging Physics (3rd eds), Mosbey Year-Book, Inc., 1992.

Reference Books:

1. John G. Webster, Bioinstrumentation John Wiley and sons,2004
2. Joseph Bronzino (Editor-in-Chief), Handbook of Biomedical Engineering, CRC Press, 1995.
3. Neelina Malsch , Biomedical nanotechnology by CRC press release, Malsch TechnoValuation, Utrecht, The Netherlands
4. L.A.Geddes and L.E.Baker,"Principles of Applied Bio-Medical Instrumentation" John Wiley & Sons 1975.
5. Khandpur R S, Handbook of Analytical Instrumentation, Tata Mc Graw Hill
6. Harold E. Smalley, "Hospital Management Engineering – A guide to the improvement of hospital management system", PHI. C. A. Caceras ,"Clinical Engineering"

Proposed Practical list

Sr.no	Topic	Title of Experiment
1	Basic principle of Photometry /Analyzer	Experiment based on any analyzer
2	Monitors	PH Meter
3		FHR (Foetus Heart Rate Monitor)
4	Orthotic and	Prosthetic Limb

5	Prosthetic Engg.	Heart Lung Machine or any other Prosthetic unit
6	Medical Imaging	Experiment to demonstrate imaging based on different Principles
7		
8	HIS	Demonstration of S/W used for hospital Information System

Termwork:

The term-work shall consist of at least six laboratory experiments covering the whole of syllabus, duly recorded and graded.

The distribution of marks for term work shall be as follows,
Laboratory work (Experiments and Journal) : 15 marks.
Test (at least one) : 10 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:
Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Theory Examination:
1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and will cover all modules.
4. Remaining questions will be mixed in nature. (e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In the question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from pre-requisite module.

University of Mumbai			
CLASS: B.E. (Electronics Engineering)		**Semester – VII (Elective)**	
SUBJECT: Elective - Microcomputer System Design			
Periods per week (each of 60 min.)	**Lecture**	**4**	
	Practical	**2**	
	Tutorial	**-**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**3**	**100**

	Practical /Oral examination		
	Oral Examination	**-**	**25**
	Term Work	**-**	**25**
	Total		**150**

Module	**Objectives: To understand the architecture and functioning of Pentium processor, its peripherals and interfacing.**	
	Pre-requisite: Fundamentals of Microprocessor	
	Contents	**Hours**
1	**The Pentium Processor** Detail discussion of Pentium architecture and functional units: super scalar architecture, dual pipe line , Integer pipeline stages, Floating point instruction stages, Overview of on chip code Maintaining coherency in on-chip cache MESI protocol Write once policy Study of Pentium signal interface, interface with various devices, misaligned data transfers data bus steering for 32, 16 and 8 bit devices	08
2	**The Pentium Processor** Code cache organization, split line access Branch Prediction logic, Instruction pairing rules Data Cache organization, detail discussion with various situations of U and V pipeline accesses Burst bus cycles, cache line fills, single transfer cycles pipelined cycles, special cycles. Interrupt acknowledge bus cycle, bus cycle state machine, bus and bus state transition. System management mode Interrupts, reliability and error reporting	10
3	Advanced features of Pentium II , Pentium Pro , Pentium IV Out of order execution , Advanced Branch Prediction, Hyper threading , On chip Level 2 cache , Trace cache .	06
4	**PCI bus :** Introduction to local bus , Need for standard bus PCI signal interface: Functional grouping of signals, their role in transactions PCI Bus arbitration , Hidden Bus Arbitration , Bus Access Latency Situations when master or target dominates the bus PCI read write commands Interrupt handling in PCI, Interrupt Routing and Chaining Need for the configuration space and its usage	10
5	**Peripheral Bus Interfaces** Basic hard disk structure IDE interface signals ,Timing Specifications, IDE	08

	register model, IDE protocols, commands SCSI Bus hardware , Phases in transactions, Commands and protocols	
6	**Universal Synchronous Bus(USB) :** Introduction to USB, PC requirements, Bus topology, understanding the host and the peripheral, the development process. USB transfer basics, Elements of a transfer, successful transfers. Transfer types, Control transfer, Bulk transfer, Interrupt transfer, Isochronous transfer, time critical transfers.	06

