Tripura University
(A Central University)

Detailed syllabus for

B.Tech in Electronics and

Communication Engineering

(Sixth Semester)

2021

SIXTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/ week	Credit	Full Marks
1.	Program Core-21	PC EC 601	Microwave Engineering	3	0	0	3	3	100
2.	Program Core-22	PC EC 602	Fiber Optic Communication	3	0	0	3	3	100
3.	Program Core-23	PC EC 603	VLSI	3	0	0	3	3	100
4.	Program Core-24	PC EC 604	Digital Signal Processing	3	0	0	3	3	100
5.	Program Core-25	PC EC 605	Microwave and Fiber Optic Communication Lab	0	0	2	2	1	100
6.	Program Core-26	PC EC 606	VLSI Lab	0	0	2	2	1	100
7.	Program Core-27	PC EC 607	Digital Signal Processing Lab	0	0	2	2	1	100
8.	Program Elective-1	PE EC 608	4)Electronic Measurement and Instrumentation 5)Power Electronics 6)Bio Medical Engineering	3	0	0	3	3	100
9.	Project - 1	PR EC 609	Mini Project	0	0	6	6	3	100
			Total :	15	0	12	27	**21**	**900**

1. Microwave Engineering (PC EC 601)

Course Code	PC EC 601
Course Title	Microwave Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	EM Theory
Course Category	Program Core (PC)
Number of classes	36 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Explain various microwave Frequency bands and Transmission Lines	K2
CO-2	Explain the properties of various Passive and Active Microwave Devices.	K2
CO-3	Explain the properties of various Microwave Semiconductor Devices and Tube Devices.	K2
CO-4	Develop microwave systems for different practical application.	K3

Course Content:-

Module-I: Introduction to RFandMicrowaveTransmissionLines (9Hours)

Microwave Frequency bands; Applications ofMicrowaves.

Rectangular Wave guides : Introduction, TE/TM mode analysis, Dominant and Degenerate Modes. Power Transmission and Power Losses in Rectangular Guide.
Circular Waveguides: Introduction, TE/TM mode analysis, Dominant and Degenerate Modes. Power Transmission and Power Losses in Rectangular Guide
Micro strip Lines: Introduction, Effective Dielectric Constant, Characteristic Impedance, , Losses, Q factor.

Module-II: Passive and Active Microwave Devices (9Hours)

Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. Microwave active components: Diodes, Transistors, Oscillators, Mixers.

Module-III: MicrowaveSemiconductorDevices and Tube Devices (9Hours)

Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tube Devices: Klystron, TWT, Magnetron.

Module-IV: MicrowaveMeasurements (9Hours)

Description of Microwave Bench – Different Blocks and their Features, Precautions; Microwave Power Measurement. Measurement of Attenuation, Frequency, VSWR, Cavity Q. Impedance Measurements. MeasurementofMicrowaveantennaparameters.

***TEXT/REFERENCEBOOKS*:**

1. Microwave Engineering by M. kulkarni
2. Annapurna Das and Sisir K. Das, Microwave Engineering ,McGrawHill.

3. K.C.Gupta and I.J.Bahl, Microwave Circuits, Artech house
4. R.E. Collins, Microwave Circuits, McGraw Hill
5. Samuel Liao - Microwave devices and circuits, PHI
6. Dennis Roddy - Microwave Technology, PHI
7. G. Kennedy - Electronic Communication systems, McGraw-Hill Book Company
8. Sitesh kumar Roy & Manojit Mitra - Microwave semiconductor devices, PHI
9. A. K. Gautam - Microwave engineering, (S. K. Kataria pub)
10. Sanjeev Gupta, Microwave Engineering, Khanna Pub.

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2. FIBER OPTIC COMMUNICATION (PCEC 602)

Course Code	PCEC 602
Course Title	Fiber Optic Communication
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Optics
Course Category	Program Core (PC)
Number of classes	36 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Explain fiber-optic communication system.	K2
CO-2	Explain theoperationofoptical Sources and detectors.	K2
CO-3	Explain thepropertiesofvarious opticalcomponents.	K2
CO-4	AnalyzesystemperformanceofOptical Networks.	K4

Course Content:-

Module-I: Optical fibres and their properties (09 Hours)

Principles of light propagation through a fiber, Different types of fibres and their properties, Acceptance angle, Numerical aperture, Signal degradationonopticalfiberdueto- Attenuation, Absorption losses, Scattering losses, Dispersion , Radiation losses.

