

Revised Syllabus & Scheme
for
Doctor of Philosophy (PhD)
in
Biomedical Engineering
[with effect from 2022]



Department of Biomedical Engineering
School of Technology
North-Eastern Hill University, Mawkyntroh
Shillong – 793 022, Meghalaya

DEPARTMENT OF BIOMEDICAL ENGINEERING
SCHOOL OF TECHNOLOGY
NEHU, SHILLONG

Scheme of Ph. D. in Biomedical Engineering

BRANCH: Biomedical Engineering

Sl. No	Subject Code	SUBJECT NAME	EVALUATION SCHEME (distribution of marks)			Credits
			Midterm Examination	End Semester Examination (ESE)	Total	
(THEORY)						
1	BM-1201	Research Methodology & Proposal Writing	25	75	100	4
2	BM-1202	Design, Technology and Innovation	25	75	100	4
3	BM-1203x	Elective- I	25	75	100	4
4	BM-1204	Research and Publication Ethics	12	38	50	2
Total					350	14

Total Marks: **350**

Total Credits: **14**

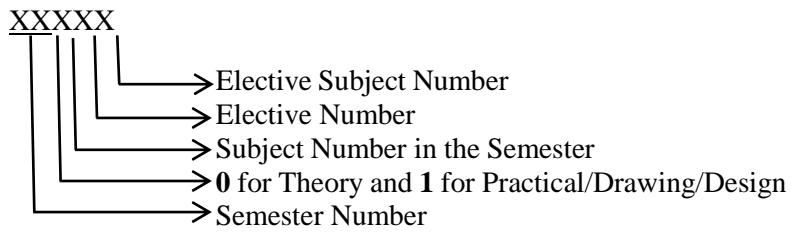
BM-1203x Elective:

1. BM-12031 :- Advanced Biomaterials
2. BM-12032 :- Advanced Biomechanics & Rehabilitation Engineering
3. BM-12033 :- Advanced Nanomedicine
4. BM-12034 :- Advanced Medical Imaging and Image Processing
5. BM-12035 :- Advanced Biomedical Instrumentations

Subject nomenclature and coding:-

BM: - Biomedical Engineering

BM-1203x- x indicates the paper number.



ELIGIBILITY FOR Ph.D. (BIOMEDICAL ENGINEERING)

- i. A candidate is eligible who has passed M. Tech./M. E. in Biomedical Engineering/Biotechnology/ Electrical/ Electronics and Communication/ Mechanical/ Computer/ Instrumentation and Control Engineering or M. Sc. in Biomedical instrumentation, Electronics, Biophysics, Instrumentation candidates having completed M.Tech. degree in the above areas or M.D. / M.S. or students with Master's Degree in Physiotherapy (2 years program) from any UGC recognized University or equivalent having secured a minimum of 60% aggregate marks (relaxable by 5% for SC/ST candidates) applicable as per NEHU norms.

- ii. The admission will be based on the combined entrance test and interview conducted by the department.

- iii. Admission will be as per applicable NEHU norms.

Subject Code: BM - 1201

Subject Name: Research Methodology & 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. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess 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.

Subject Code: BM - 1202

Subject Name: Design Technology and Innovation

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 Biomedical Engineering and its application, Basic of Anatomy & Physiology, Different Organs System

UNIT II:

Biomedical Instrumentation and Signals, Microprocessor and Microcontroller, Biomechanics and Rehabilitation Engineering, Nanomedicine and Drug delivery, Biosensor

UNIT III:

Responsible Conduction of Research in Biomedical Engineering, Biomaterials, Biomedical Product Design, Design for Manufacturability, Systems Design and Analysis

UNIT IV:

Diagnostic And Therapeutic Equipment's for Biomedical Application, Biomedical Safety and Security, Radiological and Imaging Equipment's, Biomedical waste management, Application of Biomaterials, Design aspect of Biomedical Instrumentation and Human Center Design.

Text Books:

1. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education,2004.
2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, 2003.
3. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.

References:

1. Kumar C. S. S. R., Nanomaterials for Cancer Therapy, Wiley VCH-Verlag GmbH and Company KGaA, 2006.
2. S. Paul (Eds) Biomedical Engineering and its Applications in Healthcare, Springer, 2019

ELECTIVE-I

BM-12031 ADVANCED BIOMATERIALS

4-0-0=4

Subject Code: BM - 12031

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

UNIT III

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

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

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.

References:

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.

ELECTIVE-I

BM-12032 Advanced Biomechanics & Rehabilitation Engineering

4-0-0 = 4

Subject Code: BM - 12032

Subject Name: Advanced Biomechanics & Rehabilitation Engineering

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: Basics of Biomechanics, Upper limb biomechanics, lower limb biomechanics

UNIT II

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

UNIT III

Gait and Sports Biomechanics: GAIT biomechanics, 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-tactile, auditory, visual, speech and their advancement.

Text Books:

1. Doweidar MH., Advances in Biomechanics and Tissue Regeneration, Academic Press, 2019.
2. Schnek & Bronzino, Biomechanics-Principles and Applications, CRC Press, 2004.
3. Bronzino JD., Biomedical Engineering Handbook, CRC Press, 2002.
4. John D Enderle, Introduction to Biomedical Engineering, Academic Press Series, 2004.
5. Lee Waite & Jerry Fine, Applied Biofluid Mechanics, McGraw Hill, 2002.

References:

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.

