# MASTER OF SCIENCE (BIOMEDICAL ENGINEERING)

**Programme Specifications**

SBEHS offers the MSc (Biomedical Engineering) programme by course work mode offered in full-time. The MSc (Biomedical Engineering) can be completed within three semesters (1½ years).

**General Information**

| | |
|---|---|
| 1. Awarding Institution | Universiti Teknologi Malaysia |
| 2. Teaching Institution | Universiti Teknologi Malaysia |
| 3. Programme Name | Master of Science (Biomedical Engineering) |
| 4. Final Award | Master of Science (Biomedical Engineering) |
| 5. Programme Code | MMBC |
| 6. Professional or Statutory Body of Accreditation | MQA |
| 7. Language(s) of Instruction | English |
| 8. Mode of Study (Conventional, distance learning, etc) | Conventional (Taught Courses) |
| 9. Mode of operation (Franchise, self-govern, etc) | Self-governing |
| 10. Study Scheme (Full Time/Part Time) | Full Time |
| 11. Study Duration | Minimum : 1.5 yrs Maximum : 3 yrs |

Students are required to successfully complete a minimum of 45 credits which include at least:

| **Classification** | **Credit** |
|---|---|
| University General Elective Courses (UHA* ***3) (to choose from the list given by School of Graduate Studies) | 3 |
| General Course (UMBP 0013 Research Methodology) | 3 |
| Programme Core Courses | |
| Biomedical Measurement Technique | 3 |
| Diagnostic and Therapeutic Technology | 3 |
| Advanced Biomedical Engineering | 3 |
| Medical Informatics | 3 |

| | |
|---|---|
| Biomechanics | 3 |
| Research Methodology | 3 |
| Programme Elective Courses | |
| Anatomy and Physiology for Engineers | 3 |
| Biomedical Fluid Mechanics | 3 |
| Biostatistics | 3 |
| Medical Imaging and Image Processing | 3 |
| Health Care Technology Management | 3 |
| Neuroscience | 3 |
| Pathophysiology | 3 |
| Advance Biosignal Processing | 3 |
| Quantitative System Physiology & Simulation | 3 |
| Rehabilitation Engineering | 3 |
| Speech Processing | 3 |
| Tissue Engineering | 3 |
| Ultrasound and Electromagnetic in Medicine | 3 |
| Choose 4 courses only | 12 |
| Master Project | |
| Master Project 1 | 4 |
| Master Project 2 | 8 |
| Total Credit | 45 |

**Course Classification**

| No. | Classification | | Credit Hours | Percentage |
|---|---|---|---|---|
| **i.** | Faculty Core | Courses | 15 | 35.7% |
| **ii.** | Faculty Elective Course | | 12 | 28.6% |
| **iii.** | Master Project | | 12 | 28.6% |
| **iv.** | University General Elective Course | | 6 | 7.1% |
| **Total** | | | 45 | 100 |

**Regulation of Assessment**

| Marks | Grade | Evaluation Point | Interpretation |
|---|---|---|---|
| 90-100 | A+ | 4.00 | Excellent Pass |
| 80-89 | A | 4.00 | |
| 75-79 | A- | 3.67 | |
| 70.74 | B+ | 3.33 | Good Pass |
| 65-69 | B | 3.00 | |
| 60-64 | B- | 2.67 | Pass |
| 55-59 | C+ | 2.33 | |
| 50-54 | C | 2.00 | Fail |
| 45-49 | C- | 1.67 | |
| 40-44 | D+ | 1.33 | |
| 35-39 | D | 1.00 | |
| 30-34 | D- | 0.67 | |
| 00-29 | E | 0.00 | |

