SEMESTER VI

	MICROWAVE ENGINEERING

Module	Content	No. of Lectures
1	**Introduction:** RF and microwave spectrum, historical background, application of RF and Microwave Impedance Matching–Unknown impedance measurement using shift in minima technique and impedance matching using single and double stub matching.	8
2	**Microwave waveguides and components**: Rectangular waveguide and circular waveguide, mode structure, cutoff frequency, wall current, attenuation; microwave cavities – rectangular cavity resonator, Q factor power divider, scattering matrix and transmission matrix, attenuator, phase shifter, directional coupler, Bethe hole coupler, magic tee, hybrid ring, circulator, isolator, Ferrite Devices	10
3	**Planar structures:** Strip line, microstrip line, coplanar structure **Microwave Tubes:** Limitations of conventional tubes, Multicavity Klystron, Reflex Klystron, Magnetron, Travelling Wave Tube, Backward Wave Oscillator Semiconductor Microwave Devices – Tunnel diode, Gunn diode and thei waveguide mounts	10
4	**Avalanche diodes:** IMPATT, TRAPATT, Microwave bipolar transistor, heterojunction bipolar transistor. **Microwave field effect transistor:** JFET, MOSFET, MESFET **Applications of microwave:** Industrial Applications of microwave.	8
5	**Microwave Measurement:** VSWR measurement, power measurement, impedance measurement, frequency Measurement Equivalent RF circuit parameters Low pass filter, high pass filter, band pass filter, RF amplifier.	6

Text Books/References books:

1. Golio M, Golio J (2008) The RF and Microwave Handbook. CRC Press.
2. Pozar DM (2005) Microwave Engineering. John Wiley & Sons.
3. Hong JS, Lancaster MJ (2001) Microstrip Filters for RF/Microwave Applications. John Wiley & Sons.

List of experiments:

1. To measure the frequency and wavelength using slotted line section and frequency meter.
2. To measure the Isolation and Insertion loss of Isolator and Circulator.
3. To study E-plane, H-plane and Magic Tee.
4. To measure Coupling Factor, Directivity and Isolation of directional coupler.
5. To measure VSWR and Reflection coefficient of different loads.
6. To study the characteristics of Klystron and Gunn diode.

7. Simulation of Transmission line: Waveguide and Coaxial line.
8. Simulation of directional coupler.
9. Simulation of E-plane and H-plane Tee.
10. Study of micro strip line and LPF using HFSS Software.
11. Study of BPF using HFSS Software.

	VLSI DESIGN

Module	**Content**	**No. of Lectures**
1	**Introduction:** Review of MOSFET characteristics, scaling and small-geometry effects, and MOSFET capacitances. MOS resistor, MOS current source, current mirror circuits. MOS voltage source, linear voltage and current converters.	**6**
2	**CMOS operational amplifier (OPAMP) design:** Differential amplifier, level shifter, source follower, output stage voltage and power amplifiers. Cascode OP-AMP. Compensation techniques. **Analog Filters:** Switched capacitor (SC) fundamentals, first order SC circuits, second-order SC circuits and cascade design. Analog to digital and digital to analog converters, speed of conversion and over sampling issues. **VLSI Interconnects:** Distributed RC model, transmission line model. Future inter connect technologies.	**14**
3	**Digital VLSI Circuit Design:** MOS inverters, CMOS inverter, state characteristics, switching characteristics, power dissipation issues. **CMOS logic gates:** NAND, NOR, XOR, CMOS logic design of half and full adders. CMOS transmission gates, pseudo-nMOS, domino logic gates.	**9**
4	**Sequential MOS Logic Circuits:** The SR latch circuit, clocked latch and flip-flop, CMOS D-latch and edge-triggered circuits, Schmitt trigger circuit, Comparator. **Dynamic Logic Circuits:** Pass transistor logic, synchronous dynamic circuit techniques.	**8**
5	**Semiconductor Memories:** ROM circuits, SRAM circuits, DRAM circuits, drivers and buffers, Buffer scaling and design issues	**5**

Text Books/Reference books:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th Edition, Pearson Education, 2015.

List of experiments:

1) To study the MOS characteristics and introduction to tanner EDA software tools.

