Healthcare Engineering and Management (HEM)

Based on Credit Hours System (CHS)

2018

1. INTRODUCTION (Statement of Purpose)

Healthcare Engineering and Management (HEM) is involved in all aspects of healthcare systems. Healthcare industry is one of the world's largest and fastest-growing industries. Healthcare development, assimilation of population growth and meeting increasing demand for healthcare services cannot be achieved without expertise in HEM.

Egypt -with its unique geographic location and available expertise- could play a significant role in the healthcare sector nationally, regionally and internationally. In response to the increasing national/international demand, the Faculty of Engineering at Cairo University, the pioneer in introducing biomedical engineering nationally as an undergraduate program, is proposing to establish a bachelor degree program in HEM based on the credit-hours system (CHS) of education. This program will prepare the graduates to improve the healthcare industry.

2. PROGRAM MISSION

The mission of the HEM program at Cairo University is to provide the highest standard of excellence in higher education and to pursue continuous quality improvement of various engineering and management aspects in the healthcare field.

The main goal of the program is to provide the community with graduates capable of effectively using relevant scientific and technical knowledge in digital healthcare. Problem-solving capabilities, teamwork, and communications skills developed by the graduates of HEM program will contribute to qualify the healthcare facilities for accreditation.

The HEM program supports this goal via empowering students with appropriate curriculum that would be amenable to continuous development and improvement. Students shall develop necessary knowledge and skills to understand the impact of HEM solutions in a global, societal, and cultural context.

The bachelor's degree program in HEM offers a highly structured plan during the first six semesters and a relatively flexible one during the last four semesters. This is achieved by offering an assortment of elective courses during the senior phase that will further shape the student's readiness to serve in real-life employment tracks. The HEM program provides both laboratory-based curriculum that combines hands-on practice with the appropriate basic medical and engineering theories, as well as managerial and clinical engineering basics necessary for upgrading the healthcare sector.

3. ASSESSMENT OF MARKET NEEDS

Educational programs are planned to meet the job market needs and fulfill national and/or regional strategic plans. In the healthcare area, the Egyptian government has several development plans aiming at enhancing the healthcare capabilities and reducing the associated cost. This is expected to raise the need for the HEM graduates required to implement such plans, which would drastically enhance the overall employability of HEM graduates. However, such program is not currently available in public and private universities in Egypt.

The HEM program has been preceded by a thorough investigation of market needs. The planning details of the HEM are carried out in view of the following important main contexts:

- The actual needs of the healthcare field in Egypt and regional countries to the expertise of HEM graduates.
- National strategic plans, which emphasize maintaining and/or enhancing Egypt's regional leadership.

In an effort to assess job market needs and required graduate qualifications, experts from governmental, industrial as well as private healthcare agencies, were surveyed to obtain their feedback. The feedback highlighted the need to provide multiple skills and knowledge such as creativity, ethical and legal knowledge, marketing and management skills. These market needs are now reflected in the proposed HEM program. The feedback also elucidated the need to improve the knowledge and skills required for some specific specialties such as hospital planning, healthcare facility management and practical training.

Due to the increasing complexity of the healthcare system and the associated technological, economic, social, and regulatory impacts, HEM will play a critical role in various aspects of healthcare. Accordingly, the demand for HEM professionals is expected to grow. This increase in demand is further stressed by national plans to enhance the level of healthcare services. The increasing need for healthcare engineers was stressed by the Minister of Higher Education in the workshop "Evaluation of Private Engineering Institutes" that was held at Cairo University, Faculty of Engineering (CUFE) on May 6th, 2017. The HEM program is thus carefully designed to meet international standards and to provide a competitive edge to graduates in the l regional healthcare market.

4. PROGRAM OBJECTIVES

The HEM program is designed to address all the aforementioned needs. The offered courses address applied and industry-related needs. In brief, the HEM program addresses and supports national plans and needs in the next decades.

The HEM program aims at fulfilling the following objectives:

1. Providing fundamental knowledge required for practicing high quality HEM.
2. Scientific principles, rigorous analysis, and creative design necessary for advanced study in HEM system.
3. Providing knowledge of important current issues (state of the art) in HEM, that are necessary for productive careers in both public and private sectors, and for the pursuit of graduate education.
4. Qualifying graduates for local, regional (particularly, in the Arab and African regions) and international markets.
5. Developing high communication skills, and emphasizing professional attitudes and ethics, so that graduates are prepared for complex modern work environments and lifelong learning.
6. Providing an environment that enables students to pursue their goals in an innovative program that is rigorous, challenging, open, and supportive.