**Course Menu**

| YEAR 1: SEMESTER 1 | | | |
|---|---|---|---|
| **Code** | **Course** | **Credit** | **Pre-requisite** |
| MMBC 1003 | Biomedical Measurement Technique | 3 | |
| MMBC 1013 | Diagnostic and Therapeutic Technology | 3 | |
| MMBC 1023 | Advanced Biomedical Engineering | 3 | |
| MMBC 1**3 | Elective 1 | 3 | |
| UHA* ***3 | University General Elective Course | 3 | |
| UMBP 0013 | Research Methodology | 3 | |
| **Total Credit** | | 18 | |
| **Cumulative Credits** | | 18 | |

| YEAR 1: SEMESTER 2 | | | |
|---|---|---|---|
| **Code** | **Course** | **Credit** | **Pre-requisite** |
| MMBC 1033 | Medical Informatics | 3 | |
| MMBC 1043 | Biomechanics | 3 | |
| MMBC 1184 | Master Project 1 | 4 | |
| MMBC 1**3 | Elective 2 | 3 | |
| MMBC 1**3 | Elective 3 | 3 | |
| **Total Credit** | | 16 | |
| **Cumulative Credits** | | 34 | |

| YEAR 2: SEMESTER 1 | | | |
|---|---|---|---|
| **Code** | **Course** | **Credit** | **Pre-requisite** |
| MMBC 1198 | Master Project 2 | 8 | |
| MMBC 1**3 | Elective 4 | 3 | |
| MMBC 1184 | Master Project 1 | 4 | |
| MMBC 1**3 | Elective 2 | 3 | |
| MMBC 1**3 | Elective 3 | 3 | |
| **Total Credit** | | 11 | |
| **Cumulative Credits** | | 45 | |

| Elective Course | |
|---|---|
| **Code** | **Course** |
| MMBC 1053 | Anatomy and Physiology for Engineers |
| MMBC 1063 | Biomedical Fluid Mechanics |
| MMBC 1073 | Biostatistics |
| MMBC 1083 | Health Care Technology Management |
| MMBC 1093 | Medical Imaging and Image Processing |
| MMBC 1103 | Neuroscience |
| MMBC 1113 | Pathophysiology |
| MMBC 1123 | Advance Biosignal Processing |
| MMBC 1143 | Rehabilitation Engineering |
| MMBC 1153 | Cardiovascular Engineering |
| MMBC 1173 | Biomedical Electronic System Design |
| MMBC 1183 | Bio-Material Characterization and Analysis |
| MMBC 1193 | Genetic Engineering |
| **University Elective Course** | |
| **UH** ***3** | University Elective |

**Programme Educational Objectives (PEO)**

| Code | Intended Educational Objectives |
|---|---|
| **PEO1** | Establish themselves as practicing professionals with high responsibilities in biomedical engineering discipline. |
| **PEO2** | Function effectively and efficiently in managing an organization through effective communication skills and high ethics within the biomedical engineering network. |
| **PEO3** | Continue education through special training, professional licensure, or additional certifications; or engaged in post-graduate study towards a doctoral degree in biomedical field. |

**Programme Learning Outcomes (PLO)**

After having completed the programme, graduates should be able to demonstrate the following competencies:

| Code | Intended Learning Outcomes |
|---|---|
| **PLO1** | Ability to integrate both theory and applications of advanced biomedical engineering principles. |
| **PLO2** | Ability to adapt and utilize advanced techniques and scientific thinking skills in solving complex biomedical engineering problems. |
| **PLO3** | Ability to carry out forefront research and development biomedical engineering projects through organized and systematic approach |
| **PLO4** | Ability to evaluate and make appropriate professional decisions by taking into accounts social and environmental responsibilities, and related ethics. |
| **PLO5** | Ability to communicate effectively through rational arguments via oral and written in biomedical engineering field as well as to public |
| **PLO6** | Ability to evaluate and make appropriate professional decisions by taking into accounts social and environmental responsibilities, and related ethics |

**Graduation Checklist**

To graduate, students must pass all the stated courses in this checklist. It is the responsibility of the students to ensure that all courses are taken and passed. Students who do not complete any of the course are not allowed to graduate.