2) To design and study the DC characteristics of PMOS and NMOS.

3) To design and study the DC characteristics of resistive inverter.

4) To design and study the transient and DC characteristics of CMOS inverter.

5) To design and study the characteristics of CMOS NAND and NOR gate.

6) To design and study the characteristics of CMOS multiplexer.

7) To design any Boolean function using transmission gates.

8) To design and study the characteristics of CMOS Full adder.

9) To design and study the characteristics of CMOS D Flip Flop.

10) To design and study the transient characteristics of CMOS XOR/XNOR.

11) To design and study the characteristics of Schmitt trigger circuit.

	INTERNET OF THINGS

Module	Course Content	No. of Lecture
1	**Introduction to IOT:** IoT and the connected world, Architecture of IoT, Security issues, Opportunities for IoT. **The Web of Things:** Linked data, Enterprise data, Importance of security, privacy, and authenticity, Industry standards, Web of Things layer as the driver for IoT systems.	8
2	**Lessons from the Internet:** Relevance of internet to network of things, network management, security, mobility and longevity.	5
3	**Technologies:** Wireless protocols, Connectivity options. **Data storage and analysis:** Managing high rate sensor data, Processing data streams, Data consistency in an intermittently connected or disconnected environment, Identifying outliers and anomalies.	10
4	**Use cases:** Smart Buildings, Smart health, Home automation, Location tracking.	6
5	**Smart Cities:** Collection of information including opportunistic sensing, crowd sensing, and adhoc sensing Response of the system including analytics and optimization, distributed action, people as intelligent actuators, the risk for cyber-attacks in centralized and distributed systems	10

Text Books/Reference books:

1. Designing the Internet of Things, by Adrian McEwen, Hakim Cassimally Wiley 2013.
2. Enterprise IoT Naveen Balani Create Space Independent Publishing Platform 2016.

List of experiments:

1. Eclipse IoT Project.
2. Sketch the architecture of IoT Toolkit
3. Demonstrate a smart object API gateway service reference implementation in IoT toolkit.
4. Demonstrate working of an HTTP- to-CoAP semantic mapping proxy in IoT toolkit.
5. Demonstrate gateway-as-a-service deployment in IoT toolkit.
6. Demonstrate application framework and embedded software agents for IoT toolkit.
7. demonstrate working of Raspberry Pi.
9. Connect Raspberry Pi with your existing system components.
10. Give overview of Zetta.

	BIOMEDICAL SIGNAL PROCESSING

Module	Content	No. of Lectures
1	**Introduction to Biomedical Signals**: The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. **Electrocardiography**: Basic electrocardiography, ECG lead systems, ECG signal characteristics. **Signal Conversion :**Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits	**8**
2	**Signal Averaging:** Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. **Adaptive Noise Cancelling:** Principal noise canceller model, 60-Hzadaptive cancelling using a sine wave model, other applications of adaptive filtering	**8**
3	**Data Compression Techniques:** Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms The Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG	**8**
4	**Cardiological signal processing:** Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Realtime ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor	**8**

5	**Neurological signal processing:** The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. **Analysis of EEG channels:** Detection of EEG rhythms, Template matching for EEG, spike and wave detection	**8**

Text / Reference Books:

1. D.C.Reddy, "Biomedical Signal Processing – Principles and Techniques", TMH.
2. Wills J. Tompkins, " Biomedical digital signal processing", Prentice Hall of India Pvt. Ltd.
3. Digital biosignal processing. Weitkunat R, Elsevier.
4. Biomedical signal processing. Akay M. Academic Press.
5. Computer technique in medicine. Macfarlane P.W. Butter Worth
6. Biomedical signal processing. Vol-I, Time frequency analysis. Cohen A. CRC press.

List of Experiments:

1.Computation of convolution and correlation sequences
2. Analog and digital signal conditioning
3. Signal averaging improvement in the SNR using coherent averaging
4. Signal averaging improvement in the SNR using incoherent averaging
5. Exponential averaging
6. Data polishing: mean and trend removal
7. PSD estimation
8.EEG processing and analysis
9. PCG processing and analysis
10. Electronic BP measurement and calibration
11. Spectral analysis of bio-potential signal.