5. PROGRAM LEARNING OUTCOMES

In addition to the general attributes of Engineering, the following academic reference standards represent the expectations about the qualifications attributes and capabilities that the graduates of the HEM should be able to demonstrate.

5.1 Knowledge and Understanding

On successful completion of the program, the graduates must be able to demonstrate knowledge and understanding of:

a1. Concepts, principles and theories relevant to HEM,
a2. Applied science, mathematics and the technological base relevant to HEM,
a3. The constraints within which the engineering judgment will have to be exercised,
a4. Decompose large complex systems in HEM into simpler subsystems,
a5. Basic medical, electrical, mechanical, control, computer, clinical engineering, management and auditing,
a6. Applying technology advancements for acquiring, analysing and processing of medical data, signals and images/scans providing support to Healthcare industry,
a7. Management and business techniques and practices appropriate to Healthcare society.

5.2 Intellectual Skills

On successful completion of the program, the graduates must be able to:

b1. Adopt creative and innovative thinking in solving problems, and in designing products, systems, components and processes,
b2. Apply the principles of mathematics, science and technology in problem solving scenarios in HEM fields,
b3. Analyse and interpret data, and design experiments to obtain primary data,
b4. Design systems, components and processes to meet specific needs,
b5. Evaluate and appraise designs, processes and products, and propose improvements,
b6. Assess risks, and take appropriate steps to manage these risks,
b7. Interpret numerical data and apply analytical methods for design purposes,
b8. Use the principles of engineering science in developing solutions to practical Biomedical Engineering problems,
b9. Create new engineering components and processes through the synthesis of ideas from a range of sources,
b10. Use computational tools and software packages pertaining to the discipline and develop required healthcare computer applications.

5.3 Practical and Professional Skills

On successful completion of the program, the graduates must be able to:

c1. Use a wide range of analytical and technical tools, techniques and equipment, including pertinent software.
c2. Prepare engineering drawings, computer graphics and specialized technical reports, and communicate accordingly.
c3. Carry out specialized engineering designs

c4. Employ the traditional and modern CAD and CAD/CAM facilities in design and production processes.
c5. Use basic workshop equipment safely.
c6. Understand and apply safe systems at work.
c7. Analyze experimental results and determine their accuracy and validity.
c8. Use laboratory equipment and related computer software.
c9. Demonstrate basic organizational and project management skills.
c10. Operate and maintain Biomedical Engineering departments in Healthcare society.
c11. Refer to relevant literature effectively.

5.4 General Transferable Skills

On successful completion of the program, the graduates must be able to:

d1. Communicate effectively, apply IT technologies, and develop skills that are life enriching and have value in other occupations.
d2. Present data/results in alternative forms for better understanding and/or greater impression, and utilize appropriate level of delivery.
d3. Communicate effectively the information in verbal and writing.
d4. Develop systematic thinking skills to solve general problems and identify critical factors.
d5. Evaluate given information and derive practical and new solutions.
d6. Perform efficiently in multi-disciplinary teams.
d7. Understand the usage of common IT tools.
d8. Realize the need for life-long learning and develop aptitude for continuous and independent learning of new concepts and information.

6. PROGRAM DESCRIPTION

To meet the HEM program educational objectives, a set of intended learning outcomes has been adopted. Those outcomes fall in line with the criteria set by reputable international accrediting bodies.

The HEM program offers courses related to the areas of Biomedical Engineering, electronics, industrial automation, as well as computer engineering and communications. By the end of the program, students are expected to gain deep knowledge and skills in Healthcare Engineering and Management, managerial systems for healthcare units, automation of healthcare systems and to be able to qualify healthcare units for national and international accreditation. Students are expected to complete the degree requirements in 10 semesters.

6.1 Curriculum Overview

The curriculum of the HEM program consists of 175 credits spread over 67 courses covering topics in Humanities and Social Sciences (HSS), Basic Sciences (BS), Engineering Sciences (ES), and Applied Engineering Sciences (AS) as required by the Supreme Council of Universities (SCU).