| No. | Code | Course | Credit Earned (Jkd) | Credit Count-Ed (Jkk) | Tick (√) If Passed |
|---|---|---|---|---|---|
| **Engineering Courses** | | | | | |
| **1** | MMBC 1003 | Biomedical Measurement Technique | 3 | 3 | |
| **2** | MMBC 1013 | Diagnostic and Therapeutic Technology | 3 | 3 | |
| **3** | MMBC 1023 | Advanced Biomedical Engineering | 3 | 3 | |
| **4** | MMBC 1**3 | Elective 1 | 3 | 3 | |
| **5** | MMBC 1033 | Medical Informatics | 3 | 3 | |
| **6** | MMBC 1043 | Biomechanics | 3 | 3 | |
| **7** | MMBC 1184 | Master Project 1 | 4 | 4 | |
| **8** | MMBC 1**3 | Elective 2 | 3 | 3 | |
| **9** | MMBC 1**3 | Elective 3 | 3 | 3 | |
| **10** | MMBC 1198 | Master Project 2 | 8 | 8 | |
| **11** | MMBC 1**3 | Elective 4 | 3 | 3 | |
| **12** | UMBP 0010 | Research Methodology | 3 | 3 | |
| **Total Credit** | | | 42 | 42 | |
| | | | | | |
| **University General Courses** | | | | | |
| **Kluster 1: Penghayatan Falsafah, Nilai & Sejarah (Faculty of Social Sciences and Humanities)** | | | | | |
| **1** | UHA* ***3 | University General Elective Course | 3 | 3 | |
| **Total Credit** | | | 45 | 45 | |

## COURSE SYNOPSIS

### MMBC 1003 - Biomedical Measurement Technique

**Objectives**

Identify and explain the basic and advances concept of biomedical instrumentation and measurement

Analyse physiological properties and design suitable instrumentation for specific purpose to solve biomedical engineering problems.

**Synopsis**

This course provides the students a complete exposure of various recording mechanism and biomedical parameters measured for diagnostic application. Also introduces students to design biomedical measurement systems and biomedical instrumentation. The architecture of electronic instruments used to measure physiological parameters is addressed, as well as the analysis of major process functions integrated in these instruments.

**References**

*Leslie Cromwell (1997). Biomedical Instrumentation and measurement. Prentice Hall, India, New Delhi.*

*John G. Webster (1998). Medical Instrumentation, Application and Design (3rd Ed). John Wiley.*

*Khandpur R.S (1997). Handbook of Biomedical Instrumentation Tata McGraw-Hill, New Delhi.*

*Joseph J.Carr and John M. Brown (1997). Introduction to Biomedical Equipment Technology. John Wiley and sons, NewYork.*

*Geoddes and L.E. Baker (1975).Principles of Applied Biomedical Instrumentation. John Wiley, L.A.*

*R.S. Khandpur (2003). Hand-book of Biomedical Instrumentation, TMH, 2nd Ed.*

*Mackay, Stuart R (1968). Biomedical Telemetry. John Wiley*

### MMBC 1013 - Diagnostic and Therapeutic

**Objectives**

Explain knowledge in advanced diagnostic and therapeutic technology in the clinical and hospital environment

Analyze and categorize scientific and technical knowledge for research in advanced diagnostic and therapeutic technology.

**Synopsis**

This course is designed to introduce students on how the bio-signal is measured, recorded and monitored and details on the broad collection of diagnostic and therapeutic equipments. At the end of the course, student will be able to learn various techniques that have been used in healthcare environment, clinical or research.

**References**

*Alan K. David, Scott A. Fields, D. Melessa Phillips, Joseph EScherger and Robert B. Taylor (2008). Taylor's Diagnostic and Therapeutic Challenges: A Handbook. Springer.*

*Dyro, J. F. (2004). Clinical Engineering Handbook. Elsevier.*

*Geddes, L. A., Baker, L. E. (1989). Principles of Applied Biomedical Instrumentation. Wiley Interscience.*
*Khandpur (2003). Handbook of Biomedical Instrumentation.McGraw Hill.*
*Stephen McPhee, Maxine Papadakis and Michael W. Rabow (2011). Current Medical Diagnosis and Treatment. McGraw Hil*
*Related journal papers*

**MMBC 1023 - Advanced Biomedical Engineering**

Explain advanced technology and knowledge used in medical devices to diagnose and treat patients by applying the electronics, signal processing, biomechanics medical and therapy knowledges.

**Objectives**
Design device used in diagnosis and clinical treatment by combining biological and medical science

**Synopsis**
This course provides the students with the introduction to advanced technologies of biomedical engineering in the field of bioinstrumentation, biophysics, biomaterials and biomechanics. The impact of technologies on clinical research, rehabilitation engineering, and patient care will be dealt along with professional ethics. The course explores techniques for assessing current information practices, determining the information needs of health care providers and patients, developing interventions using biomedical technology, and evaluating the impact of those interventions.

