Chhattisgarh Swami Vivekanand Technical University, Bhilai

Scheme of Teaching and Examination

M.Tech. (Biomedical Engineering and Bioinformatics)

1st Semester

S. N.	Board of Study	Sub Code	Subject Name	Periods Per Week			Scheme of Examination Theory/Practical			Total Marks	Credit L+(T+P)/2
				L	**T**	**P**	**ESE**	**CT**	**TA**		
1	Biomedical Engg.	590111(17)	Biomathematics	3	1	-	100	20	20	140	4
2	Biomedical Engg.	590112(17)	Biomedical signal processing and analysis	3	1	-	100	20	20	140	4
3	Biomedical Engg.	590113(17)	Bioinformatics	3	1	-	100	20	20	140	4
4	Biomedical Engg.	590114(17)	Drug Delivery and Drug Design	3	1	-	100	20	20	140	4
5	Elective -I			3	1	-	100	20	20	140	4
6	Biomedical Engg.	590121(17)	Biomedical signal processing and analysis Lab	-	-	3	75	-	75	150	2
7	Biomedical Engg.	590122(17)	Bioinformatics Lab	-	-	3	75	-	75	150	2
Total				**15**	**5**	**6**	**650**	**100**	**250**	**1000**	**24**

L-Lecture, **T**- Tutorial, **P**- Practical, **ESE**- End Semester Examination, **CT**- Class Test, **TA**- Teacher's Assessment

Table- 1 (**Elective -I)**

S. N.	**Board of Study**	**Sub Code**	**Subject Name**
1	Biomedical Engg.	590131(17)	Physiology for Engineering
2	Biomedical Engg.	590132(17)	Biosensors
3	Biomedical Engg.	590133(17)	Biomechanics
4	Biomedical Engg.	590134(17)	Data Mining in Bio informatics
5	Biomedical Engg.	590135(17)	Biometrics

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I Branch: Biomedical Engineering and Bioinformatics

Subject: Biomathematics Code: 590111(17)

Total Theory Period: 40 Total Tutorial Period 12

Total Marks in End Semester Exam: 100

Minimum of class test to be conducted: 02

Unit – I

Differential equations: Ordinary differential equations of the 1st order, exactness and integrating factors, variation of parameters, Picard's iteration method. Ordinary linear differential equations of nth order, solution of homogeneous and non-homogeneousequations.Operator method.Methods of undetermined coefficients and variation of parameters. Systems of differential equations, Phase plane. Critical points, stability.

Unit – II

Probability and Statistics: Mean and variance, Distribution functions: Normal Distribution,Uniform distribution, Poisson distributions, Knudson's analysis, Wright-Fisher model, Fitting afunction to experimental data (Linear fit, Least-square fit, and Errors), Examples from biology: End-to-end vector distribution of DNA,Flexible protein chain, End-to-end distance scaling withpolymer length.

Unit – III

Population models: Models for population growth, Exponential, Logistic, and Gompertz.Interacting populations, Predator - prey, Lotka -Volterra, and food webs.

Unit –IV

Mathematical Models of Biological Diffusion-Brownian Motion,Random Walks, and Fick's Law. Diffusionwith Advection and Chemotaxis.Reaction-Diffusion Equations.

Unit- V

Chemical Interactions-Law of Mass Action.Michaelis-Menten Kinetics and Enzymatic Reactions. Chemical Master Equations.

Texts & References:

1. G. Eason, C.W. Coles & G. Gittinby: Mathematics and Statistics for Biosciences, Ellis Horwood, 1980.
2. J. D. Murray: Mathematical Biology, Springer-Verlag, Berlin, 1989.
3. E. Kreyszig: Advanced Engineering Mathematics, 5th Ed., Wiley Eastern, 1991,

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I Branch: Biomedical Engineering and Bioinformatics
Subject: Biomedical signal processing and analysis Code: 590112(17)
Total Theory Period: 40 Total Tutorial Period 12
Total Marks in End Semester Exam: 100
Minimum of class test to be conducted: 02

Unit –I

Introduction to biomedical signals: Review of signals and transforms, Introduction to Biomedical signals, Natue of Biomedical signals, examples of biomedical signals, objectives of Biomedical signals analysis, Difficulties in Biomedical signal analysis, signal conversion, Review of Design of FIR and IIR filters.

Unit – II

Filters: Various types and sources of noise in biomedical signals. High frequency noise in the ECG, Motion artifact in the ECG, Power line interference in ECG signals,maternal interference in fetal ECG. Removal of high frequency noise: Butterworth low pass filters, Removal of low frequency noise: Butterworth high pass filters, Removal of periodic artifacts: Notch and comb filters, Optimal filtering, Adaptive filter, Signal averaging, selecting an appropriate filters.