	Electronics Measurement and Instrumentation

Module	Topics	No. of Lectures
1	**Measurement Errors and Standards:** Definitions, Accuracy and Precision, Significant Figures, Types of Error, Statistical Analysis, Probability of Errors, Limiting Errors, Time and Frequency Standards, Electrical Standards. **Bridge Measurements:** Wheatstone Bridge, Kelvin Bridge, AC Bridge and their Applications, Maxwell Bridge, Hay's Bridge, Unbalance Conditions, Wein Bridge.	8

Module	Topics	No. of Lectures
	Anderson's Bridge, De Sauty's Bridge, Schering Bridge.	
2	**Electronics Instrument For Measuring Basic Parameters:** True RMS Responding Voltmeter, Digital Frequency Meter, Circuit for Measurement of Frequency, High Frequency Measurements, Period Measurement, Ratio and Multiple Ratio Measurements, Time Interval Measurements, Vector Impedance Meter. **Cathode Ray Oscilloscope**: Introduction, Oscilloscope Block Diagram, Cathode Ray Tube, Delay Line, Multiple Trace, Oscilloscope Scope and Transducers, Oscilloscope Techniques, Digital Storage Oscilloscope.	11
3	**Instrument for Generation and Analysis of Waveforms:** Introduction, The Sine Wave Generator, Frequency Synthesized Signal Generator, Frequency Divider Generator, Signal Generator Modulation, Sweep Frequency Generator, Pulse and Square Wave Generator, Function Generator, Wave Analyzers, Harmonic Distortion Analyzer, Spectrum Analyzer.	6
4	**Transducers:** Electrical Transducers Selection and Considerations, Resistive, Strain Gauges, Temperature Transducers: Platinum Resistance Type, Thermistor, Thermocouples, Inductive, LVDT, Capacitive, Load Cell, Piezoelectric, Photoelectric Transducers. **Signal Converters:** I to P and P to I Converter, Temperature to Voltage Converter, Conversion To Frequency, Period, or Time Duration, Measurement of Phase Difference Using X-OR and SR Flip-Flop Method, Measurement of Active And Reactive Power of Supply Line, Locking Amplifiers, Variable Oscillators, Direct Sensor- Microcontroller Interfacing.	9
5	**Isolation Techniques:** Transformer Isolation, Optical Isolation, Digital Techniques For Optical Isolation, Hall-Effect Principle And Measurement Of Displacement, Current And Power Using Hall Sensors, Amplifications Of Low Level Signals, Guarding, Shielding. **Data Acquisition And Conversion:** Analog Signal Processing, Sample And Hold Operation, S/H Circuits Using Op-Amps, Introduction To Data Acquisition System, Various DAS Configurations, Single Channel DAS, Multi-Channel DAS, IC	12

Module	Topics	No. of Lectures
	Based DAS, Data Acquisition, Data Acquisition in PLC.	

Text Books:

1. W.D. Coopers and Helfrick, Modern Electronic instrumentation and Measurements Techniques, Prentice Hall of India Pvt. Ltd,

2. A. K. Sawhney: A course in Electrical & Electronic Measurements and Instrumentation, Edition 11, Dhanpat Rai and Sons,

3. E.W. Gowlding and F.C.Widdis, Electrical Measurements and Measuring Instruments 5/e, Wheeler Publications.

Reference Books:

1. U. A. Bakshi, A. V. Bakshi: Electrical Measurements and Instrumentation, Technical Publications.

2. J. B. Gupta: A course in Electrical and Electronic Measurements and Instrumentation, 13/E, Kataria and Sons.

List of experiments:

1. To find the value of unknown resistor using Wheatstone bridge.
2. To find the value of unknown capacitance and inductance using Maxwell's bridge.
3. To find the value of unknown capacitance using Wein's series and parallel bridge.
4. To extend the range of given voltmeter and ammeter.
5. Measurement of frequency using Lissajous method.
6. To study and verify characteristic of variable resistor transducer (strain gauge).
7. To study and verify characteristic of LVDT
8. To study and verify characteristic of Thermocouple/RTD.
9. To study the front panel controls of storage CRO.
10. To analyze analog and digital multi meter for various measurements.
11. To verify the performance characteristics of compensated attenuator.
12. To demonstrate the functionality of function generator and its use as a test and measurement equipment.
13. Measurement of LCRQ meter.
14. To demonstrate the functionality of IC tester and test various ICs.