**References**
Joesph D. Bronzino (2000). The Biomedical Engineering *Handbook. CRC Press LLC.*
Dyro, J. F. (2004). Clinical Engineering Handbook.
*Geddes, L. A. and Baker, L.E. (1989). Principles of AppliedJ. F. (2004). Biomedical Instrumentation. Wiley Interscience.*
Khandpur (2003). Handbook of Biomedical Instrumentation. McGraw Hill

**MMBC 1033 - Medical Informatics**
**Objectives**
Apply medical informatics knowledge to improve the quality of health care, reduce cost, provide better education for providers and patients.

**Synopsis**
This course provides students with the organization of medical information, the effective management of information using computer technology, and the impact of such technology on medical research, education, and patient care. The course explores techniques for assessing current information practices, determining the information needs of health care providers and patients, developing interventions using computer technology, and evaluating the impact of those interventions.

**References**

*Nordin, M. & Frankel, V. (2001). Basic Biomechanics of the Musculoskeletal System. Lippincott Williams & Wilkins.*
*Humphrey, J.D. & Delange, S.L. (2003). An Introduction to Biomechanics. Solids and Fluids, Analysis & Design. Springer.*
Hall, S. J. (2003). Basic Biomechanics. McGraw-Hill Publishers Hall.
Abd Rahman Musa (2007). Statics Made Simple. Pearson Prentice Hall.
Donald R. Peterson and Joseph D. Bronzino (2008).Biomechanics: Principles and Applications. CRC Press.
T. Clive Lee & Peter Niederer (Editors) (2010). Basic Engineering for Medics and Biologists. IOS Press BV, Netherlands

**MMBC 1043 - Biomechanics**

**Objectives**

Analyze biomechanics knowledge on specific movement patterns from both anatomical and mechanical

**Synopsis**

This course provides the students with application of the principles of mechanics and the techniques of engineering to the human body. The series of lectures explore the musculoskeletal system and highlights selected applications in the area of orthopedics (gait analysis, joint replacement) and analyzing the various forms of human movement.

**References**

*Nordin, M. & Frankel, V. (2001). Basic Biomechanics of the Musculoskeletal System. Lippincott Williams & Wilkins.*
*Humphrey, J.D. & Delange, S.L. (2003). An Introduction to Biomechanics. Solids and Fluids, Analysis & Design. Springer.*
Hall, S. J. (2003). Basic Biomechanics. McGraw-Hill Publishers Hall.
Abd Rahman Musa (2007). Statics Made Simple. Pearson Prentice Hall.
Donald R. Peterson and Joseph D. Bronzino (2008).Biomechanics: Principles and Applications. CRC Press.

**MMBC 1184 - Master Project 1**

**Objectives**

To apply engineering knowledge in professional practices in overcome biomedical engineering issues.
Solve research problems and present research results logically, creatively, innovatively and analytically based on scientific facts and research experience.
Communicate effectively across a range of context and audiences.

**Synopsis**
The research project proposal emphasizes integration and application of knowledge to solve a biomedical engineering problem. The student must identify a thesis advisor, conduct preliminary research, write research proposal and make a presentation which will be evaluated. For seminar, student will attend paper presentation to expose themselves into research and to gain new knowledge.

**References**
*School of Graduate Study. UTM Thesis Manual.http://www.sps.utm.*

**MMBC 1198 - Master Project 2**

**Objectives**
To apply engineering knowledge in professional practices in overcome biomedical engineering issues.
Solve research problems and present research results logically, creatively, innovatively and analytically based on scientific facts and research experience
Communicate effectively across a range of context and audiences.
Work responsibly with specialized laboratory equipment with appropriate technical, transferable and interpersonal skills

**Synopsis**
The research project thesis emphasizes integration and application of knowledge to solve a biomedical engineering problem. The student must conduct research, document the findings and make a presentation which will be evaluated.