Text Books:

1) Tom Shanley et al, Pentium Processor System Architecture , Addison Wesley Press
2) Tom Shanley et al , PCI System Architecture , Addison Wesley Pres
3) F. Schmidt , SCSI Bus and IDE Interface , Addison Wesley Press
4) Jan Axelson , USB Complete , Pentium Publication , Second Edition

Reference Books:

1) Tom Shanley et al, Protected Mode Architecture, Addison Wesley Press

Suggested Laboratory Experiments

Minimum six experiments on

- Use of CPUID instruction and identification of Processor
- Various uses of DOS interrupts
- PCI BIOS

And assignments /experiments covering other topics of syllabus

Oral Examination:

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Term work:

Term work shall consist of minimum Six experiments, assignments and a written test.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) : 15 marks.

Test (at least one) : 10 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus

Theory Examination:

1. Question paper will comprise of total 7 questions, each of 20 marks.
2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and will cover all modules.
4. Remaining questions will be from the same module or mixed in nature.
(e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In the question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from pre-requisite module

University of Mumbai			
CLASS: B.E. (Electronics Engineering)		**Semester – VII(Elective)**	
SUBJECT: Digital Image Processing			
Periods per week	**Lecture**	**04**	
	Practical	**02**	
(each of 60 min.)	**Tutorial**	**-**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**03**	**100**
	Practical examination		
	Oral Examination	**-**	**25**
	Term Work	**-**	**25**
	Total		**150**

Objective	Image processing has grown considerably due to fast computational systems. Many important real life applications in diverse fields are therefore possible. This first course in image processing shall teach basic concepts in the subject.
Pre-requisite	Continuous and Discrete time signals and systems

Module	Contents	Hours
1	**Digital Image Fundamentals** Introduction, components of image processing systems, Image sensing & acquisition, Image sampling & Quantization, Pixel operation,	4
2	**Image Enhancement** Gray Level Transformations, Histogram Processing, Spatial Filtering, Smoothing and Sharpening Filters. Homomorphic Filtering Colour Image Enhancement.	8
3	**Image Segmentation** Detection of Discontinuities, Edge linking & Boundary Detection, Thresholding, Region based segmentation Laplacian of Gaussian, Derivative of Gaussian, Canny Edge Detection, Morphological operation : Dilation erosion, Opening & Closing, Basic	12

	Morphological Algorithm, Image representation schemes.	
4	**Image Transform** Discrete Fourier transform, Walsh transform(WT), Hadamard transform, Cosine transform, Haar transform, Wavelet transform,	8
5	**Image Compression** Fundamentals ,Lossless compression : RLE, Arithmetic Coding, Huffman Coding, ,Lossy compression : JPEG,MPEG, Subband Coding, Vector quantization, Image & Video compression standard.	10
6	**Applications of Image Processing** Case Study on Digital Watermarking, Biometric Authentication (Face, Finger Print, Signature Recognition), Vehicle Number Plate Detection and Recognition, Object Detection using Correlation Principle, Person Tracking using DWT, Handwritten and Printed Character Recognition, Contend Based Image Retrieval, Text Compression.	6

Text- Books:

1. Gonzalez & Woods, Digital Image Processing, Pearson Education, Second edition.
2. W. Pratt, Digital Image Processing, Wiley Publication, third edition, 2002.
3. S.Jayaraman Digital Image Processing TMH (Mc Graw Hill) publication
4. Milin Sonaka , Digital Image Processing and computer vision cengage learning, Thomson publication second edition.2007.
5. A.K. Jain, Fundamentals of Image processing, Prentice Hall of India Publication, 1995
6. Gonzalez & Woods, Digital Image Processing using MATLAB, Pearson Education

Reference Books:

1.Mc Andrew ,Introduction to Digital Image processing with Matlab cengage learning publication

2 Doubhcrty, Digital Image processing for medical application, Cambridge

Suggested List of Experiments :

List of experimental: using C/C++ or matlab or java

Topic-1 : Image Enhancement [Any two Experiments]