Module-II: Optical Sources and detectors (09 Hours)

Optical Source-LEDs and Lasers . Optical detectors – PIN-diodes, APDs.

Module-III: Components(09 Hours)

Couplers, isolators and circulators, multiplexers and filters, optical amplifiers, transmitters, switches, wavelength converters and problems.

Module-IV: Optical Networks (09 Hours)

Optical transmitters and receivers, System block diagram , point to point

link , link design, power budget analysis. WDM, DWDM and SONET/SDH. Introduction to AON , PON and FTH.

TEXT/REFERENCEBOOKS

1. J. Keiser, Fiber Optic communication, McGraw-Hill, 5thEd.2013(Indian Edition).
2. *Ajoy Ghatak*, Optics, Tata McGraw-Hill Education
3. *John M. Senior, Optical Fiber Communications* , PHI, 3rd Edition,
4. T.Tamir,Integratedoptics,(TopicsinAppliedPhysicsVol.7),Springer-Verlag,1975.
5. J.Gowar, Optical communication systems, Prentice Hall India,1987.
6. S.E.MillerandA.G.Chynoweth,eds.,Opticalfiberstelecommunications,AcademicPress,1979.
7. G.Agrawal, Nonlinearfiberoptics,AcademicPress,2ndEd.1994.
8. G.Agrawal, Fiber opticCommunicationSystems, JohnWileyandsons, NewYork, 1997

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3. VLSI (PC EC 603)

Course Code	PC EC 603
Course Title	VLSI
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Electronic Devices
Course Category	Program Core (PC)
Number of classes	38 hours

Course Outcome:

After the completion of the course, students will be able to-

CO Number	CO Description	K-level
CO-1	Interpret the concepts of MOS transistors operations and their AC , DC characteristics and scaling.	K2
CO-2	Relate the fabrication process of CMOS technology and its layout design rules.	K1
CO-3	Explain the concepts of CMOS invertors and their sizing methods, dynamic CMOS logic, pass transistor and transmission gates.	K2
CO-4	Assume about VLSI system component circuits.	K4
CO-5	Explain low power VLSI design techniques	K2

Course Content:

Module 1: MOS Capacitor and MOSFET device physics (10 hours)

MOS capacitor, Simple MOS capacitance Models, Detailed MOS gate capacitance model, Detailed MOS Diffusion capacitance model., Inversion, depletion and accumulation, MOS transistor theory – Introduction, Enhancement mode transistor action, NMOS and PMOS transistors, CMOS logic, Ideal I-V characteristics, DC transfer characteristics, Threshold voltage, Body effect- Design equations. MOS models and small signal AC characteristics, scaling, short channel effects..

Module 2: VLSI Fabrication (10 hours)

CMOS fabrication and Layout, CMOS technologies, P -Well process, N -Well process, twin -tub process, Diffusion, Ion implantation, Lithography, MOS layers stick diagrams and Layout diagram, Layout design rules, Latch up in CMOS circuits, CMOS process enhancements, Technology – related CAD issues, Fabrication and packaging.

Module 3: Inverters and Dynamic CMOS (10 hours)

Resistive load inverter, enhancement and depletion load inverter, NMOS and CMOS Inverters, Inverter ratio, DC and transient characteristics , switching times, Super buffers, Driving large capacitance loads, CMOS logic structures, pass transistors, Transmission gates, Static CMOS design, dynamic CMOS design, NORA, Domino logic, Zipper circuits.

Module 4: VLSI system components and low power VLSI design (08 hours)

Multiplexers, Decoders, comparators, priority encoders, Shift registers. Arithmetic circuits – Ripple carry adders, Carry look ahead adders, High-speed adders, Multipliers, Power dissipation in cmos and its types, low power vlsi design techniques,.