Unit –III

ECG signal analysis: ECG signals characteristics; The P, QRS, and T waves in the ECG,The first and second heart sounds, The Derivative based methods for QRS detection, The Pan–Tompkins algorithm for QRS detection, ST segment analyzer, Arrhythmia analyzer.

Unit – IV

Neurological signal processing: EEG, EEG rhythms & waveform categorization of EEG activity, recording techniques, Correlation Analysis of EEG Rhythms, Detection of EEG rhythms, Template matching for EEG spike and wave detection, Detection of EEG rhythms related to seizure. EEG applications in epilepsy, Sleep disorders, Brain computer interface.

Unit –V

Frequency domain analysis: Estimation of the PSD (Power spectral density), The periodogram, The use of windows: Spectral resolution and leakage, Measures Derived from PSDs, Moments of PSD functions, Spectral power ratios, Fractal Analysis, Spectral Analysis of ECG and EEG Signals.

Text & References:

1. R. Ranngayyan," Biomedical signal analysis" Wiley, 2001.
2. D.C. Reddy, "Biomedical signal processing Principles and techniques', TMH, New Delhi, 2005.
3. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall, 2009.
4. G. R. Sinha&Bhagwati C. Patel, Medical Image Processing: Concept and Application, PHI-2014

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I Branch: Biomedical Engineering and Bioinformatics

Subject: Bioinformatics Code: 590113(17)

Total Theory Period: 40 Total Tutorial Period 12

Total Marks in End Semester Exam: 100

Minimum of class test to be conducted: 02

Unit – I

Review of basics of bioinformatics: Principles of protein structure, Tertiary structure, Quaternary structure, Similarity of ternary and quaternary structure, Bioinformatics databases. Data storage and retrieval, quality of data, data representation.Proteins: From Sequence to Structure to FunctionDNA and RNA Structure, DNA Cloning and Sequencing, Genes, Taxonomy, and Evolution.

Unit-II

Genome analysis:The Genomic Organization of Genes, Comparative Genomics, Functional Genomics Microarray and Bio-array Technology, Genomes as Gene Networks.

Unit – III

Proteome analysis: Proteomics, Hydrodynamic Methods, Predictive Biology, Systems Biology.

Unit- IV

Protein tertiary structure modeling: Basic concepts, Hydrogen bond, Defining a secondary structureelement, Methods for predicting secondary structure, Protein folding and dynamic simulation, Modelingprotein sidechains, Comparative modeling, Threading, Ab initio modeling, Combined modeling approaches.

Unit- V

Information theory and biology: Information theory and biology:Entropy, Shannon's formula, divergences fromequiprobability and independence, Markov chains, ergodic processes, redundancy,application to DNA and protein sequences.

Texts & References:

1. Bioinformatics Basics: Applications in Biological Science and Medicine, Lukas K. Buehler, Hooman H. Rashidi, CRC Press, 2005.
2. Molecular databases for protein sequence and structure studies by Sillince, J A and Sillince M (1991) springerVerlag.
3. Sequence Analysis primer by M. Gribskov, J. Devereux(1989) Stockton Press
4. Computational Methods in Mol.Biol. /Now Comprehensive Biochemistry Vol. 32 S.L. Seizberg, DB Searks, S. KasifElevier 1998.
5. P. Basldi, S Brunak, Bioinformatics," A Machine Learning Approach", MIT Press, 1998.
6. Information theory and living systems by L.I. Garfield, (1992) Columbia UniversityPress.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I Branch: Biomedical Engineering and Bioinformatics

Subject: Drug Delivery and drug design Code: 590114(17)

Total Theory Period: 40 Total Tutorial Period 12

Total Marks in End Semester Exam: 100

Minimum of class test to be conducted: 02

Unit- I

Fundamentals of Drug Delivery: Drug delivery system, drug delivery routes and drug formulations.

Unit- II

Site-Specific Drug Delivery Using Liposomes and Emulsions as Carriers: Introduction, Liposomes in Drug Delivery, The Liposome-Drug Concept, Liposomes as Carriers of Therapeutic Agents, Parenteral Emulsions.

Unit-III

Site-Specific Drug Delivery Utilizing Monoclonal Antibodies: Introduction, Production of Monoclonal Antibodies, Drug–Monoclonal Antibody Conjugates for Drug Targeting.