1. To enhance image using Histogram Equalization
2. To enhance image using Contrast Stretching
3. To enhance image using spatial filtering
3. To perform Colour Image Enhancement

Topic-2 : Image Segmentation [Any two Experiments]

1. To find edges using LOG and DOG
2. To find Edges using Prewit/ Sobel/ Fri-chen / Robert operators.
3. To find edges using canny Edge Detection.
4. To implement Morphological Operators

Topic-3 : Image Compression [Any Two Experiments]

1. To compress using Huffman coding
2. To compress DCT coefficient of Image
3. To compress Wavelet Coefficient of Image.
4. To compress Binary Image using Run Length Coding

Topic-4 : Application Development [Any Two Experiment]

1. Digital Watermarking
2. Biometric Authentication such as Face / Finger Print / Signature Recognition)
3. Vehicle Number Plate Detection and Recognition,
4. Object Detection using Correlation Principle,
5. Person Tracking using DWT,
6. Handwritten and Printed Character Recognition,
7. Contend Based Image Retrieval,
8. Morphological Toolkit Development
9. Human Expression Detection
10. Image Enhancement using Adaptive Histogram Equalization(AHE), Modified AHE(MAHE), Technique.
11. Image Compression using Vector Quantization
12. Image Compression using JPEG

Term Work:

The term work shall consist of at least six MATLAB Or C/C++ covering the whole of syllabus, duly recorded and graded.

The distribution of marks for term work shall be as follows:

Laboratory work (Experiments and Journal) : 15 marks.

Test (at least one) : 10 marks.

The final certification and acceptance of term-work ensures the satisfactory performance of laboratory work and minimum passing in the term-work.

Oral Examination:

Oral will be based on any experiment performed from the list of experiment given in the syllabus and the entire syllabus.

Theory Examination:

1. Question paper will comprise of total 7 questions, each of 20 marks.

2. Only 5 questions need to be solved.
3. Question number 1 will be compulsory and will cover all modules.
4. Remaining questions will be from the same module or mixed in nature.
(e.g.- suppose Q.2 has part (a) from, module 3 then part (b) will be from any module other than module 3.)
5. In the question paper, weightage of each module will be proportional to number of respective lecture hours as mentioned in the syllabus.
6. No question should be asked from pre-requisite module

B. E. Electronics Engineering semester VII	
Subject – Project -I	
Project Hour: 4 Hrs/week	Term work: **25 marks** Oral Exam. : **25 marks** Total marks=**50 marks**
Note: One faculty will not guide more than 3 projects in a semester. For every group allotted to faculty the load is considered as 1 Hour per group per week, be specified in time table of the faculty. Each group will not have more than 4 students.	
Rationale: Project allows the student to work independently to put the knowledge of Electronics engineering theory into practice.	
Detailed description	

Purpose:

- Engineering Project is a technical mandatory course.
- Project is the conclusive effort of independent work in the span of two semesters. The project course challenges the student to explore wide range of topics and opportunities for innovation.
- Responsibility is placed on the student to apply learning from various engineering courses and to seek out and make the best use of the available resources in terms of faculty, staff, library, laboratory, etc.
- This course is an opportunity for students to further develop the managerial skills while working in a team, creative skills by developing novel engineering solutions and communication skills presenting their end application, all necessary to be a successful engineer.
- Introducing the concept of professional literature and Gaining experience in writing a technical document.
- Enhancing employability through the evidence of independent work.

The students of Electronics Engineering are expected to build a project by designing an engineering solution to the any of the following:

- Improvise existing technology
- Real life concerns to improve basic transport/healthcare/pollution/population/security/utility services - water, gas, electricity, drainage, communication etc /infrastructure, housing etc
- Develop mathematical models to facilitate analysis and verifying the same
- Build dedicated or support applications for space/ military/medical commercial/telephone/industrial/ scientific.

To complete the project, students should describe a mathematical model, simulate, design, development, implementation or small research project in an area of specialization.

Note: Topics are given for student reference and students can explore beyond the topics specified under the guidance of project guide

Guidelines:

- Students should work under the guidance of any faculty member from the department.

