Proposed Syllabus

for

Master of Technology *(M.Tech)***Programme as per NEP 2020**

in

Biomedical Engineering

Department of Biomedical Engineering

School of Technology

North-Eastern Hill University

Mawkynroh

Shillong –793 022, Meghalaya

NORTH-EASTERN HILL UNIVERSITY, SHILLONG

DEPARTMENT OF BIOMEDICAL ENGINEERING
Scheme of Master of Technology (M.Tech.)(Biomedical Engineering)

Year 1 Semester 1

Sl. NO	Paper Code	Paper Name	Periods			EVALUATION SCHEME				Total	Credits
						Internal			ESE		
			L	T	P	TA	CT	TOT			
1	BM-CC-500	Advanced Human Anatomy and Physiology	3	1	0	5	10	25	75	100	4
2	BM-CC-501	Biomedical Engineering Laboratory I	0	0	8	5	20	25	75	100	4
3	BM-DSEC-502-XX	Discipline-Specific Elective Course-I (DSEC-I)	3	1	0	5	20	25	75	100	4
4	BM-DSEC-503-XX	Discipline Specific Elective Course (DSEC)-II	3	1	0	5	20	25	75	100	4
5	BM-GEC-504	Advances in Healthcare Technology	3	1	0	5	20	25	75	100	4
			Total							500	20

Scheme of Master of Technology (M.Tech.)(Biomedical Engineering)

Year 1 **Semester 2**

Sl.No.	Paper Code	Paper Name	P/W			EVALUATION SCHEME				Total	Credits
			L	T	P	Internal			ESE		
						TA	CT	TOT			
1	BM-CC-505	Advanced Biomedical Instrumentation and Systems	3	1	0	5	20	25	75	100	4
2	BM-CC-506	Biomedical Engineering Laboratory II	0	0	8	5	20	25	75	100	4
3	BM-DSEC-507-XX	Discipline-Specific Elective Course-III(DSEC-III)	3	1	0	5	20	25	75	100	4
4	BM-DSEC-508-XX	Discipline-Specific Elective Course-IV(DSEC-IV)	3	1	0	5	20	25	75	100	4
5	BM-RM-509	Research Methodology & Proposal Writing	3	1	0	5	20	25	75	100	4
6	BM-SEC-510	Skill Enhancement Course (SEC) [MOOCS –I/Other Departments]	3	1	0	5	20	25	75	100	4
			Total							600	24

Scheme of Master of Technology (M.Tech.)(Biomedical Engineering)

Year 2 **Semester III**

Sl. No.	Paper Code	Paper Name	P/W			EVALUATION SCHEME				Total	Credits
			L	T	P	Internal			ESE		
						TA	CT	TOT			
1	BM -CC-600	Advanced Biomechanics and Rehabilitation Engineering	3	1	0	5	20	25	75	100	4
2	BM -CC-601	Biomedical Engineering Laboratory III	0	0	8	5	20	25	75	100	4
3	BM-CC-602	Minor Project	0	0	8	5	20	25	75	100	4
4	BM-DSEC-603-XX	Discipline-Specific Elective Course V (DSEC-V)	3	1	0	5	20	25	75	100	4
5	BM-DSEC-604-XX	Discipline-Specific Elective Course VI (DSEC-VI)	3	1	0	5	20	25	75	100	4
6	BM-DSEC-605-XX	Discipline-Specific Elective Course VII (DSEC-VII)	3	1	0	5	20	25	75	100	4
			Total							600	24

Scheme of Master of Technology (M.Tech.)(Biomedical Engineering)

Year 2 Semester IV

Sl.No.	Paper Code	Paper Name	P/W			EVALUATION SCHEME			Total	Credits
			L	T	P	Internal		ESE		
						TA	TOT			
1	BM -CC-606	Major Project	0	0	48	150	150	450	600	24
		Total	0	0	48	150	150	450	600	24

Discipline-Specific Elective Course (DSEC)		
Code	**S.No.**	**Name of Paper**
BM-DSEC-502-XX	01	Advanced Nanomedicine
	02	Advanced BIOMEMS
BM-DSEC-503-XX	01	Soft Computing methods in Biomedical Engineering
	02	Medical Informatics and Telemedicine
BM-DSEC-507-XX	01	Advanced Medical Imaging
	02	Artificial Intelligence for healthcare
BM-DSEC-508-XX	01	Advanced Tissue Engineering
	02	Advanced Biomaterials
BM-DSEC-603-XX	01	IPR & Ethics
	02	Industrial Tour
BM-DSEC-604-XX	01	MOOCS-II (Basic course in Biomedical Research)
	02	Seminar
BM-DSEC-605-XX	01	MOOCS-III (Design, Technology and Innovation/ Development of Assistive Technology for person with disabilities and related)
	02	MOOCS-IV (Healthcare/Hospital Management/ Business Communication/Academic writing and related)

NORTH-EASTERN HILL UNIVERSITY, SHILLONG

DEPARTMENT OF BIOMEDICAL ENGINEERING
Structure of Master of Technology (M.Tech.)(Biomedical Engineering)