The curriculum of the HEM program is devoting special attention to issues that are capturing worldwide attention such as:

- Automated clinics and hospitals
- National / International Accreditation
- Global electronic patient record
- Remote medicine

The curriculum includes courses in engineering fundamentals such as electronics, circuit analysis, communication, automatic control, logic design, data structures and algorithms, advanced mathematics, physics, and microprocessors. Furthermore, the curriculum covers needed medical backgrounds such as anatomy, physiology, biochemistry, genetics and biology. Humanities such as economics, management, auditing and psychology are highly covered. In the specialized area, advanced and detailed courses are offered.

6.2 General (University) Requirements

The main purpose of a university education is not only to prepare students for successful careers but also to provide them with the knowledge and skills to develop a rational, well-rounded and successful personal identity. Moreover, Cairo University helps students to gain an appreciative understanding of the natural and cultural environments in which they live and their roles in the society and community services.

The general (university) requirements of the CHS bachelor programs consist of 19 credits (10.9% of total 175 credits), satisfied by completing ten (10) courses:

1. Seven (7) compulsory courses equivalent to 13 credits (7.4%), as listed in Table 1a.
2. Three (3) elective courses equivalent to 6 credits (3.4%), as listed in Table 1b.

Table 1a Compulsory Courses of General (University) Requirements (13 credits, 7.4% of total 175 credits)

	Code	Course Title	Credits
1	GENN001	History of Science and Engineering	1
2	GENN004	Computers for Engineers	2
3	GENN101	Technical Writing	2
4	GENN102	Fundamentals of Management	2
5	GENN201	Communication and Presentation Skills	2
6	GENN210	Risk Management and Environment	2
7	GENN224	Concepts of Economics and Accounting	2

Table 1b Elective Courses of General (University) Requirements (6 credits, 3.4% of total 175 credits)

	Code	Course Title	Credits	Group
1	GENN301	Ethics and Legislation	2	E-1(1)
2	GENN303	Critical Thinking	2	
3	GENN305	Interdisciplinary Project	2	
4	GENN310	Advanced Risk Management	2	
5	GENN311	Technical Writing in Arabic	2	
6	GENN321	Foreign Language	2	
7	GENN326	Marketing	2	
8	GENN327	Selections of Life-long Skills	2	
9	GENN328	Scientific Research Methods		
10	GENN331	Business Communication	2	
11	GENN332	Service Management	2	

Remarks:

(1) Student selects at least three (3) courses equivalent to six credits such that one of the three courses should be GENN303

6.3 College Requirements

College requirements provide students with the knowledge and skills that are essential to develop a successful engineer. A college core that is common to all credit hours programs is implemented. This unified college core contains two categories of courses. The first category of college core courses includes courses of basic knowledge essential to all engineering graduates such as Mathematics, Physics, Mechanics, Graphics and Design, Manufacturing, and Chemistry. The second category includes courses that all students are required to undertake in order to develop certain intended learning outcomes common to all engineering graduates, such as Seminar, Industrial Training, and Graduation Project courses.

The college requirements of the CHS bachelor programs consist of 44 credits (25.1% of total 175 credits), which are satisfied by completing eighteen (18) compulsory courses, as listed in Table 2.

Table 2 Compulsory Courses of College Requirements
(44 credits, 25.1% of total 175 credits)

	Code	Course Title	Credits
1	CHEN 001	Chemistry	3
2	GENN 003	Basic Engineering Design	2
3	MDPN 001	Engineering Graphics	3
4	MDPN 002	Fundamentals of Manufacturing Engineering	3
5	MECN 001	Mechanics-1	2
6	MECN 002	Mechanics-2	2
7	MTHN 001	Introduction to Linear Algebra and Analytic Geometry	3
8	MTHN 002	Calculus I	3
9	MTHN 003	Calculus II	3
10	MTHN 102	Multivariable Calculus and Linear Algebra	3
11	MTHN 203	Probability and Statistics	3
12	PHYN 001	Mechanics, Oscillations, Waves and Thermodynamics	3
13	PHYN 002	Electricity and Magnetism	3
14	HEMN 280	Engineering Seminar	1
15	HEMN 281	Industrial Training-1	1
16	HEMN 381	Industrial Training-2	2
17	HEMN 480	Graduation Project-1	1
18	HEMN 481	Graduation Project-2	3