ELECTIVE-I

BM-12033 ADVANCED NANOMEDICINE

4-0-0=4

Subject Code: BM - 12033

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, microfluidic devices

Text Books:

1. K. D. Tripathi, Essentials of Medical Pharmacology, 1995.
2. M. Sebastian, A. K. Hagi 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. M. Gogoi, S. Patra, D. Kundu (Eds): Nanobiosensors for point-of-care medical diagnostics Springer, 2022.

References:

1. W. M. Saltzman Engineering Principles for Drug Therapy, Oxford University Press, 2001.
2. B. Wang, T. Siahaan, R. Soltero Drug Delivery Principles and Applications, Wiley-Inter-science, 2005.

ELECTIVE-I

BM-12034 ADVANCED MEDICAL IMAGING AND IMAGE PROCESSING

4-0-0=4

Subject Code: BM - 12034

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, Diffusion Tensor imaging, fMRI; Ultrasonic –Physics of ultrasound – Principles of image formation, principles of A-Mode, B-Mode, M-Mode., Thermography.

UNIT III

Introduction to Medical Image Processing: Image acquisition, processing and analysis. Visual perception: Image formation in human eye, brightness and contrast, Medical Image formats; Image enhancement: Image smoothing, point operators, contrast manipulation, histogram modification, noise clipping image sharpening, spatial operators, Median filtering, frequency domain filtering, and algorithm implementation with applications.

UNIT IV

Image Transforms and Segmentation: 2D DFT and its properties, Image Restoration: Degradation Models and its restoration, Morphological operations, Colour image processing, Image Segmentation: Thresholding, Detection of discontinuity and continuity, advanced segmentation techniques, Diagnosis and therapeutic algorithm implementation, Recent Advancement in Biomedical Engineering.

Text Books:

1. R. C. Gonzalez, 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.

References:

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.

ELECTIVE-I

BM-12035 ADVANCED BIOMEDICAL INSTRUMENTATIONS

4-0-0=4

Subject Code: BM - 12035

Subject Name: Advanced Biomedical Instrumentations

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

Generation and recording of Bio potentials: Genesis and propagation of bio-signals, Electrode-electrolyte interface, electrode– skin interface, half-cell potential. Types of electrodes, biomaterial used for electrode designing, characteristics of bio-signals. Recording of ECG, EMG, EOG and EEG signals.

UNIT II

Amplifier characteristics: Need for bio-amplifier - single and differential bio-amplifier. Filtering, isolation amplifiers and optical isolation- isolated DC and AC amplifier, chopper amplifier and power line interference.

UNIT III

Measurement of electrical parameters: Pulse and respiration rate measurements. Blood Pressure measurements, electronic manometer, Blood flow and cardiac output measurement techniques, neural control mechanism

UNIT IV

Advance biomedical instruments and patient safety: ESU; pulse oximeter, cardiac pacemaker and defibrillators. Electrical and patient safety, medical devices classification and their safety standards, different types of safety circuits for medical equipment and measures to reduce shock hazards.

Text Books:

1. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education,2004.
2. John G. Webster, Medical Instrumentation Application and Design, John Wiley and sons, 2004.
3. Joseph Bronzino, Biomedical Engineering and Instrumentation, PWS Engg., 2010.

References:

1. Leslie Cromwell, Biomedical Instrumentation and measurement, Prentice hall of India, 2007.
2. Khandpur R.S, Handbook of Biomedical Instrumentation, Tata McGraw-Hill, 2003.

Subject Code: BM - 1204

Subject Name: Research and Publication Ethics

No. of Hours Per Week: 2(Two) hours

Marks Distribution: Sessional Works = 12, End Semester Examination = 38.

Questions to be set: 8 (Eight)

Questions to be answered: Any 5 (five)

Duration of End Semester Examination: 1.5 (One and half) Hours.

UNIT 1

1. PHILOSOPHY AND ETHICS

- a. Introduction to philosophy: definition, nature and scope, concept, branches
- b. Ethics: definition, moral philosophy, nature of moral judgements and reactions

2. SCIENTIFIC CONDUCT

- a. Ethics with respect to science and research
- b. Intellectual honesty and research integrity
- c. Scientific misconduct: Falsification, Fabrication, and Plagiarism (FFP)
- d. Redundant publications: duplicate and overlapping publications, salami slicing
- e. Selective reporting and misrepresentation of data

3. PUBLICATION ETHICS

- a. Publication ethics: definition, introduction and importance
 - b. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.
 - c. Conflicts of interest
 - d. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
 - e. Violation of publication ethics, authorship and contributor ship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

UNIT II

1. OPEN ACCESS PUBLISHING

- a. Open access publications and initiatives
- b. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
- c. Software tool to identify predatory publications developed by SPPU
- d. Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

2. PUBLICATION MISCONDUCT

- a. Group Discussions
 - i. Subject specific ethical issues, FFP, authorship
 - ii. Conflicts of interest
 - iii. Complaints and appeals: examples and fraud from India and abroad
- b. Software tools
 - i. Use of plagiarism software like Turnitin, Urkund and other open-source software tools

3. DATABASES AND RESEARCH METRICS

- a. Databases

- i. Indexing databases
 - ii. Citation databases: Web of Science, Scopus, etc.
- b. Research Metrics
 - i. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, CiteScore
 - ii. Metrics: h-index, g index, i10 index, altmetrics

Text Books:

1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London.
3. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978_9387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.

References:

4. Resnik, D.B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from <https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>
5. Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179- 179. <https://doi.org/10.1038/489179a>
6. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics_Book.pdf