***REFERENCES / SUGGESTED LEARNING RESOURCES*:**

1. Neil H.E. Weste and Kamran Eshraghian, Principles of CMOS VLSI Design, Pearson Education ASIA, 2nd edition, 2000.
2. John P. Uyemura "Introduction to VLSI Circuits and Systems", John Wiley & Sons, Inc., 2002.
3. Kang and Leblebici – CMOS digital integrated circuits – McGraw Hill International Edition.
4. Pucknell, "Basic VLSI Design", Prentice Hall of India Publication, 1995.
5. Eugene D. Fabricius, Introduction to VLSI Design McGraw Hill International Editions, 1990

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4. Digital Signal Processing (PC EC 604)

Course Code	PC EC 604
Course Title	Digital Signal Processing
Number of Credits	03 (L:3,T:0,P:0)
Prerequisites	Set Theory
Course Category	Program Core (PC)
Number of classes	38 hours

Course Outcome:

After successful completion of this course, students will be able to-

CO Number	Description	K- Level
CO-1	Classify the concept of Discrete Fourier Series and Discrete Fourier Transform	K2
CO-2	Solve the problems related to DFT by FFT	K3

CO-3	Analyze FIR and IIR systems	K4
CO-4	Design Digital FIR and IIR filters	K6
CO-5	Interpret the Digital Signal Processor Architecture	K2
CO-6	Make use of to simulate DSP Algorithms by using TMS320 series	K3

Course Content:

Module 1: Fourier Analysis of Discrete Time Signals (10 hours)

Review of Discrete Fourier series and Discrete Time Fourier Transform, Frequency domain sampling, Discrete Fourier Transform, Properties, Circular convolution, Linear convolution using DFT, Linear filtering of long data sequences, Overlap add and overlap save methods, Computation of DFT by FFT, Decimation in Time and Decimation in Frequency algorithms.

Module 2: Structures for realization of Discrete Time Systems(10 hours)

Structures for realization of discrete time systems, Signal flow graph representation, structures for FIR and IIR systems, direct form, cascade form, parallel form, lattice, and transposed structures representation of numbers & errors due to rounding and truncation, Quantization of filter coefficients, round off effects in digital filters.

Module 3:Design of Digital Filters (10 hours)

Design of Digital filters, Types of digital filters, FIR and IIR filters, Specifications of digital filters, Design of FIR filters, Linear phase Characteristics: Window method, Optimal method and Frequency Sampling method, Design of IIR filters from analog filters, Impulse invariant and bilinear transformation methods, Frequency transformation in the analog and digital domains.

Module 4: Computer Architectures for Signal Processing(8 hours)

Computer Architectures for signal processing, Harvard Architecture, Pipelining, Multiplier, Accumulator, Special Instructions for DSP. General Purpose DSP Processors, Implementation of DSP Algorithms for various operations, Special purpose DSP hardware, Hardware Digital filters and FFT processors, Case study and overview of TMS320 series processor.

***TEXT/ REFERENCE BOOKS*:**

1. J.G. Proakis& D.G. Manolakis, Digital Signal Processing, Principles, Algorithms and Applications.,PHI/Pearson
2. Chen, Digital Signal Processing, OUP
3. Meyer-Basse U, Digital Signal Processing with FPGA, Spriger India
4. Ingle, Digital Signal Processing using MATLAB, Vikas
5. Babu R, Digital Signal Processing , Scitech
6. S. Salivahanan et al, Digital Signal Processing, TMH
7. S.K.Mitra, Digital Signal Processing - A Computer based approach, TMH

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5.MICROWAVEANDFIBEROPTICCOMMUNICATIONENGINEERINGLAB (PC EC 605)

Course Code	PC EC 605
Course Title	MicrowaveandFiberOpticCommunicationEngineeringLab.
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	EM Theory and Optics
Course Category	Program Core (PC)
Number of classes	20 - 24 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Make use of Optical fiber for signal communication link establishment.	K3
CO-2	Make use of Optical fiber for Loss measurement.	K3
CO-3	Analyse the performance of plastic fiber.	K4
CO-4	Make use of Microwave bench setup to measure different parameters.	K3