6.4 Discipline Requirements

The HEM program is a new bachelor program based on the credit hours system under the umbrella of Systems and Biomedical Engineering Department. The discipline requirements consist of 60 credits (34.3% of total 175 credits), which are satisfied by completing twenty (21) courses, as listed in Table 3. Nine (6) of these courses are interdisciplinary courses (coded by CMP, ELC, MTH), which are equivalent to 18 credits (10.3%). All the discipline core courses are compulsory.

Table 3 Compulsory Courses of Discipline Requirements: Biomedical Engineering (60 credits, 34.3% of total 175 credits)

	Code	Course Title	Credits
1	MTHN103	Differential Equations	3
2	ELCN103	Circuit Analysis	3
3	ELCN123	Basic Electronics & Digital Design	3
4	CMPN102	Data Structures & Algorithms	3
5	CMPN103	Programming Techniques	3
6	HEMN130	Basics of Computer Architecture	3
7	HEMN230	Database Systems for Medical Data	3
8	CMPN203	Software Engineering	3
9	HEMN330	Embedded Systems in Medical Equipment	3
10	HEMN113	Anatomy & Physiology for Engineers	3
11	HEMN115	Introduction to Biomedical Engineering	2
12	HEMN121	Biosignals and Systems	2
13	HEMN123	Medical Physics	3
14	HEMN216	Analytical & Lab Instruments	3
15	HEMN223	Measurements & Quantitative Experimentation	3
16	HEMN226	Medical Monitors & Life Support Equipment	3
17	HEMN224	Computer Graphics & Visualization	3
18	HEMN227	Clinical Engineering	2
19	HEMN311	Biomedical Signal Processing	3
20	HEMN316	Medical Device Technologies	3
21	HEMN416	Medical Imaging Modalities	3

6.5 Major Requirements

The program offers a major specialty in Healthcare Engineering and Management (HEM), which requires the successful completion of at least 52 credits (29.7% of total 175 credits). These are satisfied by completing nineteen (19) courses as follows:

1. Thirteen (13) compulsory courses equivalent to 37 credits (21.1%), as listed in Table 4.
2. Five (5) elective courses equivalent to 15 credits (8.6%), as listed in Table 5.

Table 4 Compulsory Courses of Major Requirements: (37 credits, 21.1% of total 175 credits)

	Code	Course Title	Credits
1	HEMN125	Requirements Engineering for Digital Health	2
2	HEMN213	Biomedical Transducers	3
3	HEMN215	Entrepreneurship in Healthcare Industry	2
4	HEMN314	Medical Distributed Application Development	3
5	HEMN315	Quantitative Management	3
6	HEMN323	HealthCare Information Systems (HCIS)	3
7	HEMN324	Medical Image Processing & Computer Vision	3
8	HEMN325	Biomedical Systems Modeling & Simulation	3
9	HEMN328	Medical Device Standards	3
10	HEMN417	Healthcare Facilities Planning and Design	3
11	HEMN419	Operations Research in Healthcare	3
12	HEMN428	Medical QA and Accreditations	3
13	HEMN429	Biomedical Data Analytics	3

Table 5 Elective courses of Major Requirements:
(15 credits, 8.6% of total 175 credits)