**References**
*School of Graduate Study. UTM Thesis Manual.http://www.sps.utm.*

**UMBP0010 - Research Methodology**

**Objectives**
To discuss the principles, various techniques, skills and process in conducting academic research.

**Synopsis**
This course covers the general principles of Research Methodology that are applicable to any discipline. It discusses the fundamental process in conducting an academic research. The theoretical and practical aspects of preparing a research proposal presented. Amongst topics that will be covered are introduction to research and its philosophy, problem formulation and research objective, literature review, research methodology and design, data collection procedures, data analysis, research proposal and thesis preparation and research management.

**References**

FSKSM ((2010). *Handbook of Research Methods in Computing*, UTM.

## ELECTIVE COURSES

### MMBC 1053 - Anatomy and Physiology for Engineers

**Objectives**

Identify and relate the structure and function of the tissue, organ, and systems in humans.

**Synopsis**

This course provides fundamental concepts of the basic structure and function of the human body as an integrated set of systems from an engineering perspective. This course will expand student's knowledge in the engineering approach toward understanding functions and by giving some engineering solutions and increasing the ability of the students to integrate between the engineering technology and multiple related medical disciplines. Engineering principles will be used to analyse anatomical structures and physiological functions at the tissue, organ, and systems levels.

**References**

*Principles of Anatomy and Physiology, 12th Edition, Gerard J. Tortora, Bryan H. Derrickson, 2009*

*Hole's human anatomy and physiology, David Shier, Jackie Butler and Ricki Lewis, McGraw-Hill, 2004*

*Essentials of anatomy and physiology, Frederic H. Martini and Edwin F. Bartholomew, Prentice Hall, 2000*

*Atlas Netter Interactive Atlas of Human Anatomy v3.0, F. Netter.Medical. CD-ROM*

### MMBC 1063 - Biomedical Fluid Mechanics

**Objectives**

Explain and categorize biomedical fluids mechanic knowledge of mass conservation, energy conservation, and momentum balance to flowing fluids to solve biomedical engineering problem and relate the structure and function of the tissue, organ, and systems in humans.
Analyze biomedical problems related to biofluid using current techniques

**Synopsis**

This course provides the students with application of the principles of mechanics and the engineering techniques which is the fluid mechanics to the biological fluid flow, in particular cardiovascular system. Other system related to biological flow will be explored such as respiratory flow, flow around body, and bird flight mechanism. By the end of the course, student should be able to understand fluid mechanics and its pertinent application to flow in the biological system – cardiovascular system, respiratory system and the likes. Other outcome of this course would be for the student to apply fluid mechanics analysis of human circulation, as well as artificial organs implanted within human body for disease treatment.

**References**

*Jagan N. Mazumdar, Biofluid Mechanics, World Scientific Publishing, 2004*
*Krishnan B. Chandran, Stanley E. Rittgers, and Ajit P. Yoganathan, Biofluid Mechanics: The Human Circulation, 2nd Edition, CRC Press, 2012*
*Megh R. Goyal, Biofluid Dynamics of Human Body Systems, Apple Academic Press, 2014*
*Biofluid Methods in Vascular and Pulmonary Systems, Biomechanical Systems Technicques and Application Volume IV, Editor : Cornelius Leondes, CRC Press LLC, 2001*

**MMBC 1073 - Biostatistics**

**Objectives**

Explain and apply biostatistics knowledge in biomedical engineering

**Synopsis**

This course provides statistical concepts and methods with emphasis on applications in clinical medicine, epidemiology and public health. This course also explores advanced biostatistical methods that have been used in designing and analyzing biomedical and public health investigations.

**References**

*Bernard Rosner (2005). Fundamental of Biostatistics. Duxbury Press.*
*Jerrold Zar (2009). Biostatistical Analysis. Pearson.*
*Leon Gordis (2004). Epidemiology. WB Saunders.*
*Douglas G. Altman (1990). Practical Statistics for Medical Research. Chapman & Hall, CRC.*

**MMBC 1083 - Health Care Technology Management**

**Objectives**

To Identify and explain the systems or procedures relating to plan and procurement, utilization and maintenance of healthcare technologies
Analyze and adapt the existing health care technology policies in health care management

**Synopsis**

This course provides the students the ability to develop a systematic process for planning and managing health technology assets to achieve the highest quality care at the best cost. It explains the concepts of health care management and describes the various types of health plan in operation today. This course also covers the strategic planning as well as technology assessment, facilities planning, procurement, and service or maintenance management.