FIRST SEMESTER			
Paper Code	**Paper**	**No. of Papers**	**Total Credit**
BM-CC-500 **BM-CC- 501**	Advanced Human Anatomy and Physiology Biomedical Engineering Laboratory I	2	8
BM-DSEC-502-XX **BM-DSEC-503-XX**	Discipline-Specific Elective Course-I (DSEC-I) Discipline-Specific Elective Course-II (DSEC-II)	2	8
BM-GEC-504	Advances in Healthcare Technology	1	4
Total		**5**	**20**
SECOND SEMESTER			
Paper Code	**Paper**	**No. of Papers**	**Total Credit**
BM-CC- 505 BM-CC- 506	Advanced Biomedical Instrumentation and Systems Biomedical Engineering Laboratory II	2	8
BM-DSEC-507-XX BM-DSEC-508-XX	Discipline-Specific Elective Course-III(DSEC-III) Discipline-Specific Elective Course-IV(DSEC-IV)	2	8
BM-RM-509	Research Methodology & Proposal Writing	1	4
BM-SEC-510	Skill Enhancement Course (SEC)[MOOCS -I]	1	4
Total		**6**	**24**
THIRD SEMESTER			
Paper Code	**Paper**	**No. of Papers**	**Total Credit**
BM -CC-600 BM -CC-601 BM-CC- 602	Advanced Biomechanics and Rehabilitation Engineering Biomedical Engineering Laboratory III Minor Project	3	12
BM-DSEC-603-XX BM-DSEC-604-XX BM 605	Discipline-Specific Elective Course V (DSEC-V) Discipline-Specific Elective Course VI (DSEC-VI) Discipline-Specific Elective Course VII (DSEC-VII)	3	12
Total		**6**	**24**
FOURTH SEMESTER			
Paper Code	**Paper**	**No. of Papers**	**Total Credit**
BM -CC-606	Major Project	1	20
	Problem Identification and Review of Related Literature.		

	Proposal Writing and Presentation		
	Data Collection		
	Data Analysis, Interpretation and Discussion.		
	Report Writing		
	Viva-Voce		
Total		**1**	**20**

Discipline-Specific Elective Course (DSEC)		
Code	**S.No.**	**Name of Paper**
BM-DSEC-502-XX	01	Advanced Nanomedicine
	02	Advanced BIOMEMS
BM-DSEC-503-XX	01	Soft Computing methods in Biomedical Engineering
	02	Medical Informatics and Telemedicine
BM-DSEC-507-XX	01	Advanced Medical Imaging
	02	Artificial Intelligence for healthcare
BM-DSEC-508-XX	01	Advanced Tissue Engineering
	02	Advanced Biomaterials
BM-DSEC-603-XX	01	IPR & Ethics
	02	Industrial Tour
BM-DSEC-604-XX	01	MOOCS-II (Basic course in Biomedical Research)
	02	Seminar
BM-DSEC-605-XX	01	MOOCS-III (Design, Technology and Innovation/ Development of Assistive Technology for person with disabilities and related)
	02	MOOCS-IV (Healthcare/Hospital Management/ Business Communication/Academic writing and related)

BM-CC-500 ADVANCED HUMAN ANATOMY AND PHYSIOLOGY **L-T-P=C**

3-1-0 = 4

Subject Code: **BM-CC-500**

Subject Name: *Advanced Human Anatomy and Physiology*
No. of Hours per Week: *4(Four) hours*
Marks Distribution: *Sessional Works = 25, End Semester Examination = 75.*
Questions to be set: 8 *(Eight)*
Questions to be answered: Any 5 *(five)*
Duration of End Semester Examination: 3 *(Three) Hours.*

UNIT I

Cells and Tissue: Structure and function of Cell and cellular components, Tissues and its types. Cardiovascular system: Heart, conductive tissue of heart, cardiac cycle, heart valves, systemic and pulmonary circulation, Transmission of cardiac impulse, blood pressure. Respiratory system: respiration external (ventilation), Exchange in gases in the alveoli.

UNIT II

Excretory system: Structure of Nephron, formation of urine and function of kidneys, urinary bladder, urethra, internal/external sphincters. Nervous system: different parts, their functions, Reflex action and reflex arc. Function of sympathetic nervous system. Nervous conduction & action potentials.

UNIT III

Alimentary system: All organs of the digestive system, other secretions and main functions, Blood: types and its functions.

UNIT IV

Reproductive system: Male and female reproductive system, Endocrine system: All glands, their secretions. Control of secretions, Muscle physiology, Physiological aspects of skin resistance.

Text Books:

1. James Palmer, Essentials of Human Anatomy and Physiology,Cognella Academic Publishing, 2019.
2. Paul S., Biomedical Engineering and its Applications in Healthcare, Springer, 2019.
3. Anatomy and physiology in health and illness by: Ross and Wilson (ELBS pub), 2014.
4. A.G. Guyton; Textbook of Medical Physiology; Saunders, Philadelphia, 1986.

Reference Books:

1. J Gibson, “Modern Physiology and Anatomy of Nurses”, Black Well, 1981.
2. S. West, E.R. Todd, W.S. Mason and H.J.T. Van Bruggen; Text Book of Biochemistry. Macmillan Co., 1976.
3. C.A. Keele and Eric Neil; Samson Wright's Applied Physiology. ELBS, London,1984
4. H.B. Charles and B.N. Taylor; The Physiological Basis of Medical PracticeWilliamand, Wilkins, Baltimore, 1985.
5. Charles E Tobin , “Manual of Human Dissection”, Mc Graw Hill, Edition 4, 1961

BM-CC-501 BIOMEDICAL ENGINEERING LABORATORY I **L-T-P=C**

0-0-8 = 4

Subject Code: **BM-CC-501**
Subject Name*:* *Biomedical Engineering Laboratory I*
No. of Hours per Week: *8(Eight) hours*
Marks Distribution: *Sessional Works = 25, End Semester Examination = 75.*
Minimum number of Experiments to be carried out: 8 (Eight)
Question to be answered: One experiment will be allotted to a student on lottery basis.
Duration of End Semester Examination: Four Hours.