Course Content

List of Experiments*(Minimum 6 experiments to be performed). Use of virtual laboratory to perform few experiments may be exploredif available.*

1. Settingupofa fiberoptic analoglink.
2. Settingupofafiberopticdigitallink.
3. Settingupofa fiberoptic voicelink.
4. Studyoflossesinopticalfiber.
5. Studyofcharacteristicsoffiberoptic.
6. Studyofnumericalapertureofopticalfiber.
7. DeterminationofFrequency&WavelengthofRectangular Waveguide.
8. DeterminationofVSWRofaTransmissionLine.
9. DeterminationofReflectionCoefficient ofaTransmissionLine.
10. RadiationPatternsMeasurementsofAntenna.
11. StudyofcharacteristicsofKlystronTube.
12. StudyofI-Vcharacteristics ofGunnDiode.

TEXT/REFERENCE BOOKS

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 5th Ed. 2013 (Indian Edition).
2. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
3. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
4. S.E. Miller and A.G. Chynoweth, eds., Optical fibres telecommunications, Academic Press, 1979.
5. G. Agrawal, Nonlinear fibre optics, Academic Press, 2nd Ed. 1994.
6. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1997

7. F.C. Allard, Fiber Optics Handbook for engineers and scientists, McGraw Hill, New York (1990).

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6. VLSI Lab (PC EC 606)

Course Code	PC EC 606
Course Title	VLSI Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Electronic Devices
Course Category	Program Core (PC)
Number of classes	20 - 24 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Analyze a simulated CMOS inverter and Buffer at circuit level using CAD tool and be familiar with its various dc characteristics.	K4
CO-2	Analyze a simulated CMOS inverter and Buffer at layout level using CAD tool and be familiar with its various electrical aspects and behavior.	K4
CO-3	Interpret various combinational and sequential VLSI circuits using CAD tool.	K2
CO-4	Build a small project where they can apply whole of their analytical and engineering skill that they learn throughout the course.	K3

List of experiments: Use of virtual laboratory to perform few experiments may be explored if available.

1) Simulation of logic gates using schematic & layout diagram by CAD tool.
2) Draw a schematic structure of CMOS inverter and buffer to evaluate its various characteristics like delay, power consumption, V-I characteristics, etc, by CAD tool.
3) Simulate a CMOS inverter and buffer using its layout diagram by CAD tool.
4) Simulation of combinational circuits using CAD tools.
5) Simulation of sequential circuits using CAD tools.
6) Simulation of counter using CAD tool.
7) Simulation of state machines using CAD tool.
8) Project(Simulation/ Implementation of VLSI circuit at schematic and layout level) using CAD tool.

***REFERENCES / SUGGESTED LEARNING RESOURCES*:**

1. CMOS Digital Integrated Circuit by Sung-Mo Kang and Yusuf Leblebici.
2. VLSI Design and EDA Tools by Angsuman Sarkar.
3. Low Power CMOS VLSI Circuit Design by Kaushik Roy.
4. CMOS Circuit Design, Layout and Simulation by R. Jacob Baker.
5. VLSI Design by Deba prasad Das.

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7. Digital Signal Processing Laboratory (PC EC 607)

Course Code	PC EC 607
Course Title	Digital Signal Processing Laboratory
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Set Theory
Course Category	Program Core
Number of classes	20 - 24 hours

Course Outcome: After successful completion of this course, a student will be able to-

CO Number	CO Description	K- Level
CO-1	Make use of software to demonstrate generation of test signal and various signal operations.	K3
CO-2	Make use of software to demonstrate the convolution, correlation operations.	K3
CO-3	Analyse LTI system using software.	K4
CO-4	Develop program to compute Z-transform, inverse Z-transform, DFT, IDFT and circular convolution.	K6
CO-5	Determine FIR and IIR filter in software.	K5
CO-6	Develop FIR/IIR Filter design on digital signal processors.	K3

LIST OF EXPERIMENTS: Use of virtual laboratory to perform few experiments may be explored if available.