- A faculty member must officially supervise all projects. Industry/ research Institute's supervisor (Qualified) may, under the direction of a faculty member, also supervise students. A faculty member is always responsible for the grading of every project.

- Group members should not be more than four
- Project is expected to be completed by end of VIII semester
- At the end of VII semester, students should submit synopsis summarizing the work done in VII semester. The objective of this activity is to achieve the following

    - Introduction/need/scope of the project
    - Clarity on the status of project and plan of action for VIII semester
    - Accumulation of the literature survey done (No un-authentic URL): The literature survey should be through standard Text book, References, Other publications of journals like-IEEE, Wiley Interscience, Springer, Elsevier or similar, of repute.
    - Procurement of Software/ Hardware needed for Installation/ Testing of projects in VIII semester
    - Corrective steps to be taken if any

- **Students are expected to adopt systematic approach towards project completion**

    - Each project should follow the scientific method and should apply the problem-solving approaches studied in earlier courses. In general, this includes: Gathering Information: A review of the state of the art should be made using the published literature as well as textbooks and student reports from previous projects if available.
    - Proper Planning: Students must define the project goals and must organize a logical sequence of steps to achieve these goals. This will vary depending on the project, ability to procure materials, availability of equipment, etc.
    - Regular Meetings: Students must meet regularly (weekly-4Hrs in VII Semester and 8 Hrs in VIII Semester) with the project guide.
    - Professional Record Keeping: Proper records are essential and are typically kept in a log book with all details of activity noted. Be sure to

use standard nomenclature and work in the SI system of units. (Log-book will contain in table format: Date/ Activity/ outcome/ comment on outcome/ Resources utilized/ Next meeting date, Target/ Guide's Remark)
Term work
Term work should consist of the above mentioned activities which shall be evaluated and shall carry a weightage of 25 marks.
Oral Examination
The oral examination shall be conducted on the basis on presentation given by the students and shall carry a weightage of 25 marks.

UNIVERSITY OF MUMBAI
SCHEME OF INSTRUCTION AND EVALUATION (R2007)
Programme: B.E. (ELECTRONICS ENGINEERING)

SEMESTER: VII

Sr. No	Subjects	No. of periods of 1Hour		Duration of Theory Paper in Hours	Marks			
		Lecture	Practical		Theory Paper	Term Work	Oral	Total
1	VLSI Design	4	2	3	100	25	25	150
2	Filter Design	4	2	3	100	25	25	150
3	Power Electronics and Drives	4	2	3	100	25	25	150
4	Communication Networks	4	2	3	100	25	25	150
5	**Elective-II** 5. Wireless communication 6. Advances in Biomedical Instrumentation 7. Micro computer system design 8. Digital Image Processing Design	4	2	3	100	25	25	150
6	**Project -I**					25	25	50
TOTAL		20	10	15	500	150	150	**800**

SEMESTER: VIII

Sr. No	Subjects	No. of periods of 1Hour		Duration of Theory Paper in Hours	Marks			
		Lecture	Practical		Theory Paper	Term Work	Oral	Total
1	Advance VLSI Design	4	2	3	100	25	25	150
2	Robotics and Automation	4	2	3	100	25	25	150
3	Embedded Systems and Real-Time Programming	4	2	3	100	25	25	150

4	**Elective-III** 5. Advanced Networking Technologies 6. DSP Processors and architectures 7. Neural Networks & Fuzzy Systems 8. Electronics Product Design	4	2	3	100	25	25	150
5	**Project -II**			--		50	100	150
TOTAL		16	08	12	400	150	200	**750**

University of Mumbai			
CLASS: B.E. (Electronics Engineering)		**Semester - VIII**	
SUBJECT: Advanced VLSI Design			
Periods per week	**Lecture**	**04**	
	Practical	**02**	
(each of 60 min.)	**Tutorial**	**-**	
		Hours	**Marks**
Evaluation System	**Theory Examination**	**3**	**100**
	Practical examination		
	Oral Examination	**-**	**25**
	Term Work	**-**	**25**
	Total		**150**