List of Experiments:

1. To visit SAIF facilities in the university for demonstration of different instruments at NEHU, Shillong.
2. To perform characterization of implant materials: strength measurements, contact angle, morphological structure.
3. To synthesis and characterize of Biopolymers in department laboratory.
4. To prepare nanoparticles for drug delivery applications.
5. To characterize drug delivery systems.
6. To carry out drug release studies at different physiological conditions (Temperature, pH).
7. To prepare and characterize tissue scaffolds from biopolymers.
8. Fabrication of tissue scaffolds using 3D printing.
9. To study blood group
10. To perform SGOT and SGPT

Text Books:

1. Sean P. Flanagan, Flanagan, Biomechanics: A case based Approach, Jones and Bartlett Publishers, 2013.
2. James Palmer, Essentials of Human Anatomy and Physiology,Cognella Academic Publishing, 29-Mar, 2019.
3. Clemens van Blitterswijk, Tissue Engineering, Academic Press, 2008.

References Books:

1. B. Roy Biological Control (Pb), Medtech Publishers, 2017.
2. Robert R. L., LangerJ. Vacanti A., Principles of Tissue Engineering, Academic Press, 2020.
3. Prof. Ghista, Biomechanics, Private Publication UAF, 2009.
4. White and Puyator, Biomechanics, Private publication UAF, 2010.
5. Kenneth J. Klabunde, Nanoscale Materials in Chemistry, John Wiley and Sons, Inc., 2001.

BM-DSEC-502-01: ADVANCED NANOMEDICINE **L-T-P=C**

Subject Code: **BM-DSEC-502-01** **3-1-0 = 4**
Subject Name: *Advanced Nanomedicine*
No. of Hours per Week: *4(Four) hours*
Marks Distribution: *Sessional Works = 25, End Semester Examination = 75.*
Questions to be set: 8 *(Eight)*
Questions to be answered: Any 5 *(five)*
Duration of End Semester Examination: 3 *(Three) Hours.*

UNIT I

Drug Administration: Routes of drug administration, Pharmacokinetics process: Absorption, Distribution, Metabolism and Excretion; Pharmacodynamics: Principles and Mechanism of Drug Action, Dose Response Relationship, Drug Potency and Efficiency, Combined Effect of Drug and Factors Modifying Drug Action.

UNIT II

Synthesis and Characterization of Nanomedicines: Nanoparticles preparation Techniques and Characterization, Preparation of lipid based nanoparticles, polymeric nanoparticles, and metallic nanoparticles.

UNIT III

Nanoparticles for drug delivery: Tumour Physiology and Targeting using Nanoparticles, Cancer drug delivery and Hyperthermia, Photodynamic Therapy and Immunotherapy, drug delivery for diabetes and malaria.

UNIT IV

Nanomedicine in diagnostic applications: Biosensors, biomarkers for cancer imaging and sensing, paper based point-of-care devices, micro-fluidic devices.

Text Books:

1. K. D. Tripathi, Essentials of Medical Pharmacology, 1995.
2. M. Sebastian, A. K. Haghi and N. Ninan, Nanomedicine and Drug Delivery, Apple Academic Press, 2013.
3. Kumar C. S. S. R., Nanomaterials for Cancer Therapy, Wiley VCH-Verlag GmbH and Company KGaA, 2006.
4. Manashjit Gogoi et al. (Eds): Nanobiosensors for point-of-care medical diagnostics Springer, 2022.

Reference Books:

1. Saltzman W. M., Engineering Principles for Drug Therapy, Oxford University Press, 2001.
2. Wang B, Siahaan T and Soltero R, Drug Delivery Principles and Applications, Wiley-Inter-science, 2005.
3. Manashjit Gogoi et al. (Eds): Nanobiosensors for point-of-care medical diagnostics Springer, 2022.
4. Paul S., Biomedical Engineering and its Applications in Healthcare, Springer, 2019

BM-DSEC-502-02: ADVANCED BIOMEMS **L-T-P=C**

3-1-0 = 4

Subject Code: **BM-DSEC-502-02**
Subject Name: *Advanced Bio-MEMS*
No. of Hours per Week: *4(Four) hours*
Marks Distribution: *Sessional Works = 25, End Semester Examination = 75.*
Questions to be set: 8 *(Eight)*
Questions to be answered: Any 5 *(five)*
Duration of End Semester Examination: 3 *(Three) Hours.*

UNIT I

Fundamental of MEMS: Introduction to MEMS, principles and fabrication technologies, fundamental of MEMS structures, MEMS materials, sensing and Application in bio-mems

UNIT II

Fabrication of BioMEMS devices: BioMEMS design, fabrication and packaging, photolithography, film deposition techniques, micromachining techniques.

UNIT III

Introduction to Micro and Nano fluidics: Introduction to micro/ nano fluidics, Basic components of lab-on-a-chips and its integration.

UNIT IV

Biosensors and actuators for medical instrumentation: Biosensors and Biochips: Fundamentals of biosensors, fundamentals of electrochemistry and electrochemical biosensors.

Text Books:

1. A. Chio, Biomaterials for MEMS, Panima, 2011.
2. Steven S. Saliterman, Fundamentals of Bio-MEMS and Medical Microdevices, S PIE Press Monograph, 2006.
3. Gerald Urban, Bio-MEMS, Springer, 2006.
4. Dinesh Bhatia, The Role of 3D Printing for the Growth and Progress of Medical Healthcare Technology, Cambridge Scholars Publishing, U.K., 2022.

Reference Books:

1. James Palmer, Essentials of Human Anatomy and Physiology,Cognella Academic Publishing, 29-Mar, 2019
2. D. L. Wise, Biosensors: Theory and Applications, CRC Press, 1993.
3. Rao & Guha, Principles of Medical Electronics & Biomedical Instrumentation, Orient Longman, 2001.
4. Albert Folch, Introduction to BioMEMS **,** CRC Press, 2020.

BM-DSEC-503-01: SOFT COMPUTING METHODS IN BIOMEDICAL ENGINEERING

L-T-P=C

Subject Code: **BM-DSEC-503-01** **3-1-0 = 4**
Subject Name: *Soft Computing methods in Biomedical Engineering*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I
Introduction to Artificial Neural Networks: Neuron model and network architecture, perceptron, learning rules, supervised and unsupervised learning, back propagation algorithm, deep learning and application in medical field.