Perform at least 6 experiments (3 using Software simulation and 3 using DSP kit)

Perform the following exercises using suitable (Prefer MATLAB) software:

1. To develop elementary signal function modules for unit sample, unit step, unit ramp and exponential sequences.
2. To develop program modules based on operation on sequences like signal shifting, signal folding, signal addition and signal multiplication.
3. To develop program for discrete convolution and correlation.
4. To develop program for finding response of the LTI system described by the difference equation.
5. To develop program for computing Z transform and inverse Z-transform.
6. To develop program for computing DFT and IDFT.
7. To develop program for computing circular convolution.
8. To develop program for cascade realisation of IIR and FIR filters.
9. To develop program for designing FIR/IIR filter.

Perform the following exercises using TMS320C50 or Higher Board:

1. To study the architecture of DSP chips – TMS320C50 or higher.
2. To verify linear convolution.
3. To verify the circular convolution.
4. To design FIR filter (LP/HP) using windowing technique
    a. Using rectangular window

b. Using triangular window
c. Using Kaiser window

5. To Implement IIR filter (LP/HP) on DSP Processors, N-point FFT algorithm.

***TEXT/ REFERENCE BOOKS*:**

1. J.G. Proakis& D.G. Manolakis, Digital Signal Processing, Principles, Algorithms and Applications.,PHI/Pearson
2. Chen, Digital Signal Processing, OUP
3. Meyer-Basse U, Digital Signal Processing with FPGA, Spriger India
4. Ingle, Digital Signal Processing using MATLAB, Vikas
5. Babu R, Digital Signal Processing , Scitech
6. S. Salivahanan et al, Digital Signal Processing, TMH
7. S.K.Mitra, Digital Signal Processing - A Computer based approach, TMH

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Program Elective-1.1: Electronic Measurement and Instrumentation (PEEC 608/1)

Course Code	PEEC 608/1
Course Title	Electronic Measurement and Instrumentation
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic Electrical Engineering
Course Category	Program Elective-1
Number of classes	38 hours

Course Outcome:

After successful completion of this course, a student will be able to-

CO Number	CO Description	K-level
CO-1	Explain importance of measurement and various error in measurement.	K2
CO-2	Explain the working principles of different Electrical Measuring Instruments and their characteristics.	K2
CO-3	Analyse the unknown quantities of different components using DC &AC bridges.	K4
CO-4	Combine different power & energy measuring instruments with working principle.	K6

Course Content:

Module 1: Measurement and error (8 Hours.)

Introduction, Definition, significance of measurement, Measurement characteristics, Calibration of instruments, Static & dynamic characteristics. Types of errors, Statistical analysis, Probability of errors, Limiting error with examples.

Module 2: Electrical and Electronic Measuring instruments(10 Hours.)

Classification of instruments, Overview of PMMC, Moving iron, Dynamometer type instruments, Galvanometer, different types of galvanometer and its application. Overview of Ammeter, Voltmeter & Multi-meter, True r.m.s voltmeter, Potentiometers. Extension of range of instruments- shunts & multipliers- Current transformers- Potential Transformers.Measurement of quality factor (Q), Digital voltmeter (DVM)-Ramp type, Integrating type, ADC, Digital frequency meter, CRO, Construction, Time based circuit, Measurement with CRO, CRO probes. DSO-construction, working principle and applications.Function generator-Square, triangular Sinusoidal waveform generator, Spectrum analyzer.

Module 3: A. C And D. C Bridges(10 Hours.)

General equation for bridge balance, D.C. bridges, Wheatstone bridge, Kelvin's double bridge, General form of an A.C. bridge, Maxwell's inductance –capacitance bridge, Hay's bridge, Anderson's bridge, Schering bridge, Wien's bridge, Sources of errors in bridge measurement, Wagner earthing device.

Module 4: Measurement of Power and Energy (10 Hours.)

Definitions of power, types, Measurement of power, different methods, construction and working of Electrodynamometer type of Wattmeter. Errors in power measurements. Energy, Induction type energy meter, Indicating type Frequency meter, Electrodynamometer type P.F. meter- construction and working principle, advantages, disadvantages of all.