**References**

*Dyro, J. F. (2004). Clinical Engineering Handbook. Elsevier.*
*Joseph D Bronzino and Robert J Austin-LaFrance (1992). Management of medical technology: a primer for clinical engineers, Boston: Butterworth-Heinemann.*

*David Y, Judd T (1993). Medical technology management, Redmond, WA, SpaceLabs Medical, INC.*

**MMBC 1093 - Medical Imaging and Image Processing**

**Objectives**
To apply the techniques in image major by using image analysis knowledge.

**Synopsis**
This course provides students with an overview of the key concepts behind the main imaging modalities used in diagnostic imaging. The course also introduces students in the basic concepts and methods for image analysis and processing in biomedical engineering and medical physics as well as the use of basic software for image analysis and processing in biomedical engineering and medical physics.

**References**
*Gonzalez, Rafael C., and Richard E. Woods. "Digital image processing prentice hall." Upper Saddle River, NJ (2002).*
*Gonzalez, Woods, and Richard E. Woods. "Eddins, Digital Image Processing Using MATLAB." Third New Jersey: Prentice Hall (2004).*
*Suri, Jasjit S., David Wilson, and Swamy Laxminarayan, eds. Handbook of biomedical image analysis. (Vol 1) Springer Science & Business Media, 2005.*
*Suri, Jasjit S., David Wilson, and Swamy Laxminarayan, eds. Handbook of biomedical image analysis. (Vol 2) Springer Science & Business Media, 2005.*
*Suri, Jasjit S., David Wilson, and Swamy Laxminarayan, eds. Handbook of biomedical image analysis. (Vol 3) Springer Science & Business Media, 2005.*
*Isaac. N. Bankman, "Handbook of Medical Imaging, Processing and Analysis", Academic Press, 2000.*

**MMBC 1103 - Neuroscience**

**Objectives**
To analyze on various techniques, skills and modern equipment used in neuroscience.

**Synopsis**
This Neuroscience course is a comprehensive introduction to the mammalian nervous system, focusing on the structure and function of the human brain. Anatomical, cellular, chemical, physiological, and molecular aspects of neuroscience will be discussed. Topics that will be covered include: neurons and glia, neuroanatomy, action potentials, synaptic transmission, neurotransmitters, sensory systems (vision, hearing, and touch), motor systems, behavioral responses, development, learning and memory, aging, mental illness, neurodegenerative diseases, and genomics. An inquiry-based approach will be taken to facilitate student learning of the material.

**References**

*Bear, Mark F., Barry W. Connors, and Michael A. Paradiso. Neuroscience: Exploring the Brain. 3rd ed. Baltimore, Md.: Lippincott Williams & Wilkins, 2001. ISBN: 0-7817-6003-8.*

*Kandel, Eric R., James H. Schwartz, and Thomas M. Jessell. Principles of Neural Science. 4th ed. New York: McGraw-Hill, 2000. ISBN: 0-8385-7701-6. This textbook is recommended.*

*Dale Purves, George J. Augustine, David Fitzpatrick , William C. Hall, Anthony-Samuel Lamantia , James O. McNamara , Leonard E. White (2007). Neuroscience. Sinauer Associates Inc., U.S.*

*Larry R. Squire, James L. Roberts, Nicholas C. Spitzer, Michael J. Zigmond, Susan K. McConnell, Floyd E. Bloom (2002). Fundamental Neuroscience. Academic Press.*

## MMBC 1113 – Pathophysiology

**Objectives**

To attain and apply knowledge in the field of pathophysiology and how to use advanced techniques to provide solution or innovative practice

**Synopsis**

This course provides concepts of physiology of altered health state,
specifically, the changes that accompany injury, syndrome or diseases. Clinical features will be described to provide an overview of pathological aspects of common physiological disorders in human body. Discussion on the basis of the illustration of the systemic approach for understanding diseases and rational therapeutic design of their diagnosis/treatment through an engineering approach will be addressed in this course.