UNIT II
Artificial Intelligence and Pattern recognition: Classification techniques, clustering, principle component analysis (PCA), kohonen network and competitive learning, hebbian learning, adaptive resonance theory (ART), random forest classifier.

UNIT III
Fuzzy Logic: Classical sets and fuzzy sets, classical relation and fuzzy relations, properties of membership functions, fuzzification and defuzzification, logic and fuzzy systems, medical applications of fuzzy logic.

UNIT IV
Neuro fuzzy system and Genetic Algorithms: Neuro fuzzy classifier, mamdani and sugeno fuzzy inference and, ANFIS, genetic algorithms and genetic modelling and application.

Text Books:

1. Donna L. Hudson and Maurice E. Cohen, Neural Networks and artificial Intelligence for Biomedical Engineering, Prentice Hall of India. Pvt., Ltd., 2011.
2. Toshinori Munakata, Fundamentals of the New Artificial Intelligence, Springer, 2008.
3. Timothy J. Ross, Fuzzy Logic with Engineering Applications, John Wiley & Sons, 2009.
4. Mohamad H. Hassoun, Fundamentals of Artificial Neural Networks, MIT Press, 1995.

Reference Books:

1. Himanshu Singh Yunis Ahmad Lone , Deep Neuro-Fuzzy Systems with Python: With Case Studies and Applications from the Industry, Apress, 2019.
2. J.S.R Jang, C.T. Sun and E Mizutani, Neuro, Fuzzy and soft computing, Prentice Hall of India. Pvt., Ltd., 2010.
3. S. Rajasekaran, G. A. Vijayalakshmipai, Neural Networks, Fuzzy Logic and Genetic Algorithm, PHI learning pvt. 2003.

BM-DSEC-503-02: MEDICAL INFORMATICS AND TELEMEDICINE **L-T-P=C**
3-1-0=4

Subject Code: BM-DSEC-503-02
Subject Name:*Medical Informatics And Telemedicine*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I
Introduction – Introduction to Medical Informatics, Medical documentation, Computer based medical information retrieval, Clinical Decision Support Modelling, Hospital management and information system, Functional capabilities of a computerized HIS, CIS, m-health, e-health services and Healthcare Informatics.

UNIT II
Data Compression and Safety- Introduction, Interaction with computer, Classification of data, Data mining, Database Management System (DBMS), Components and functionality of EPR, EMR and CPR, Intranet, Application server provider, Clinical information system, Computerized prescriptions for patients, Security issues and its prevention.

UNIT III
Computers in medical imaging and Expert system: Computers in Medical Imaging, Image capturing, analysis and processing techniques, Medical Decision making, Medical knowledge representation and decision support system, **Expert system:** Components and Model design, Computer assisted surgery (CAS) v/s Robotic Surgery with applications, IOT in medical field.

UNIT IV
Telemedicine and Artificial Intelligence: Telemedicine Systems- Principle, functional blocks of Telemetry and Telecontrol system, Methods of telemetry, Telemetry technology and standards, Networking, Medical Peripheral devices and cyber medicine. Artificial Intelligence (AI), Artificial neural networks (ANN) and its applications, Neurocomputers. Fuzzy systems, application of AI in healthcare.

Text Books:

1. R.S. Khandpur, Telemedicine: Technologies and Applications, PHI Learning Pvt. Limited, Delhi, 2020
2. Dinesh Bhatia, Medical Informatics, PHI Learning Pvt. Limited, Delhi, 2015
3. Ramona N., Nancy S., Health Informatics: An Interprofessional Approach, 2nd Edition, Elsevier, 2020
4. R. D. Lele, Computers in medicine progress in medical informatics, Tata McGraw Hill Publishing computers Ltd, New Delhi, 2005.

Reference Books:

1. Mohan Bansal, Medical informatics, Tata McGraw Hill Publishing Ltd, 2003 New Delhi, 2003.
2. Neil C. Jones and Pavel A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, 2005.

BM-GEC-504: ADVANCES IN HEALTHCARE TECHNOLOGY **L-T-P=C**

Subject Code: BM-GEC-504 **3-1-0=4**
Subject Name: *Advances in Healthcare Technology*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I:
Advances in Healthcare Technology: Disruption of healthcare and introduction to digital and mobile health, leveraging technology and Innovation to improve patient care, Electronic Medical Records and Hospital Management Strategies for Healthcare IT, opportunities in medical informatics.

Unit II:
Telemedicine in Healthcare: Telemedicine Meets Technology- Remote Presence and Monitoring, Telehealth and Telemedicine Business Model, advances in telemetry technology and standards, privacy and security issues in remote healthcare monitoring

Unit III:
Innovative Medical Technologies: Innovation in Drug Delivery Technology, Design and development of healthcare technologies, Analytical Approaches for Optimising Healthcare Ecosystem, Personalized Genomics, Redefining pharmaceutical R&D and introduction to adaptive clinical trial design, Next generation sequencing.

UNIT IV:
Social Diagnostics in Healthcare: Medical devices: development and clinical applications, Companion Diagnostics and Outlook for personalized medicine, social network platform to achieve better health outcomes, Core technology opportunities, Smarter healthcare models, future of healthcare.

