AC: 23/07/2020
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PET SYLLABUS FOR BIOMEDICAL ENGINEERING STUDENTS 2020 ONWARDS
PAPER I
Research Methodology

1.0	**Introduction and Basic Research Concepts**	
	1.1	Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology
	1.2	Need of Research in Business and Social Sciences
	1.3	Objectives of Research
	1.4	Issues and Problems in Research
	1.5	Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical
2.0	**Types of Research**	
	2.1	Basic Research
	2.2	Applied Research
	2.3	Descriptive Research
	2.4	Analytical Research
	2.5	Empirical Research
	2.6	Qualitative and Quantitative Approaches
3.0	**Research Design and Sample Design**	
	3.1	Research Design – Meaning, Types and Significance
	3.2	Sample Design – Meaning and Significance Essentials of a good sampling Stages in
	3.3	Sample Design Sampling methods/techniques Sampling Errors
4.0	**Research Methodology**	
	4.1	Meaning of Research Methodology
	4.2	Stages in Scientific Research Process: **a.** Identification and Selection of Research Problem **b.** Formulation of Research Problem **c.** Review of Literature **d.** Formulation of Hypothesis **e.** Formulation of research Design **f**. Sample Design **g.** Data Collection **h.** Data Analysis **i.** Hypothesis testing and Interpretation of Data **j.** Preparation of Research Report
5.0	**Formulating Research Problem**	
	5.1	Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis
6.0	**Outcome of Research**	
	6.1	Preparation of the report on conclusion reached
	6.2	Validity Testing & Ethical Issues
	6.3	Suggestions and Recommendation

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education

PAPER II

Biomedical Engineering

1.0	**Engineering Mathematics**	**Weightage = 10%**
	1.1	***Linear Algebra:*** Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors.
	1.2	***Calculus:*** Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series, Vector identities, Directional derivatives, Line integral, Surface integral, Volume integral, Stokes's theorem, Gauss's theorem, Green's theorem.
	1.3	***Differential equations:*** First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's equation, Euler's equation, Initial and boundary value problems, Partial Differential Equations, Method of separation of variables.
	1.4	***Complex variables:*** Analytic functions, Cauchy's integral theorem, Cauchy's integral formula, Taylor series, Laurent series, Residue theorem, Solution integrals.
	1.5	***Probability and Statistics:*** Sampling theorems, Conditional probability, Mean, Median, Mode, Standard Deviation, Random variables, Discrete and Continuous distributions, Poisson distribution, Normal distribution, Binomial distribution, Correlation analysis, Regression analysis.
	1.6	***Numerical Methods*****:** Solutions of nonlinear algebraic equations, Single and Multi-step methods for differential equations.
2.0	**Electrical Circuit and Electronics**	**Weightage = 10%**
	2.1	***Electric Circuits and Measurements:*** Network graph, KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Passive filters, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Two-port networks, Three phase circuits, Power and power factor in ac circuits. Bridges and Potentiometers, measurement of voltage, current, power, energy and power factor; Instrument transformers, Digital voltmeters and multi-meters, Phase, Time and Frequency measurement
	2.2	***Analog and Digital Electronics:*** Characteristics of diodes, BJT, MOSFET; Simple diode circuits: clipping, clamping, rectifiers; Amplifiers: Biasing, Equivalent circuit and Frequency response; Oscillators and Feedback amplifiers; Operational amplifiers: Characteristics and applications; Simple active filters, VCOs and Timers, Combinational and Sequential logic circuits, Multiplexer, Demultiplexer, Schmitt trigger, ADC and DAC; Basics of Micro-processors and Microcontrollers.
3.0	**Biomedical Signal and Image Processing**	**Weightage = 10%**
	3.1	***Biomedical Signal Processing:*** Representation of continuous and discrete-time signals and operations, Linear Time Invariant and Causal systems, Sampling theorem, Applications of Fourier Transform, Laplace Transform and z-Transform, Discrete Fourier Transform Digital Filter Design, Adaptive Cancellation and Statistical Processing, Adaptive Noise Control. Wavelets: HAAR Wavelet, Daubechies Wavelet, Wavelet Filter Bank and it's complete reconstruction, application of Wavelet for Biomedical Signal Processing. Auto and Cross Correlation Techniques: Correlation and Auto Correlation Sequences, Auto Regressive Process, Cross Correlation
	3.2	***Image Processing:*** Image enhancement in Frequency & Spatial Domain, Histogram Modelling, Image Segmentation, Image Compression, Image Transforms ,Image Restoration ,Feature extraction & Classification, Applications of Image Processing in Medical Images.