**References**

*Carol M Porth (2010). Essentials of Pathophysiology Concepts of Altered Health States,3rd Edition.*

*Pathophysiology: Functional Alterations in Human Health By CarieA. Braun,Cindy Anderson(2007)*

*Carie A Braun, RN Cindy M Anderson (2010). Pathophysiology A Clinical Approach 2nd edition.*

*Mary V. Burns (1998). Pathophysiology: A Self Instructional Program, Prentice Hall.*

*Wheater's Functional Histology: A Text and Colour Atlas, 5Th Edition (2006) Barbara Young, James S. Lowe, Alan Stevens, and John W. Heath*

## MMBC 1123 – Advanced Biosignal Processing

**Objectives**

To explain concepts of signal processing and apply signal processing tools from various sources in standard medical devices to solve biomedical engineering problems

**Synopsis**

This course presents two fundamental concepts of signal processing: linear systems and stochastic processes. Various estimation, detection and filtering methods are taught and

demonstrated on biomedical signals. All methods will be developed to answer concrete question on specific biomedical signal such as ECG, EEG and etCO2. The focus of the course is a series of labs that provide practical experience in processing biomedical data, with examples from cardiology, neurology, respiratory and speech processing.

**References**

*Introduction to Biomedical Engineering, Second Edition by John Enderle, Publisher: Elsevier Academic Press, ISBN: 0-12-238622-0*

*Biomedical Signal Processing: Principles and Technique, D. C. Reddy, McGraw-Hill Publishing Company Limited, ISBN: 0-07-058388-9*

**MMBC 1143 – Rehabilitation Engineering**

**Objectives**

To apply knowledge, concepts and methods in rehabilitation engineering and adapt current technical concepts and practices for optimal outcomes issues pertaining to rehabilitation engineering

**Synopsis**

This course will focus on the principles and application of rehabilitation sciences & assistive technology from the rehabilitation engineering perspective. It aims to provide the students with in depth understanding pertaining important issues in rehabilitation engineering and equip students with knowledge and skills for the application of science, technology and engineering to the design and development of assistive (adaptive) technology and rehabilitation systems. It will also provide students with an understanding of the nature of problems confronting people with disabilities and an ability to provide technical solutions for these problems. Interdisciplinary interaction and teamworking for optimal disability management will be stressed, with emphasis being given to the role of the rehabilitation engineering professional in the team.

**References**

*Cook and Hussey's Assistive Technologies: Principles and Practice Albert M. Cook and Janice Miller Polgar Publisher: Mosby; 3 edition (September 19, 2007)*

*Rehabilitation Engineering Applied to Mobility and Manipulation Rory A Cooper, Publisher: Taylor & Francis; 1 edition (January 1, 1995)*

*Aaos Atlas of Orthoses and Assistive devices, JOHN D. HSU, JOHN MICHAEL , JOHN FISK Publisher: Mosby; 4 edition (June 24, 2008)*

*An Introduction to Rehabilitation Engineering, Cooper, Rory A., Hisaichi Ohnabe, and Douglas A. Hobson Publisher: Taylor & Francis; 1 edition (December 26, 2006)*

*Intelligent Systems and Technologies in Rehabilitation Engineering Teodorescu, Horia-Nicolai L., and Lakhmi C. Jain Publisher: CRC Press; 1 edition (December 26, 2000)*

**MMBC 1153 – Cardiovascular Engineering**

**Objectives**

To adapt the basic anatomical and cardiovascular principles in the teaching and coaching of existing cardiovascular diagnostic skills in producing scientific research and to signal processing tools from various sources in standard cardiovascular devices

**Synopsis**

Cardiovascular Engineering integrates physiology, cell and molecular biology, bioelectricity and biomechanics to describe, understand, and re-engineer the cardiovascular systems. The objective of this course is to provide the students with tools for modeling and understanding of cardiovascular disease development and treatment, and for designing appropriate systems and devices for diagnosis and intervention.

**References**

Ned H. C. Hwang. (2010). Advances in Cardiovascular Engineering. NATO ASI series, Springer; 1 edition (February 28, 1993).
Guccione, Julius M.; Kassab, Ghassan S.; Ratcliffe, Mark B. (Eds.) 2010. Computational Cardiovascular Mechanics Modeling and Applications in Heart Failure. Springer.
Dhanjoo N. Ghista (2008). Cardiovascular Engineering: Protheses, assist and artificial organs. University of Michigan.
Ajit Yoganathan. Cardiovascular Engineering and Technology. Springer.