***REFERENCES / SUGGESTED LEARNING RESOURCES*:**

1. Electrical and Electronic Measurements & Instrumentation By A.K. Sawhney - Dhanpat Rai.
2. Electronic Measurement & Instrumentation By H. Cooper - PHI.
3. Electronic Instrumentation by H. S. Kalsi - McGraw HilI.
4. Electrical and Electronics Measurements and Instrumentation by PrithwirajPurkait - McGraw HilI.
5. Electrical and Electronic Measurements & Instrumentations By J.B. Gupta – KATARIA.

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Program Elective 1.2:Power Electronics (PEEC-608/2)

Course Code	PEEC-608/2
Course Title	Power Electronics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Electronic Devices
Course Category	Program Elective-1
Number of classes	36 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Explain and extend knowledge about various power semiconductor devices.	K2
CO-2	Apply and construct different power converter circuits.	K3
CO-3	Demonstrate the different modern power semiconductor devices.	K2
CO-4	Construct various topologies and make use of the operation of power electronic circuits such as ac to dc, dc to dc, ac to ac and dc to ac converters	K3
CO-5	Explain PWM, various power regulation and Power systems.	K2

Course Content:-

Module- 1: Characteristics of Semiconductor Power Devices (09 Hours)

Power diode : Special features of construction & v-i characteristics Turn on & turn off characteristics, reverse recovery time, reverse recovery current.**Power BJT :** Construction, working principle Special features, quasi saturation, primary breakdown, secondary breakdown.**Power MOSFET :**Construction, working principle, special features of construction Special properties of power MOSFET with V-groove structure.**IGBT:** Construction & working principle. Comparative study of important performance parameters of power BJT, MOSFET & IGBT

Module- 2: Thyristor, Controlled rectifiers and AC voltage controllers (09Hours)

Thyristors : Construction, working principle. di/dt& dv/dt protection, snubber circuit. Series & parallel operation, static & dynamic equalization network. Commutation circuits: - natural commutation &self commutation. **AC voltage controllers (AC/AC) :**Single phase half wave & full wave controllers Single phase cyclo-converter. Single phase PWM AC voltage controllers.**Controlled rectifiers (AC/DC): -** Single phase semi converter, full converter, dual converter.

Module- 3: Choppers and Inverter (10Hours)

Choppers/Switched mode converters (DC/DC) : Principle of step up/step down operation. Classifications – A.B.C.D.E. Buck, boost, buck-boost, Cuk regulators Principle of operation (qualitative) of full bridge converter. **PWM switch mode inverters (DC/AC) :**Principle of operation. Harmonic profile: - harmonic factor for nth harmonic (HF_n), Total harmonic distortion (THD), Distortion factor (DF), Lowest order harmonic (LOH). Single phase bridge inverter: - operating principle & harmonic profile. Voltage control of single-phase bridge inverter: - single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation; - estimation of RMS output and harmonic factor in each case.Three phase 120 and 180 degree conduction with star connected resistive load and R-L load.

Module- 4:Applications (8Hours)

Power supplies: Overview of SMPS, its merits over linear regulated DC power suppliesWorking principle of various techniques of SMPS, - fly back, feed forward, push-pull, half bridge & full bridge.**UPS**– Construction and operating principle.

***REFERENCES / SUGGESTED LEARNING RESOURCES*:-**

1.M.H. Rashid, „Power Electronics: Circuits, Devices and Applications", Pearson Education, PHI Third edition, New Delhi 2011.
2.M.D. Singh, K.B. Khanchandani, "Power Electronics", TMH Publishing Co. Ltd., 2008.
3.Ned Mohan, Tore.M.Undeland, William.P.Robbins, „Power Electronics: Converters, Applications and Design", John Wiley and sons, third edition, 2009.
4.Vidhyathil Joseph, "Power Electronics Principles and Applications", McGraw-Hill, 2013.
5.Williams, B. W., Power Electronics: Devices, Drivers, Applications, and Passive Components, McGraw Hill, 2nd edition 1992.
6.Andrzej M. Trzynadlowski " Introduction to Modern Power Electronics" Wiley India Pvt. Ltd., Second edition 2012
7.P.S.Bimbra "Power Electronics" Khanna Publishers, third Edition 2003