Unit-IV

Role of Polymers in Drug Delivery: Introduction, Currently Available Polymers, Soluble Polymers as Drug Carriers, Biodegradable or Bioerodible Polymers, Mucoadhesive Polymers, Polymers Containing Pendant Bioactive Substituents, Matrix Systems, Heparin-Releasing Polymers, Ionic Polymers, Oligomers.

Unit –V

Implants in Drug Delivery: Introduction, Insulin Delivery as a Model Implant Pump System, Implants for Contraception, Delivery of Chemotherapeutic Agents Using Implants.

Texts & References:

1. Drug Delivery Systems, Third Edition, Vasant V. Ranade, John B. Cannon, CRC Press, 2011.
2. Drug Delivery Systems, Ed. K. K. Jain, Humana Press, Springer. 2008.
3. Seltzman WM, Engineering Principles of Drug Therapy, Oxford University Press(2001)
4. Wang B., iahaan T, Soltero R, Drug delivery principles and applications, Wiley-Interscience,(2005)

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I
Branch: Biomedical Engineering and Bioinformatics
Subject:Physiology for Engineering.
Code: 590131(17)
Total Theory Period: 40
Total Tutorial Period 12
Total Marks in End Semester Exam: 100
Minimum of class test to be conducted: 02

Unit- I

Basic cell physiology: The Cell and its functions, genetic control of protein synthesis, cell function and cell reproduction.

Unit- II

Membrane physiology, nerve and muscle: Transport of substances through the cell membrane, membrane potential and action potential, Contraction and excitation of skeletal muscle and smooth muscle.

Unit- III

Physiology of Arteries: Mechanics of Arterial Walls, Pulse Wave Velocity and the Moens–Korteweg Equation, Vascular Pathologies, Stents, Coronary Artery Bypass Grafting Physiology of Valves: Aortic and Pulmonic Valves, Mitral and Tricuspid Valves, Pressure Gradients across a Stenotic Heart Valve, Prosthetic Mechanical Valves, Prosthetic Tissue Valves ;Pulsatile Flow in Large Arteries: Pulsatile Flow in Rigid Tubes—Womersley Solution, Pulsatile Flow in Rigid Tubes—Fry Solution, Instability in Pulsatile Flow.

Unit- IV

Physiology of heart and circulatory system: Heart muscle, functioning of heart, Normal ECG, Arrhythmias, Overview of the Circulation; Medical Physics of Pressure, Flow, and Resistance, Cardiac Output, Venous Return, and Their Regulation, Muscle Blood Flow and Cardiac Output During, Exercise; the Coronary Circulation and Ischemic Heart Disease, Cardiac Failure, and Heart Sounds.

Unit-V

Biochemical cycles:Systematic physiology; Neuromuscular system; Blood and lymph; Circulatory system; Gastro-intestinal system; Kidney and excretory system; Sensory system-visual, auditory, vestibular; Endocrine-pituitary, adrenal, pancreatic etc.

Texts & References:

1. A. C. Guyton; Textbook of Medical Physiology, 8th Ed., Prism Books(Pvt) Ltd. & W. B. Saunders Company, 1991.
2. J. B. West(Ed): Best and Taylor's Physiological Basis of Medical Practice, 11th Ed, Williams and Wilkins , Balatimore, 1985.
3. W. F. Ganong: Review of Medical Physiology, 13th ed. Prentice Hall, Connecticut, 1987.
4. D. S. Luciano, A. J. Vander & J. S. Sherman: Human Anatomy and Physiology, 2nd ed. McGraw Hill, New York, 1983.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I
Branch: Biomedical Engineering and Bioinformatics
Subject: Biosensor
Code: 590132(17)
Total Theory Period: 40
Total Tutorial Period 12
Total Marks in End Semester Exam: 100
Minimum of class test to be conducted: 02

Unit-I

Introduction: , Transducers, Biosensors, Bioreceptors, Transducers for Biosensors,Sensor Architecture and Classification; Medically significant measurands, Functional specifications of medical sensor; Sensor characteristics; Linearity, repeatability, hysteresis, drift, Sensor models in time and frequency domain.

Unit-II

Sensor for physical measurands: Sensors for measurement of strain, force, pressure, acceleration, flow, volume, temperature, and biopotentials, light sensors.

Unit-III

Electochemical sensors: Electrolytic and Electrochemical Cells, Ion-Selective Electrodes (ISEs; Potentiometric), pH Electrode (Potentiometric), Amperometric Biosensors, Conductometric Biosensors.