**MMBC 1173 Biomedical Electronic System Design**

**Objectives:**

To construct front-end biomedical sensors and transducers with amplifiers, filters and analog to digital converters and to design a back-end digital computation system targeted for biomedical or health care application from high level algorithm down to low level architecture implementation.

**Synopsis:**

Biomedical Electronic system design covers the design scope from front-end analog circuit design down to back-end digital computation architecture design to form a complete system targeted for biomedical or health care application. The front-end analog circuit design includes signal acquisition and conditioning circuit design, which involves amplifier, analog filter, analog to digital converter and so on. On the other hand, the back-end digital system design involves the design methodology from high-level algorithm down to low-level computing architecture using Register Transfer Level (RTL) design approach to generate a synthesizable circuit. The digital system will be verified in terms of simulation or prototyping on Field Programmable Gate Array (FPGA) platform.

**References:**

*C. Raja Rao, Sujoy K. Guha, Principles of Medical Electronics and Biomedical Instrumentation, Universities Press, 2001.*

*Claudio Becchetti, Alessandro Neri, Medical Instrument Design and Development: From Requirements to Market Placements, John Wiley & Sons, 2013.*

*John G. Webster, Amit J Nimunkar, Medical Instrumentation: Application and Design, Edition 5, Wiley, 2020.*

*Zainalabedin Navabi, Verilog Digital System Design: RT Level Synthesis, Testbench and Verification, Second Edition, McGraw-Hill, 2006.*

*Stephen Brown and Zvonko Vranesic, Fundamentals of Digital Logic With Verilog Design, 3rd edition, McGraw-Hill Education, 2013.*

*Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Second Edition, Prentice Hall, February 21, 2003.*

## MMBC 1183 Bio-Material Characterization and Analysis

**Objectives**

To introduce basic principle of material's characterization instruments in characterizing biomaterials and to adapt suitable characterization instruments to analyze specific physico-chemical properties of biomaterials

**Synopsis**

This course is intended to expose the students with the most important characterization instruments to analyze the physico-chemical properties of biomaterials. A range of advanced techniques for the materials characterization analysis, including materials composition, surface morphological, thermal, spectroscopy and chromatography analyses are introduced by discussing the basic underlying principle and the analysis procedures. Several case studies and recording data are evaluated and analyzed to improve the student's understanding in selecting types of characterization instruments in analyzing biomaterials. Depending on the availability and functionality of instruments, lab visits and demonstrations will be scheduled following the class.

**References**

*Yang Leng, 2008, Materials Characterization – Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons Pte Ltd*

*D.O. Northwood, T. Rang, J. De Hosson & C.A. Brebbia, 2018, Materials Characterisation, WIT Press*

*J. Richard Brundle, Charles A. Evans, Jr & Shaun Wilson, 1992, Encyclopedia of Materials Characterization, Elsevier*

**MMBC 1193 Genetic Engineering**

**Objectives**

To interpret the concept of genetic engineering including the techniques, applications and limitations and to demonstrate the ability to design recombinant molecules and their functions.

**Synopsis**

This course will provide students with the recent knowledge of genetic engineering. Participants are given information related to cellular and molecular function and those responsible for DNA transcription and translation processes. Additionally, this course will focus on recombinant DNA technology, DNA manipulation, transgenic animals, and the ethics of genetic engineering. The participants will be equipped with basic emphasis on assembling a gene for expression in a cell. More advanced studies of genes appear in high-level classes and may include subjects such as Mendelian genetics, speciation, and evolutionary genetics. This course also equips the participants with social responsibility and ethics for the development of effective genetic manipulation for beneficial purpose.

**References**

*Nicholl D.S.T. (2008) An Introduction to Genetic Engineering, 3rd Edition, Cambridge University Press.*

*Rastogi S., and Pathak N. (2009) Genetic Engineering, New Delhi: Oxford University Press.*

*Fridell R. (2006) Genetic Engineering, Minneapolis: Lerner Publications Group.*