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Program Elective 1.3: Bio-Medical Engineering (PEEC-608/3)

Course Code	PE EC608/3
Course Title	Bio-Medical Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Biology, Electrical Measurement & Instrumentation
Course Category	Program Elective (PE)
Number of classes	36 hours

Course Outcome:

After completing the course in Bio-Medical Engineering, the students will be able to:

CO Number	CO Description	K-level
CO-1	Relate the basic fundamental concept of biomedical engineering	K1
CO-2	Demonstrate how to monitor the condition of patients using different electrical application based instruments.	K2
CO-3	Compare the different modern Imaging System used in biomedical applications	K4
CO-4	Relate the working of different therapeutic Equipment used in biomedical applications	K1

Course Content:

Module 1: Introduction to Bio-Medical Engineering (8 hours)

The age of Biomedical Engineering, Development of Biomedical Instrumentation, Physiological system of the body, Problem encountered in measuring a living system.Sources of bio-electric potential: Resting and action potential, propagation of action potentials. Bioelectric potentials examples (ECG, EEG, EMG, ERG, EOG,EGG, etc. introduction only.)

Module 2: Patient Monitoring Instruments (8 hours)

Concept of ECG, EEG, EMG, ERG. Measurement of heart rate and blood flow, concept of pulse oximeters, Bio telemetry system and its importance, Concept of spirometry, Holter monitor and cardiac stress test, Blood gas analyzer. Measurement of blood pressure.

Module 3: Modern Imaging System (12 hours)

Different types of analytical and diagnostic instruments. Working concept of X-Ray machine, computed tomography (CT), magnetic resonance imaging system (MRI), Ultrasonography. Doppler ultrasonography and contrast ultrasonography. Pulmonary function measurements. Plethysmography: Photo Plethysmography and Body Plethysmography.Ultrasonic imaging systems: Basic pulse echo system, propagation of ultrasonic through tissues and reflections, display types, A-Scan, B-Scan, M-Scan, applications, real-time ultrasonic imaging systems and probes. Magnetic Resonance Imaging – Basic NMR components, Biological effects and advantages of NMR imaging.

Module 4: Therapeutic Equipment (8 hours)

Cardiac pacemaker with classification, Concept of cardiac defibrillators – its importance and types, principle of surgical diathermy, safety aspects in electro surgical units, applications of laser in bio-medical field, concept and working of haemodialyzer machine, concept of ventillators, its classifications, Concept of Heart-Lung machine.

***REFERENCES / SUGGESTED LEARNING RESOURCES*:**

1. Handbook of Biomedical Instrumentation, by: R.S Khandpur (Tata McGraw Hill, 3e)
2. Biomedical Instrumentation and Measurements, by : Leslie Cromwell, Fred J. weibell, Erich A. Pfeiffer (PHI publications)
3. Essentials of Biomedical instruments and Techniques by : C.S Datta (AITBS publishers)
4. Biomedical Instrumentation and Measurements, by : R. AnandaNatarajan (PHI publications)
5. Text book of Biomedical Instrumentation, by : K.N Scott, A.K Mathur (CBS publishers)

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9. Mini Project (PR EC 609)

Course Code	PR EC 609
Course Title	Mini Project
Number of Credits	3 (L: 0, T: 0, P: 6)
Prerequisites	Nil
Course Category	Project(PR)
Number of classes	70 hours

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Demonstrate a through and systematic understanding of project contents	K2
CO-2	Identify the methodologies and professional way of documentation and communication	K3
CO-3	Illustrate the key stages in development of the project	K2
CO-4	Develop the skill of working in a Team	K3
CO-5	Apply the idea of mini project for developing systematic work plan in major project	K3

Course Content:-

The mini project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Perform detailed study about various components of a project.
2) Study about methodologies and professional way of documentation and communication related to project work.
3) Develop idea about problem formulation.

4) Knowledge of how to organize, scope, plan, do and act within a project thesis.
5) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
6) Demonstrate the implementation of a mini project work.

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