Unit-IV

Glucose and Immunosensors: Optical and electrochemical Glucose Sensor, Continuous Glucose Monitoring (CGM), Enzyme-Linked Immunosorbent Assay (ELISA), Antibodies, Antibody Fragments and Aptamers, Lateral-Flow Assay (LFA), Optical Immunosensors, Surface Plasmon Resonance (SPR) Immunosensor, Electrochemical, Immunosensors, Impedance Immunosensors: Interdigitated Microelectrode (IME) Immunosensor .

Unit-V

Application of Biosensors. General Aspects. Biosensors for Clinical Chemistry.Continuous Patient Monitoring and Implantable Sensors.Food Analysis, Bioprocess Control and Environmental Monitoring.

Texts & References:

1. Yoon, Jeong-Yeol , Introduction to Biosensors From Electric Circuits to Immunosensors, 2nd edition, Springer, 2016.
2. J.G. Webster(Ed): Medical Instrumentation- Application and Design; Houghton Mifflin Co. Boston, 1992.
3. R. Ason: Princioples of Biomedical Instrumentation and Measurement, Merril Publishing Co., Columbus, 1990.
4. R.S.C. Cobbold: Transducers for Biomedical Measurements: Principles and Applications, John Wiley & Sons, 1974.
5. E.O. Doebin: Measurement Systems, Appliction and Design, McGraw-Hill, 1985.
6. A.P.F. Turner and J.G. Karube& G.S. Wilson: Biosensors: Fundamentals & Applications, Oxford University Press, Oxford, 1987.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I
Branch: Biomedical Engineering and Bioinformatics
Subject:Biomechanics
Code: 590133(17)
Total Theory Period: 40
Total Tutorial Period 12
Total Marks in End Semester Exam: 100
Minimum of class test to be conducted: 02

Unit-I

Introduction of Mechanics: Review of the principles of mechanics, Vector mechanicsResultant forces of Coplaner&Noncoplaner and Concurrent & non-concurrent forces, parallel force in space, Equilibrium of coplanar forces, Newton's laws of motion, Work and energy, Moment of inertia.

Unit-II

Biomechanics of Joints: Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, free body diagrams, types of joint, biomechanical analysis of elbow, shoulder, spinal column, hip knee and ankle.

Unit-III

Hard and Soft Tissues Mechanics: Bone structure & composition mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell&Voight models – anisotropy. Structure and functions of Soft Tissues: Cartilage, Tendon, Ligament, and Muscle; Material Properties: Cartilage, Tendon, Ligament, and Muscle; Modeling: Cartilage, Tendon, Ligament, and Muscle

Unit-IV

Cardiovascular and Respiratory Mechanics: Cardiovascular system, artificial heart valves, biological and mechanical valves development, testing of valves. Mechanism of air flow, respiratory cycle, lung ventilation model, methods of determining pressure, flow rate and volume; spirometer.

Unit-V

Biomechanics of Implants: Design of orthopedic implant, specifications for a prosthetic joint, biocompatibility, requirement of a biomaterial, characteristics of different types of biomaterials, manufacturing process of implants, fixation of implants.

Texts & References:

1. Y C Fung, Biomechanics: Mechanical Properties of Living Tissues, springer, 2nd edition, 1993.
2. N. Ozkaya and M. Nordin, Fundamentals of Biomechanics-Equilibrium, Motion and Deformation, springer-verlag, 2nd edition 1999
3. J. G Webster, Medical instrumentation –Application & design, John Wiley and sons Inc. 3rd ed. 2003. 4. D. J. Schneck and J. D. Bronzino, Biomechanics- Principles and Applications, CRC Press, 2nd Edition, 2000.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I
Branch: Biomedical Engineering and Bioinformatics
Subject: Data Mining in Bioinformatics
Code: 590134(17)
Total Theory Period: 40
Total Tutorial Period 12
Total Marks in End Semester Exam: 100
Minimum of class test to be conducted: 02

Unit-I

Biological Databases Integration and knowledge discovery: Biological Data Storage and Analysis, The Curse of Dimensionality, Data Cleaning, Problems of Data Cleaning, Challenges of Handling Evolving Databases, Data Integration,Data warehousing: Data Management with QueryOptimization, Analysis of Data Using Large DatabasesChallenges in Data Cleaning, Models of Data Cleaning, data integration techniques.

Unit-II

Feature Selection and Extraction Strategies in Data Mining: Overfitting, Data Transformation, Normalization and Standardization, Features and Relevance, Overview of Feature Selection, Filter Approaches for Feature Selection, ach.Feature Subset Selection Using Forward Selection, Other Nested Subset Selection Methods, Feature Construction and Extraction, Singular Vector Decomposition (SVD), Principal Component Analysis (PCA), Partial Least-Squares-Based Dimension Reduction (PLS), Factor Analysis (FA), Independent Component Analysis (ICA).