Text Books:

1. R.S. Khandpur, Telemedicine: Technologies and Applications, PHI Learning Pvt. Limited, Delhi, 2020
2. Sudip Paul and Dinesh Bhatia, Smart healthcare for disease diagnosis and prevention, Elsevier Publisher, 2020
3. Dinesh Bhatia, Medical Informatics, PHI Learning Pvt. Limited, Delhi, 2015
4. Dinesh Bhatia, Prabhat Chaudhari, Bhupinder Chaudhary, Sushman Sharma, Kunal Dhingra A guide to hospital administration and planning, Springer, 2022

Reference Books:

1. S. Rajasekaran, G. A. Vijayalakshmipai, Neural Networks, Fuzzy Logic and Genetic Algorithm, PHI learning pvt. 2003.
2. Huff and Finholt, "Social Issues in Computing: Putting Computing in Place", McGraw Hill, 1994.
3. Christine Guzzo Vickery, Gary Nyberg, and Douglas Whiteaker**,** Modern Clinic Design: Strategies for an Era of Change**,** Wiley, 2015.
4. Dinesh Bhatia, Modern Technological Intervention Advancements for the Physically Challenged and Disabled Population, Cambridge Scholars Publishing, U.K., 2021.

BM-CC- 505: ADVANCED BIOMEDICAL INSTRUMENTATION AND SYSTEMS

L-T-P=C

3-1-0 = 4

Subject Code: BM-CC-505
Subject Name: *Advanced Biomedical Instrumentation and Systems*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I:

Bio potential electrodes and electrode configurations: Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode– skin interface, half-cell potential, impedance, polarization effects of electrode – non-polarizable electrodes. Types of electrodes -surface, needle micro electrodes and their equivalent circuits. Bio-signals characteristics – frequency and amplitude ranges. Basics of ECG – Einthoven's triangle, standard lead system. Basics of EEG – 10-20 electrode system. Basics of EMG, ERG and EOG – unipolar and bipolar modes.

UNIT II:

Bio amplifier: Need for bio-amplifier, Specifications of bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven bio (ECG) amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier, chopper amplifier, power line interference.

UNIT III:

Measurement of non-electrical parameters: Temperature, respiration rate and pulse rate measurements. Blood Pressure: Indirect methods- auscultatory methods, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output measurement: Indicator dilution, thermal dilution and dye dilution methods, Electromagnetic and ultrasound blood flow measurement.

UNIT IV:

Biomedical instruments and patent safety: Electro surgical unit; pulse oximeter, cardiac pacemaker, defibrillators. Electrical safety of medical equipment and patient: patient safety, classification of medical devices and their safety standards, leakage current, micro, macro shock, different types of safety circuits for medical equipment, measures to reduce shock hazards.

Text Books:

1. Khandpur R.S, Compendium of Biomedical Instrumentation, Volume 3, Wiley, 2019.
2. Paul S., Biomedical Engineering and its Applications in Healthcare, Springer, 2019.
3. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, 2004.
4. Joseph Bronzino, Biomedical Engineering and Instrumentation, PWS Engg., 2010.

Reference Books:

1. Himanshu Singh Yunis Ahmad Lone , Deep Neuro-Fuzzy Systems with Python: With Case Studies and Applications from the Industry, Apress, 2019.
2. Leslie Cromwell, Biomedical Instrumentation and measurement, Prentice hall of India, 2007.

BM -CC-506: BIOMEDICAL ENGINEERING LABORATORY II **L -T-P = C**

Subject Code: **BM -CC-506** **0-0-8 = 4**
Subject Name: *Biomedical Instrumentation, Image and Signal Processing Laboratory II*
No. of Hours per Week: 8(Eight) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75
Minimum number of Experiments to be carried out: 8(Eight)
Question to be answered: One experiment will be allotted to a student on lottery basis.
Duration of End Semester Examination: Four Hours.

List of Experiments: -

1. Introduction to different type of electrodes surface**,** suction**,** floating**,** disposable**,** needle and microelectrodes**.**
2. Measurement of waveform, amplitude, durations and frequency of bio signals (ECG / EMG) using CRO.
3. To study the placement of EEG electrodes**,** recording of EEG waveform and its interpretation.
4. Recording of ECG waveform from 12 leads and the interpretation of ECG waveform**.**
5. To study the placement of EMG electrodes**,** recording of EMG waveform and its interpretation.
6. Measurement of Blood Pressure using digital blood pressure meter.
7. To study the FIR filter.
8. To study an IIR filter.
9. Time frequency domain properties of different windows.
10. Fourier analysis of a periodic signal.
11. EMG processing–Rectification and Signal Averaging.
12. Implementation of the Double-Precision Complex FFT for ECG signal.
13. Write a program to draw the histogram of provided image and on the basis of histogram perform threshold operation.
14. Write a program for histogram equalization and apply on given image.

Text Books

1. A. P. Malvino, Electronics Principles, 6TH Edition, TMH, 2005.
2. R. L. Boylestead and L. Nashelsky, Electronic Devices and Circuit Theory, 9th Edition, PHI, 2006.
3. Neil C. Jones and Pavel A. Pevzner, An Introduction to Bioinformatics Algorithms, MIT Press, 2005.

Reference Books

1. Miguel Rocha, Pedro G. Ferreira, Bioinformatics Algorithms: Design and Implementation in Python, Academic Press, 2018
2. Micheal R. King, Nipa A. Mody, Numerical and Statistical Methods for Bioengineering: Applications in MATLAB, Cambridge University Press, 2011.
3. Himanshu Singh Yunis Ahmad Lone, Deep Neuro-Fuzzy Systems with Python: With Case Studies and Applications from the Industry, Apress, 2019
4. R.F. Ziemer, W.H. Tranter and D.R. Fannin, Signals and Systems – Continuous and Discrete, 4th Edition, PHI, 2005.
5. J. Nagrath, S.N. Saran, R. Ranjan and S. Kumar, Signals and Systems, TMH, 2001.