	Code	Course Title	Credits	Group
1	HEMN331	Bioinformatics I	3	
2	HEMN332	Biomechanics I	3	
3	HEMN333	Human Factor Engineering	3	
4	HEMN334	Usability Engineering in Healthcare	3	
5	HEMN335	Medical Expert Systems	3	
6	HEMN336	Telemedicine Technologies	3	
7	HEMN337	Clinical Decision Support Systems	3	
8	HEMN370	Introduction to Nano-Biosensors	3	
9	HEMN431	Bioinformatics II	3	
10	HEMN432	Biomechanics II	3	
11	HEMN433	Virtual & Augmented Reality	3	
12	HEMN434	Introduction to Big Data	3	
13	HEMN435	Introduction to Deep Learning	3	
14	HEMN436	Medical Robotics I	3	
15	HEMN437	Medical Robotics II	3	
16	HEMN438	Rehabilitation Robotics	3	
17	HEMN439	Stochastic Processes	3	E-2(1)
18	HEMN440	Magnetic Resonance Imaging	3	
19	HEMN441	X-Ray imaging Modalities	3	
20	HEMN442	Ultrasound Imaging	3	
21	HEMN443	Nuclear Medicine	3	
22	HEMN444	Point-Of-Care Equipment	3	
23	HEMN448	Quantitative Functional Imaging	3	
24	HEMN450	Neuroengineering	3	
25	HEMN451	Medical Pattern Recognition	3	
26	HEMN452	Neural Networks for Biomedical Applications	3	
27	HEMN453	Surgery for Engineers	3	
28	HEMN454	Data Mining and Machine Learning in Healthcare	3	
29	HEMN455	Introduction to Health Care and Public Health in Egypt	3	
30	HEMN460	Statistics II	3	
31	HEMN465	Internet of Medical Things (IoMT)	3	
32	HEMN466	Business Process Mining and Enterprise Architecture	3	
33	HEMN470	Medical Optics	3	

Remarks:
(1) Student selects at least five courses equivalent to 15 credits subject to the AA approval.

6.6 Conformity to SCU Requirements

The classification and categorization of the courses offered by the Healthcare Engineering and Management (HEM) program follow the guidelines provided by the Supreme Council of Universities (SCU), as shown in Table 6. The classification is based upon the "Sample Study Plan and Course Sequence" described in Section 7. The categorization is given for the following five student levels according to the regulations of the credit hours system of education at the Faculty of Engineering, Cairo University:

- **Freshman**: a student who completed less than 36 credits,
- **Sophomore**: a student who completed more than 35 credits but less than 72 credits,
- **Junior**: a student who completed more than 71 credits but less than 108 credits,
- **Senior-1**: a student who completed more than 107 credits but less than 144 credits,
- **Senior-2**: a student who completed more than 143 credits.

Table 6 Conformity to Supreme Council Criterion

Category	Freshman	Sophomore	Junior	Senior-1	Senior-2	Total Credits	%
Humanities and Social Sciences	3	4	6	2	4	19	10.9
Basic Sciences	22	11	4	3	0	40	22.9
Engineering Sciences	10	10	17	15	3	55	31.4
Applied Engineering Sciences	0	12	7	14	28	61	34.9
Total	35	37	34	34	35	175	100
General (University) Requirements	5	4	4	2	4	19	10.9
College Requirements	30	3	5	2	4	44	25.1
Discipline Requirements	0	28	20	9	3	60	34.3
Major Requirements	0	2	5	21	24	52	29.7
Total	35	37	34	35	35	175	100

The HEM program consists of 67 courses: 60 compulsory courses (158 credits) and 7 elective courses (19 credits). The total 175 credits of the program are distributed between lectures (LEC) and tutorials (TUT), where a tutorial is classified as a problem-solving session (PSS) and/or a practical work/laboratory session (PLS). The one credit of a tutorial corresponds to 2-3 hours to provide sufficient practical training for the students. Thus, the total contact hours of learning are around 272 hrs.

7. SAMPLE STUDY PLAN and COURSE SEQUENCE

A sample study plan for the HEM program is presented as one recommended sequence to complete the graduation requirements of the bachelor program over 10 main semesters, the Fall and Spring semesters per academic year. Since the program is based on the credit hours system of education, the student does not have to take the courses during the semester indicated in the study plan as long as the course prerequisites are satisfied.

The HEM curriculum encourages students to interact with the industrial sector and government agencies by offering two industrial training courses in at least two summer sessions. In addition, the curriculum gives the student the opportunity to select courses from a number of electives. The students will be trained on teamwork and be exposed to projects about Healthcare Engineering and Management (HEM) during their practical training and graduation projects.