Unit-III

Feature Interpretation for Biological Learning: Normalization Techniques for Gene Expression Analysis, Identification of Differentially Expressed Genes, Selection Bias of Gene Expression Data, Data Preprocessing of Mass Spectrometry Data, Data Transformation Techniques, Techniques for MS Data Analysis, Feature Selection Techniques, Univariate Methods, Multivariate Methods, Data Preprocessing for Genomic Sequence Data, Feature Selection for Sequence Analysis, Ontologies in Bioinformatics.

Unit-IV

Clustering Techniques in Bioinformatics: Clustering in Bioinformatics, Clustering Techniques, Distance-Based Clustering and Measures, *k*-Means Algorithm, *k*-Modes Algorithm, Genetic Distance Measure (GDM), Gene Expression Clustering Using Mutual Information Distance Measure, Gene Expression Data Clustering Using a Local Shape-Based Clustering, Hierarchical Clustering, Applications of Hierarchical Clustering Techniques in Bioinformatics, Self-Organizing Maps Clustering (SOM), Identifying Distinct Gene Expression Patterns Using SOM, Fuzzy Clustering.

Unit-V

Classification techniques: Classification using neural network (Back propagation algorithm), Support vector machine, Bayesian classifier, Decision trees, Random forest. Performance measures, validation and benchmarking

Texts & References:

1. SumeetDua, PradeepChowriappa, Data Mining for Bioinformatics, CRC press, 2012.
2. Pang-NingTan , Michael Steinbach, Vipin Kumar, Introduction to Data Mining, Addison-Wesley, 2005.
3. Jiawei Han, Jian Pei,MichelineKamber, Data Mining: Concepts and Techniques, Morgan Kaufmann; 3 edition (June 9, 2011).

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I
Branch: Biomedical Engineering and Bioinformatics
Subject: Biometrics
Code: 590135(17)
Total Theory Period: 40
Total Tutorial Period 12
Total Marks in End Semester Exam: 100
Minimum of class test to be conducted: 02

Unit-I

Introduction- Person recognition, biometric systems, functionalities, errors, The Design Cycle of Biometric Systems, applications, security and privacy issues.

Unit- II

Finger print recognition: Friction ridge pattern, finger print acquisition, Techniques of feature extraction and matching.

Unit-III

Face recognition: Image acquisition, face detection, feature extraction and matching.

Unit-IV

Iris recognition: Design of iris recognition system, Image acquisition, segmentation, normalization, encoding and matching, quality assessment and performance evaluation.

Unit-V

Other biometric traits: Ear, Gait, Hand geometry, Handwriting. Biometrics scope and future.Biometric standards. Facial Scan, Features'- Component-Operation (Steps), Competing facial Scan technologies- Strength and weakness.

Texts & References:

1. Anil Jain, Arun A. Ross, KarthikNanda Kumar,Introduction to Biometrics 2011th Edition, springer.
2. Biometrics of Network Security-Paul Reid, Pearson Education.
3. Biometrics: Concepts and Applications- G.R. Sinha and S. Patil, Wiley India.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I Branch: Biomedical Engineering and Bioinformatics

Subject: Biomedical Signal Processing and Analysis Lab Code: 590121(17)

Total Marks in End Semester Exam: 75

1. Study of Trainer kits for acquisition of biosignals such as ECG, EEG, EMG etc.
2. Real time data acquisition of ECG.
3. Real time data acquisition of EEG.
4. Real time data acquisition of EMG.
5. Filter design for removing noise and artifacts from ECG.
6. Filter design for removing noise and artifacts from EEG.
7. Filter design for removing noise and artifacts from EMG.
8. ECG feature extraction in time domain.
9. Implementation of QRS complex detection techniques.
10. HRV analysis.

Chhattisgarh Swami Vivekanand Technical University, Bhilai

Semester: M. Tech- I Branch: Biomedical Engineering and Bioinformatics

Subject: Bioinformatics Lab Code: 590122(17)

Total Marks in End Semester Exam: 75

1. Biological Databases with Reference to Expasyand NCBI (National center for Biotechnological information)
2. Queries based on Biological databases
3. Sequence similarity searching using BLAST
4. Pairwise sequence alignment
5. Multiple Sequence and Phylogenetic Analysis
6. Gene Prediction
7. Secondary Structure prediction.
8. Tertiary Structure Predication
9. Drug and vaccine designing using bioinformatics tools.
10. Molecular dynamics simulation of macro-molecules