BM-DSEC-507-01: **ADVANCED MEDICAL IMAGING AND PROCESSING L-T-P=C**

Subject Code: **BM-DSEC-507-01** **3-1-0 = 4**
Subject Name: *Advanced Medical Imaging and Image processing.*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75. **Questions to be set: 8** (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I

X-Ray and Computed Tomography: Principles and production of X-rays**,** X-Ray Detectors, details of radiographic and fluoroscopic images. Principles of CT, evolution of CT machines, Artefacts in CT imaging, CT Angiography.

UNIT II

Ultrasonic and Magnetic Resonance Imaging: Principle of MRI, Image acquisition in MRI – T1, T2, proton density weighted images, spin-echo technique and spin relaxation technique and MRI hardware parts, MR Angiography, fMRI; Ultrasonic –Physics of ultrasound – Principles of image formation, principles of A-Mode, B-Mode, M-Mode., Thermograph and its medical application.

UNIT III

Introduction to Medical Image Processing: Image acquisition, processing and analysis,. Visual perception: Structure of Human Eye, Image formation in human eye, brightness and contrast, Medical Image formats, Digital image, sampling, quantization, Basic relationship in pixel in 2D and 3D image, Image enhancement: Image smoothing, point operators, contrast manipulation, histogram modification, noise clipping image sharpening, spatial operators, frequency domain method, low pass and high pass filtering, Median filtering and algorithm implementation with applications.

UNIT IV

Image Transforms and Segmentation: DFT, Properties of 2D Fourier Transforms, Image Restoration: Degradation Model, A prior knowledge required in restoration, Morphological operations, Colour image processing, Image Segmentation: Thresholding, Detection of discontinuity, continuity based segmentation, Active contour, advanced segmentation techniques, Diagnosis and therapeutic algorithm implementation.

Text Books

1. R. C. Gonsalez, R.E. Woods, Steven L. Eddins, Digital Image Processing, 1st Edition, Dorling Kindersley Pvt Ltd, 2006.
2. Anil Kr. Jain, Fundamental of Image Processing, Prentice Hall, 1988.
3. WilliamK. Pratt, Digital Image Processing, John Wiley, NJ, 1987.
4. Albert Macouski, Medical Imaging systems, Prentice Hall, New Jersey, 1983.

Reference Book

1. William K. Pratt, Digital Image Processing, John Wiley, NJ, 1987.
2. Albert Macouski, Medical Imaging systems, Prentice Hall, New Jersey.1983.
3. S Sridhar, Digital Image Processing Second Edition, Oxford University Press, 2016
4. John R. Jensen, Introductory Digital Image Processing, 4Th Ed, Pearson, 2018.

BM-DSEC-507-02 ARTIFICIAL INTELLIGENCE FOR HEALTHCARE L-T-P=C

Subject Code: **BM-DSEC-507-02** **3-1-0 = 4**
Subject Name: *Artificial Intelligence for healthcare*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I:
Introduction to Artificial neural networks: Neuron model and network architecture, perceptron, learning rules, supervised and unsupervised learning, back propagation algorithm.

UNIT II:
Machine Learning: Basic Mathematics for ML, Data and Model. Machine Learning Workflow and Applications; Learning as optimization, Linear Regression, Regularization and Logistic Regression; Machine Learning for physiological signal processing. Time series modelling

UNIT II:
Deep Learning in Healthcare: Deep Learning: Basics, MLPs, Back propagation, CNNs ; Practical considerations in Deep Learning. Avoiding Overfitting- Regularization, Dropout. Convolutional Neural Networks. Recurrent Neural Networks. Forward and Backward propagation. Various Architectures for sequence to sequence and sequence to vector mapping.

UNIT IV:
Deep Learning in Medical Imaging : Medical Image Analysis: Basics, Imaging Physics-Based Methods, and Need for Deep Learning; Deep learning: Loss function, Optimization, CNNs, Training Convolutional Neural Networks for Object Detection and Segmentation, Deep Learning models: AlexNet, VGG, GoogleNet, ResNet,U-Net.

Text Books:

1. S. Rajasekaran, G. A. Vijayalakshmipai, Neural Networks, Fuzzy Logic and Genetic Algorithm, PHI learning pvt. 2003.
2. Computer Vision: Models, Learning, and Inference, by Simon J.D. ,Cambridge University Press, 2012
3. Donna L. Hudson and Maurice E. Cohen, Neural Networks and artificial Intelligence for Biomedical Engineering, Prentice Hall of India. Pvt., Ltd., 2011.
4. ToshinoriMunakata, Fundamentals of the New Artificial Intelligence, Springer, 2008.

Reference Books:

1. S. Rajasekaran, G. A. Vijayalakshmipai, Neural Networks, Fuzzy Logic and Genetic Algorithm, PHI learning pvt. 2003.
2. Machine learning and AI for healthcare by arjunpanesar, springer nature customer service centerllc, 1st edi, 2019
3. Deep Learning in Healthcare: Paradigms and Applications: 171 (Intelligent Systems Reference Library) Hardcover – Import, 27 November 2019,by Yen-Wei Chen (Editor), Lakhmi C. Jain (Editor)

BM-DSEC-508-01: ADVANCED TISSUE ENGINEERING **L-T-P=C**

Subject Code: **BM-DSEC-508-01** **3-1-0=4**
Subject Name: *Advanced Tissue Engineering*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I

Introduction: Basic cell biology, Tissue dynamics and cell migration, principles and strategies of tissue engineering, soft and hard tissue and its function, vascularity and angiogenesis, wound healing.

UNIT II

Cell culture and its preservation: Different cell types, Stems cells: Introduction, Haematopoiesis,

Progenitor cells and cell differentiations, Different kind of matrix. Aspect of cell culture: Sterilization, Cell expansion, Cell transfer, Cell storage and cell characterization. Cell to cell interactions. Bioreactors, Microfluidic in tissue engineering. Application of stem cell in tissue engineering.