Freshman Year Course Schedule

	Semester-1: Fall		Semester-2: Spring	
	Course Code	CR	Course Code	CR
1.	MECN001	2	MECN002	2(1)
2.	MTHN001	3	CHEN001	3
3.	MTHN002	3	MTHN003	3(2)
4.	PHYN001	3	PHYN002	3
5.	MDPN001 OR MDPN002	3 OR 3	MDPN002 OR MDPN001	3 OR 3
6.	GENN001 OR GENN101	1 OR 2	GENN101 OR GENN001	2 OR 1
7.	GENN004 OR GENN003	2 OR 2	GENN003 OR GENN004	2 OR 2
Semester Credit Hrs.		17 or 18		17 or 18

Remarks:

(1) Course MECN002 has a prerequisite course MECN001

(2) Course MTHN003 has a prerequisite course MTHN002

HEM Program Study Plan

	Semester-3: Fall		Semester-4: Spring		Semester-5: Fall		Semester-6: Spring	
	Course Code	CR	Course Code	CR	Course Code	CR	Course Code	CR
1.	GENN102	2	GENN201	2	GENN210	2	GENN224	2
2.	MTHN102	3	MTHN103	3	MTHN203	3	HEMN281(0)	1
3.	ELCN103	3	CMPN103	3	HEMNN280	1	CMPN203	3
4.	CMPN102	3	HEMN121	3	HEMN230	3	HEMN223	3
5.	HEMN130	3	ELCN123	3	HEMN213	3	HEMN224	3
6.	HEMN113	3	HEMN123	3	HEMN215	2	HEMN226	3
7.	HEMN115	2	HEMN125	2	HEMN216	3	HEMN227	2
Semester Credit Hrs.		18		19		17		17

	Semester-7: Fall		Semester-8: Spring		Semester-9: Fall		Semester-10: Spring	
	Course Code	CR	Course Code	CR	Course Code	CR	Course Code	CR
1.	GENN303	2	HEMN381(0)	2	GENN3XX(1)	2	GENN3XX(1)	2
2.	HEMN311	3	HEMN323	3	HEMNN480	1	HEMNN481	3
3.	HEMN330	3	HEMN324	3	HEMN416	3	HEMN428	3
4.	HEMN314	3	HEMN325	3	HEMN417	3	HEMN429	3
5.	HEMN315	3	HEMN328	3	HEMN419	3	HEMN4xx(2)	3
6.	HEMN316	3	HEMN3xx(2)	3	HEMN4xx(2)	3	HEMN4xx(2)	3
7.					HEMN4xx(2)	3		
Semester Credit Hrs.		17		17		18		17

Remarks:
(0) training courses to be completed in the summer sessions
(1) General elective course (Group E-1, Table 1b, 2 credits per course).
(2) Major elective course (Group E-2, Table 5, 3 credits per course).

8. COURSE Descriptions (Credits: Total Credit (Lecture+Tutorial+Lab))

8.1 General (University)-Core Courses

GENN001	**History of Science and Engineering** **Compulsory, Credits: 1 (1+0+0)** **Prerequisite(s): None** History of Technology: Engineering and technology in a cultural, social, and historical context. Development of technology as a key to history of civilization in a comparative perspective - Exploring Humanities: Modes of thought found within humanities and social sciences. Humanities for Engineers: Humanities themes of increased complexity - Different work methodologies - Critical analysis of information & choice of argumentation - Work methodologies and pedagogical interest.
GENN004	**Computers for Engineers** **Compulsory, Credits: 2 (1+0+3)** **Prerequisite(s): None** Developing basic concepts of algorithmic thinking to solve problems of relevance in engineering practice and implementing these algorithms using high-level computer language. Using data types, input/output commands, loops, control structures, functions, arrays, and other programming language constructs in a computer program. Evaluating and interpreting the results of programming work.
GENN101	**Technical Writing** **Compulsory, Credits: 2 (1+1+0)** Discovering and outlining ideas. Organizing outlines. Ways To begin the three parts of technical writing. Writing abstracts, summaries, and conclusions of long reports. The thesis statements. Forms: letters, memos, reports, scientific articles, job description, CV, references and footnotes. Selection of key words, titles, and subtitles. Editing, revising and proofreading techniques. Electronic word processing and technical writing, vocabulary building, and basic types and patterns of argument.
GENN102	**Fundamentals of Management** **Compulsory, Credits: 2 (1+1+0)** **Prerequisite(s): 28 credits** Introduction to management, Historical view and evolution of concepts. Basic Managerial Functions: Planning, Strategies, Objectives, MBO; Organizing, Departmentation, Job Description; Elements of Human Resource Management: Staffing, Directing, Controlling. Total Quality Management, Continuous Improvement. Engineering Applications.
GENN201	**Communication and Presentation Skills** **Compulsory, Credits: 2 (1+1+0)** **Prerequisite(s): GENN101** Analyzing the audience. Selecting presentation topics and objectives. Recognizing different types of speeches and presentations. Overcoming nervousness and developing confidence while addressing an audience. Researching and generating information for informative presentations. Chucking presentation content. Designing effective visual aids. Using explicit and effective transitions throughout a presentation. Creating benefit statements for persuasive presentations. Using persuasive devices such as pathos and logos in speeches. Planning and delivering informative, persuasive, entertaining and inspiring presentations. Handling question and answer sessions effectively.