Module	**Contents**	**Hours**
Objective	**To introduce advance design concepts, develop basic understanding of analog VLSI field and relate to issues occurring at chip level**	**-**
Pre-requisite	**VLSI Design, DSD I and II, BEC**	**-**
1. Wire interconnect for circuit simulation	Interconnect parameters (Capacitance, Resistance and Inductance) their effect on circuit performance. Electrical wire models (ideal, lumped, lumped rc, distributed rc and transmission line), switching characteristics, transistor sizing, sizing routing conductors, charge sharing and reliability issues. (Numericals on each subtopic expected)	07
2. Sequential logic circuits design	Clocked systems (Single phase, Two phase and four phase clocking), recommended clocking approaches – clocked CMOS – Dynamic CMOS circuits – solutions for charge sharing - Implementation of general	09

	VLSI sequential system components such as Flip Flops, static as well as dynamic latches and Registers. Pipelining concepts	
3.Aritmetic Circuits in CMOS VLSI	Dynamic adders, Fast adders, Wide adders: Carry look ahead, Block generate and propagate, carry save, carry skip, carry save	06
4. Design of memories & programmable logic	CMOS Memory structures – SRAM and DRAM design –Sense amplifier design - Low power design techniques. ROM Arrays and Logic Arrays. EPROM, EEPROM, Flash cell working . Design of basic 6T SRAM Cell with read and write stability criteria	08
5. Timing issues & System Level Physical Design	Timing classification, Synchronous timing basics, clock skew, propagation delay estimation, clock jitter, combined clock skew and clock jitter estimation, synchronous and asynchronous design timing estimations. Clock generation and distribution Crosstalk, Interconnect Scaling, Floor planning & Routing, I/P & O/P Circuit, Power dissipation and consumption, Low power Design considerations.	09
6. Introduction to Analog and Mixed signal design	Building blocks for CMOS amplifiers, CMOS operational transconductance amplifiers. Frequency compensation schemes. Design of fully differential amplifiers, common mode feedback circuits, switched capacitor circuits. Design of sample and hold and comparator circuits.	09

Text books

1. John P. Uyemura, *Introduction to VLSI Circuits and systems*, John Wiley & sons.
2. Sung-Mo Kang & Yusuf Leblebici, *CMOS Digital Integrated Circuits - Analysis & Design*, Second Ed., MGH
3. Jan M Rabaey, *Digital Integrated Circuits - A Design Perspective*, Prentice Hall
4. D.Razavi, *Design of Analog CMOS circuits,* McGraw Hill

Additional Reading

1. Neil H.E. Weste, Kamran Eshraghian, *Principles of CMOS VLSI Design: A system perspective*, Addison Wesley publication.
2. Fabricius, Eugene D, *Introduction to VISI Design.* TMH
3. P.R. Gray & R.G. Meyer, *Analysis and design of analog integrated circuits*, John Wiley

Proposed Practical list

B.E. Electronics Engineering	
VII-Seventh Semester (R2001) -Old	Equivalent VII-Seventh Semester (R2007)-Revised
1. Basics of VLSI	VLSI Design
2. Instrumentation Systems	Electronic Instrumentation Systems (TE, VI sem R-2007)
3. Digital Communication	Digital Communication and Coding Techniques (TE, V sem R-2007)
4. Filter Theory and Applications	Filter Design
5. Elective – I	
Wireless Communication	Wireless communication
Image Processing	Digital Image Processing Design
Microprocessor System Design	Micro computer system design
DSP Architecture	DSP Processors and architectures (VIII – R2007)
Process Control Instrumentation	No Equivalent*

*** Student needs to appear in the same subject of R-2001**

B.E. Electronics Engineering	
VIII-Eighth Semester (R2001) - Old	Equivalent VIII-Eighth Semester (R2007)-Revised
1. Power Electronics	Power Electronics and Drives(VII –R2007)
2. Data Communication & Networking	Communication Networks
3. Mechatronics	No Equivalent*
4. Elective – II	
VLSI Design	Advance VLSI Design
Robotics	Robotics and Automation
Telecom Network Management	No Equivalent*
Embedded System	Embedded Systems and Real-Time Programming
Advance DSP	No Equivalent*
Bio-medical Instrumentation	Advances in Biomedical Instrumentation

*** Student needs to appear in the same subject of R-2001**