UNIT III

Cell molecular biology and Immune response: Cell signalling molecules, Growth factors in tissue engineering, Cell attachment: Differential cell adhesion, Receptor-ligand binding, Cell surface markers. Immune system and infections, Cell source and immune response. CarT cells and its application.

UNIT IV

Artificial Organ and scaffolds: Engineering biomaterials for Artificial Organ, Degradable materials (collagen, silk and polylactic acid), Porosity, Mechanical strength of scaffolds, 3-D architecture, 3D Printing of scaffolds and cell incorporation. Engineering tissues for replacing bone, Cartilage, skin and liver etc. Software's for Tissue Engineering Applications.

Text Books:

1. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
2. Burdick, Biomaterial for Tissue Engineering Applications, Panima, 2012.
3. Lanza RP, Langer R, Vacanti JP, Principles of Tissue Engineering, Academic Press, 3rd Edition, 2007.
4. Dinesh Bhatia, The Role of 3D Printing for the Growth and Progress of Medical Healthcare Technology, Cambridge Scholars Publishing, U.K., 2022.

References Books:

1. Robert R. L., LangerJ., Vacanti A., Principles of Tissue Engineering, Academic Press, 2020.
2. Blitterswijk CV, Tissue Engineering, Academic Press, 2008.
3. Saltzman WM, Tissue Engineering, Oxford University Press, 2004.
4. Palsson B and Bhatia SN, Tissue Engineering, Pearson Prentice Hall, 2003.

BM-DSEC-508-02: ADVANCED BIOMATERIALS **L-T-P=C**

Subject Code: BM-DSEC-508-02 **3-1-0=4**
Subject Name: *Advanced Biomaterials*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I

Introduction to Biomaterials: General structure and properties, classification of common biomaterials and applications- chemical bonding, crystalline, amorphous, melting, solidification, nucleation, phase diagrams

UNIT II

Metal, Alloys and Ceramics: Stainless steel, cobalt based alloys, titanium based alloys (including shape memory alloys), Ceramics and glasses-bio-ceramics: processing and development of bio-ceramics for medical applications

UNIT III

Polymers and composites: Definition, classification, polymerization (rubber, plastics, fibers and resins) and their structure-properties, biodegradable polymers, natural polymers, composites for medical applications

UNIT IV

Principles and Techniques of Materials Characterizations: Optical microscopy and spectroscopy techniques, texture measurement, tensile and compressive strength measurement, Operating principles of XRD, FTIR, TEM, SEM, EDS, AFM. Biomaterial coating techniques and advance biomaterial for medical application.

Text Books:

1. Buddy D**.** Ratner, Biomaterials Science**:** An Introduction to Materials in Medicine**,** Academic Press**,** San Diego**,** 1996**.**
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
3. J. B. Park, Biomaterials - Science and Engineering, Plenum Press, 1984.
4. Burdick, Biomaterial for Tissue Engineering Applications, Panima, 2012.

Reference Books:

1. M. C. Tanzi, S. Farè, G. Candiani, Foundations of Biomaterials Engineering, Academic Press, 2019.
2. Ratner, Biomaterials Science: An Introduction to Materials in Medicine 3rd Ed.Panima, 2011.
3. S. Ramakrishna, Biomaterials: A Nano Approach, Panima, 2011.
4. A. Kulshrestha, Biomaterials, Panima, 2011.

BM-RM-509: RESEARCH METHODOLOGY AND PROPOSAL WRITING L-T-P=C

Subject Code: BM-RM-509 **3-1-0=4**
Subject Name: *Research Methodology and Proposal Writing*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I:

Research Problem Formulation and Data Collection: Research methods, types of research, Development of research problem, Identify research gap, literature review-primary and secondary sources, methods of data collection, sampling methods, data processing and hypothesis testing

UNIT II:
Statistical analysis: Computer and its role in research, Use of statistical software SPSS, Neural network, fundamentals of genetic algorithms (GA) and fuzzy based optimization techniques.

UNIT III:
Research Ethics and Indexed Publishing: Ethical issues, Ethical clearance, Intellectual Property Rights (IPR), Patent laws, Copyright, Design, Royalty, citation, plagiarism check, authenticity and accountability of research.

UNIT IV:
Result Interpretation and Proposal Writing: Interpretation, Techniques for interpretation, report writing and its significance, layout of research report, presentation of report, precautions in writing report, conclusion and discussions.

Text Book:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p. 3.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. V.K. Ahuja, Law relating to IPR, Lexis Nexis Publications, 2021

References:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Govindarajan, Natarajan and Senthil Kumar, “Engineering Ethics”, PHI, 2004.
3. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.

BM-CC-600 ADVANCED BIOMECHANICS AND REHABILITATION ENGINEERING

L-T-P = C

Subject Code: **BM-CC-600** **3-1-0 = 4**
Subject Name: *Advanced Biomechanics and Rehabilitation Engineering*
No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT I

Introduction to Biomechanical concepts: Advance biomechanics: forces, torque, momentum acceleration. Kinesiology**,** kinematics and dynamics of motion,types of body motion**,** kinematics concepts,vectors and trigonometry, position of anatomical axis and corresponding movements of the body parts.

UNIT II

Tissue and Bio-fluid mechanics: Mechanics of hard and soft tissues, joint-articulating surface motion, cochlear and vestibular mechanics, fluid mechanics of heart, lungs, blood vessels and heart valves.

UNIT III

Gait and Sports Biomechanics: Gait terminology, analysis of gait, sports and exercise physiology, factors affecting mechanical work in humans, ergonomics and changes in gait patterns during disability and disease.

UNIT IV

Rehabilitation Engineering: Introduction to Rehabilitation, design of prosthetics and orthotics devices, spinal and neural prosthesis, stroke rehabilitation, rehabilitation team, principles of assistive technology assessment, sensory rehabilitation- tactual, auditory, visual and speech, 3D printing for rehabilitation.