	BIOSENSORS

Module	Course Content	No. of Lecture
1	**General principles:** A historical perspective, Signal transduction, Physico-chemical and biological transducers, Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary, Main technical definitions, calibration, selectivity, sensitivity, reproducibility, detection limits, response time.	8
2	**Physico-chemical transducers:** Electrochemical transducers (amperometric, potentiometric, conductimetric), optical transducers (absorption, fluorescence, SPR), Thermal transducers, piezoelectric transducers.	5

3	**Bio recognition systems: Enzymes:** Oligonucleotides and Nucleic Acids, Lipids (Langmuir-Blodgett bi-layers, Phospholipids, Liposome's), Membrane receptors and transporters, Tissue and organelles (animal and plant tissue), Cell culture, Immuno receptors, Chemoreceptor's, Limitations & problems, Immobilization of biomolecules.	**10**
4	**Biosensor Engineering:** Methods for biosensors fabrication, self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS, Engineering concepts for mass production.	**8**
5	**Application of modern sensor technologies:** Clinical chemistry, Test-strips for glucose monitoring, Urea determination; Implantable sensors for long-term monitoring, Environmental monitoring, Technological process control, Food quality control, Forensic science benefits, Problems & limitations.	**8**

Text Books:

1. Donald G. Buerk, Biosensors: Theory and Applications, First Edition, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

4. R. S. Khandpur, "Handbook of Biomedical Instrumentation", Tata McGraw Hill.

5.S.C. Cobbold, "Transducers for Biomedcial Instruments", Prentice Hall.

6. Brown & Gann, "Engineering Principles in Physiology Vol. I", Academic Press.

7. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
8. Rao & Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India.

Reference books:

1.Iberall & Guyton , "Regulation & Control in Physiological System" , Instruments Society USA.

2. A.V.S. De Renck , "Touch Heat & Pain", Churchill Ltd. London.

3.Harry Thomas , "Handbook of Bio medical Instrumentation", Reston, Virginia.

4.D. L. Wise , "Applied Bio Sensors", Butterworth, London.

List of experiments:

1. To study about various static and dynamic characteristics of Transducers.

2. To study about Electrochemical & optical Transduction.

3. Introduction to various types of Biosensors.

4. To study about different types of Force Measurement Techniques.

5. To study about different types of Torque Measurement Techniques.

6. Introduction to BioMEMs

7. To study about various fabrication techniques of BioMEMs.

8. Demonstration of Biosensor Microchip.

9. Demonstration of BioMEMS: Revolution in drug delivery and analytical techniques

10. Demonstration of MEMS to Bio-MEMS and Bio-NEMS: Manufacturing Techniques and Applications

11. Demonstration of POLYMER BioMEMS for Implantable Drug delivery

	DIGITAL SIGNAL PROCESSING

Module	Content	No. of Lectures
1	**Signals and systems:** Basic elements of DSP, concepts of frequency in Analog and Digital Signals, sampling theorem, Discrete time signals, systems analysis of discrete time LTI systems, Z transform, Convolution, Correlation.	**6**
2	**Frequency transformations:** Introduction to DFT, Properties of DFT, Circular Convolution, Filtering methods based on DFT, FFT Algorithms, Decimation in time Algorithms, Decimation in frequency Algorithms, Use of FFT in Linear Filtering, DCT, Use and Application of DCT.	**10**
3	**IIR filter design:** Structures of IIR, Analog filter design, Discrete time IIR filter from analog filter, IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives (LPF, HPF, BPF, BRF) filter design using frequency translation.	**10**
4	**FIR filter design:** Structures of FIR, Linear phase FIR filter, Fourier Series, Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques.	**8**
5	**Finite word length effects in digital filters:** Binary fixed point and floating point number representations, Comparison, Quantization noise, truncation and rounding, quantization noise power, input quantization error, coefficient quantization error, limit cycle oscillations-dead band, Overflow error-signal scaling.	**8**

Text Books/Reference books:

1. J.G.PROAKIS & D.G.MANOLAKIS, Digital Signal Processing - Principles, algorithms & Applications, PHI, 2000.
2. .B.Venkataramani, M.Bhaskar, "Digital Signal Processors, Architecture, Programming and Application", Tata McGraw Hill, New Delhi, 2003
3. A.V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, 2nd Edition, PHI, 2000.