4.0	**Biomedical Sensors and Instrumentation**	**Weightage = 20%**
	4.1	***Transducers and Bio-Instrumentation:*** Transducers, Classification, Principle of operation and their applications, Characteristics and choice of Transducers, Input, Output and Transfer Characteristics, Types of Errors. Types: Displacement and Pressure Transducer: Resistive: Bonded and unbonded strain gauge, Rotary Variable Differential Transformer (RVDT), Linear Variable Differential Transformer(LVDT) Capacitive: Parallel plate transducer, Self-generating Transducers: Thermocouple, Integrated circuit Temperature Transducers, Radiation Sensors, Piezoelectric transducers, Hall effect transducers. Flow sensors: Electromagnetic flow meter, Ultrasonic Blood flow meter, Laser Doppler Blood flow meter, Spirometer. Fibre Optic Sensors: Blood Pressure sensor system, Extravascular sensors, Intravascular fibre Optic sensors, Chemical Biosensors: Blood Gas and Acid- Base Physiology, Electrochemical Sensors, Measurement of pH, Pco2, The PO2 Electrode, Chemical Fibro sensors, Intravascular measurements of oxygen saturation, Electrodes for bioelectric signals, Bioelectric signals and their characteristics. Biopotential Amplifiers, Noise and artefacts and their management, Electrical Isolation (optical and electrical) and Safety of Biomedical Equipment, Intensive and coronary care units, Emergency equipment, Therapeutic equipment. Generation, Acquisition, and signal conditioning and analysis of biosignals: ECG, EMG, EEG, EOG, Blood ERG, PCG, GSR. Principles of measuring blood pressure, Core temperature, volume & flow in arteries, veins and tissues, Lung volumes, respiration and cardiac rate.
	4.2	***Electro-diagnostic techniques:*** Specifications and design of ECG, EMG, EEG, PPG amplifiers and filters.
	4.3	***Therapeutic and general equipment:*** Ultrasound therapy, short wave therapy, nerve and muscle stimulator, infant incubator, hemodialysis machine, heart lung machine, cobalt therapy.
5.0	**Intensive Care, Emergency Equipment and Medical Imaging**	**Weightage = 20%**
	5.1	***Intensive and coronary care units:*** Special care units, ICU/CCU equipment, bedside monitors circuits, central monitoring consoles, physiological telemetry.
	5.2	***Emergency equipment:*** Introduction and design concepts of cardiac pacemaker and defibrillator, types and application techniques, analysis of pacemaker and defibrillator waveform, Respiratory and pulmonary function monitoring equipment, clinical lab equipment.
	5.3	***Medical Imaging Systems*** Basic physics and Instrumentation of medical images in X-Ray, Ultrasound, CT, MRI, PET, FMRI, SPECT, and their characteristics.
6.0	**Human Physiology, Biomechanics and Biomaterials**	**Weightage = 30%**
	6.1	***Human Physiology:*** Basic elements of human body – musculo-skeletal system, respiratory system, circulatory system, excretory system, endocrine system, nervous system, digestive, nervous, immune, integumentary, and reproductive systems, Basics of cell and molecular biology.
	6.2	***Biomechanics Engineering Mechanics:*** Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions. Hard Tissues: Definition of Stress and Strain; Deformation Mechanics. Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell & Voight models - anisotropy, Fatigue Analysis, Soft Tissues: Structure, functions, material properties and modelling of Soft Tissues: Cartilage, Tendon, Ligament, Muscle - Hodgkin-Huxley Model. Human Joints and Movements: Skeletal joints, forces and stresses in human joints, types of joint, biomechanical analysis joints, parameterization and

		analysis in Gait, Biofluid mechanics: Flow properties of blood, Dynamics of fluid flow in the intact human cardiovascular system - modelling and experimental approaches, Pulse wave velocities in arteries, Measurement/Estimation of In-vivo elasticity of blood vessels.
	6.3	***Biomaterials:*** Basic properties of biomaterials, biocompatibility, bioactivity, biodegradable materials, Fundamentals of implants and medical devices, drug delivery carriers, scaffolds for tissue engineering.

References:

1. Theory and Problems of Fourier Analysis with applications to BVP, Murray Spiegel, Schaum's Outline Series
2. Complex Variables and Applications, Brown and Churchill, McGraw-Hill education.
3. Probability, Statistics and Random Processes, T. Veerarajan, McGraw-Hill education
4. Electronics Circuit. Analysis & Design, 2nd ed., Donald A. Neamen, McGraw Hill, 2001
5. Design with Operational Amplifiers and Analog Integrated Circuits, by Sergio Franco, McGraw Hill, 2002
6. Op-Amps and linear integrated circuits by Ramakant. Gayakwad Prentice Hall
7. Handbook of Biomedical Instrumentation (Third edition): R S. Khandpur. (PH Pub)
8. Biomedical Instrumentation and measurements : Leislie Cromwell, Fred J. Weibell, Enrich A. Pfeiffer. (PHI Pub)
9. Medical Instrumentation, Application and Design: J G. Webster. (John Wiley)
10. Digital signal processing Principles Algorithms and Application –Proakis &Manolakis –Third edition PHI
11. Imag

10. Christensen's Physics of Diagnostic Radiology- Thomas S. Curry, James E. Dowdey, Robert C. Murry, Lippincott Williams & Wilkins Publication,
11. Medical Imaging Physics- William R. Hendee, E. Russell Ritenour- Wiley Publications.
12. Digital Image Processing, Gonzalez and Woods, Pearson Education
13. Physiology of Human Body: Guyton. (Prism Book)
14. Essentials of Anatomy and Physiology: Elaine N Marieb. (Pearson Education)