Text Books:

1. Doweidar MH.**,** Advances in Biomechanics and Tissue Regeneration**,** Academic Press, 2019.
2. Dinesh Bhatia, The Role of 3D Printing for the Growth and Progress of Medical Healthcare Technology, Cambridge Scholars Publishing, U.K., 2022.
3. Dinesh Bhatia, Modern Technological Intervention Advancements for the Physically Challenged and Disabled Population, Cambridge Scholars Publishing, U.K., 2021.
4. Schnek andBronzino, Biomechanics-Principles and Applications, CRC Press, 2004.
5. Bronzino JD., Biomedical Engineering Handbook, CRC Press, 2002.
6. Lee Waite and Jerry Fine, Applied Biofluid Mechanics, McGraw Hill, 2002.

Reference Books:

1. Peterson &Bronzino, Biomechanics-Principles and Applications, CRC Press, 2002.
2. Mofrad&Kamm, Cytoskeleton Mechanics: Models & Measurements, Cambridge Press, 2004.
3. Fung Y.C., Biomechanics, Springer Verlag,1984.
4. Sunder S., Text book of Rehabilitation Jaypee Publishers, 2006.
5. Jamir M., The Physics of Coronary blood Flow, Springer Publishers, 2004.
6.

BM-CC- 601 BIOMEDICAL ENGINEERING LABORATORY III L-T- P = C

Subject Code: **BM-CC- 601** **0-0-8 = 4**
Subject Name: *Biomedical Engineering laboratory III*
No. of Hours per Week: 8(Eight) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Minimum number of Experiments to be carried out: 8 (Eight)
Question to be answered: One experiment will be allotted to a student on lottery basis.
Duration of End Semester Examination: Four Hours.

List of Experiments:

1. To identifythe different upper and lower extremity muscles in humans.
2. To perform characterization of implant materials: strength measurements, contact angle, morphological structure.
3. To Study and analysis of Sit-to Stand movement from stationary chair employing EMG, Gonimeter and Force plate.
4. Study and analysis of Stand-to Sit movement on a stationary chair employing EMG, Goniometer and Force plate
5. To prepare and characterize tissue scaffolds from biopolymers.
6. Fabrication of biodegradable scaffolds using 3D printing
7. To evaluate the biomechanics parameters of Upper and Lower limbs.
8. Inverse dynamics of human gait
9. Angle measurement using goniometer for upper extremity movements.
10. Angle measurement using goniometer for lower extremity movements.
11. Study and analysis of Sit-to Stand movement from stationary chair employing EMG and Force plate.

Text Books:

1. Sean P. Flanagan, Flanagan, Biomechanics: A case based Approach, Jones and Bartlett Publishers, 2013.
2. James Palmer, Essentials of Human Anatomy and Physiology,Cognella Academic Publishing, 29-Mar, 2019.
3. Clemens van Blitterswijk, Tissue Engineering, Academic Press, 2008.

References Books:

1. B. Roy Biological Control (Pb), Medtech Publishers, 2017.
2. Robert R. L., LangerJ., Vacanti A., Principles of Tissue Engineering, Academic Press, 2020.
3. Prof. Ghista, Biomechanics, Private Publication UAF, 2009.
4. White and Puyator, Biomechanics, Private publication UAF, 2010.
5. Kenneth J. Klabunde, Nanoscale Materials in Chemistry, John Wiley and Sons, Inc., 2001.

BM-DSEC-603-01: IPR AND PROFESSIONAL ETHICS **L-T- P = C**

Subject Code: **BM-DSEC-603-01** **3-1-0= 4**
Subject Name: *IPR & Professional Ethics*

No. of Hours per Week: 4(Four) hours
Marks Distribution: Sessional Works = 25, End Semester Examination = 75.
Questions to be set: 8 (Eight)
Questions to be answered: Any 5 (five)
Duration of End Semester Examination: 3 (Three) Hours.

UNIT – I
Professional Ethics, Historical and Social Context, Ethics in Engineering, Codes of Engineering Ethics, History and Purpose, Consequentialism and Utilitarianism, Deontological Approaches, Duties, Rights and Respect for a Person, Responsibility, Virtue Ethics, Honesty, Moral Autonomy, Obligations of Engineering Profession and Moral Propriety.

UNIT-II
Engineer's Moral Responsibility for Safety and Human Right: Risk assessment and communication, Product liability, Development ethics, Employee and employer relationship, Whistle blowing and its moral justifications. Computer Ethics: Social impact of computers, Privacy, Cybercrime, Hacking, Ethical use of software.

UNIT- III
Intellectual property, definition, types, rights and functions, patents, trademark, software design, industrial designs, semi-conductor and integrated circuits layout design, grant of patent in India, authority and procedure, patent forms, surrender and revocation of patents and compulsory licensing, acquisition of inventions by the Government.

UNIT- IV
Contents of draft application for patents, Drafting patent specification and claims, TRIPS agreement, Paris Convention, Berne Convention, WIPO, Origin of WTO, drafting of patent specification and claims, IPR infringement and piracy under Indian Laws.

Text Books
1. V.K. Ahuja, Law relating to IPR, Lexis Nexis Publications, 2021
2. Vinod V. Sople, "Managing Intellectual Property: The Strategic Imperative", PHI, 2006.
3. Charles, Harri Michael, S Pritchard and Michael J Robins, "Engineering Ethics: Concepts and cases", Wordsworth/ Thompson Learning, Belmont Calif, 2000.
4. Dr. B. L. Wadehra, "Law Relating to Intellectual Property", Universal Law Publishing, 2009.

Reference Books
1. Huff and Finholt, "Social Issues in Computing: Putting Computing in Place", McGraw Hill, 1994.
2. Govindarajan, Natarajan and Senthil Kumar, "Engineering Ethics", PHI, 2004