4. S.K.MITRA, Digital Signal Processing – A computer Based Approach, 2nd Edition, MGH, 2001.
5. Multi Rate Systems and Filter Banks – P.P.Vaidyanathan – Pearson Education.
6. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007.

	VERY LARGE SCALE INTEGRATION

Module	Content	No. of Lectures
1	**System Level Design:** System level design-Tools & methodologies for system level design, System level space & modeling languages, SOC block based design & IP assembly, Performance evaluation methods for multiprocessor SOC design.	**8**
2	**Power Management And Synthesizing** : System level power management, Processor modeling & design tools, Embedded software modeling & design Using performance metrics to select microprocessor for IC design, Parallelizing High-Level Synthesize, A code transformational approach to High Level Synthesize.	**12**
3	**Micro-Architecture Design and Power Optimization**: Micro-architecture design, Cycle accurate system – level modeling, Performance evaluation Micro architectural power estimation optimization, Design planning.	**8**
4	**Software Design Verification**: logical verification, Design & Verification languages, Digital simulation, using transactional, level models in an SOC design, Assertion based verification.	**8**
5	**Hardware Design Verification**: Hardware acceleration & emulation, Formal property verification, TEST, DFT, ATPG, Analog & mixed signal test.	**6**

Text Books/Reference books:

1. Louis Scheffer Luciano Lavagno and Grant Martin, "EDA for IC System verification and Testing",CRC, 2006.
2. Wayone Wolf, "Modern VLSI Design: SOC Design"
3. Prakash Rashnikar, Peter Paterson, Lenna Singh "System-On-A-Chip Verification methodology & Techniques", Kluwer Academic Publishers.
4. Alberto Sangiovanni Vincentelli," Surviving the SOC Revolution: A Guide to Platform based Design", Kluwer Academic Publishers.

	BIOMEDICAL ELECTRONICS

Module	Course content	No. of Lectures
1	**Basic Medical Instrumentation System**: Static and dynamic characteristics of medical instruments, Bio-signals and characteristics. Problems encountered with measurements from human beings. **Bio-Potential Electrodes and Physiological Transducers:** Electrode potential, Electrode equivalent circuit, Types of Electrodes-Surface Electrodes, Needle Electrodes, Micro Electrodes. Pressure transducers, Transducers for body temperature measurement.	**14**
2	Electrical Conduction system of the heart, Block diagram Of Electrocardiograph, ECG leads, Einthoven triangle, ECG amplifier, EEG 10-20 lead system, Specifications and Interpretation of ECG, EEG, EMG.	**8**
3	**Blood flow meters:** Electromagnetic blood flow meter, Ultrasonic Doppler blood flow meter. Blood pressure measurement-Ultrasonic blood pressure monitoring. **Physiological Assist Devices & Therapeutic Equipment:** Pacemakers, External & internal, Defibrillators, External & internal, Hemodialysis machine.	**10**
4	Spirometry, Pnemuotachograph, Ventilators Monitoring Equipment: Arrhythmia Monitor, Foetal Monitor, and Incubator. **Medical Imaging Equipment:** X-ray generation, X-ray tube, X-ray machine, Computed Tomography (CT), Ultrasound Imaging system .	**10**
5	Electric shock hazards, Leakage currents, Test instruments for checking safety parameters of biomedical equipments.	**8**

Text books/Reference books:

1. L.A.Geddes and Wiley, Principles of Biomedical Instrumentation L.E.Baker (2nd Ed.)
2. L.Cromwell, Biomedical Instrumentation and Measurements, Prentice Hall.
3. John G.Webster (Ed.), Medical Instrumentation – Application and Design, 3rd Edition, John Wiley & Sons Inc.
4. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata McGraw Hill.
5. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication.
6. Medical Instrumentation Application and Design by J. G. Webster, Wiley Publication.