GENN210	**Risk Management and Environment** **Compulsory, Credits: 2 (1+1+0)** **Prerequisite(s): GENN102** Risk Management: Introduction. Risk Definition. Basic Axioms Behind Risk Management. Systemic Approach to Handling Risk. Principle of Risk Management: Identification of Risks. Preliminary Risk Analysis (PRA). Risk Assessment. Risk Evaluation. Risk Control. Hierarchies of Control. Monitoring and Reviewing. Documentation. Study of a practical problem in which the student applies Basic Risk Management Environment: Environmental Systems: Local, Regional and Global. Influence of Air Pollutants on the, Environment, Water Pollutants, Industrial Waste, Hazardous Wastes, Management of Pollutant Releases, Pollution Prevention, Recycling of Waste Materials, Waste Treatment Technologies, Ultimate Disposal of Wastes, Water Treatment Technologies. Control of Air Pollution, Contaminated Land and Its Reclamation, Principals and Uses of the Environmental Risk Assessment, Environmental Risk Assessment Methodology, Environmental Impact Assessment Environmental Health Risk Assessment. National and International regulations.
GENN224	**Concepts of Economics and Accounting** **Compulsory, Credits: 2(1+1+0)** **Prerequisites (s): 42** The main objective of this course is to provide engineers with the basic concepts of Economics and Accounting where the engineer has to be able of conceiving a business' vision from financial & strategic dimensions alongside to his/her technical skills. The course includes introduction to financial accounting, overview of managerial accounting, and economic concepts. The financial accounting includes the accounting cycle and financial statements. It also includes financial ratios for measuring the organization's performance. The Managerial accounting and behavior of cost includes the cost volume relationships and its further use in Budgeting & Forecasting. Economic concepts are addressed in microeconomics & macroeconomics where microeconomics includes the basic principles of economics, theory, assumptions, and models of economics as a social science, it also includes market forces of supply and demand, and elasticity & its applications. Another important topic addressed in this part is the competitive markets where decisions regarding maximizing profit, shutting down or exiting the market are discussed through computational methods & formulas. Macroeconomics includes measuring the nation's income where it explains the gross domestic product (GDP), its components & types.
GENN301	**Ethics and Legislation** **Elective (group E-1), Credits: 2 (1+1+0)** **Prerequisite(s): 80 credits** Engineering profession: Ethical issues in engineering practice. Conflicts between business demands and professional ideals. Social and ethical Responsibilities of Technologists. Codes of professional ethics. Case studies. Value Crisis in contemporary society. Nature of values: Psychological values, Societal values, Aesthetic values, Moral and ethical values. Work ethics and professional ethics. The legal rule: Mandatory and complementary. Sources of Law. Formal sources: Statutory Law, Custom, the Principles of natural Law and rules of justice. Informal sources: Jurisprudence, Doctrine. Application of Law. Holders of right; Natural persons, Juristic persons. Theory of Obligation; definition, forms. Sources of Obligations. Labor Law. Safety and Vocational Laws. The contract; Parties, Formation, Validity, Effect, Interpretation, Responsibilities, Dissolution, and compensation of Damage. Contracts.

GENN303	**Critical Thinking** **Elective (group E-1), Credits: 2 (2+0+0)** **Prerequisite(s): GENN003** The aim of the course is to apply critical thinking in the context of problem solving in the engineering field. Critical thinking and abstract thought are invaluable tools, which complement an engineer's technical expertise. Critical Thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. The following terms and applications are also discussed: Analysis, breaking down the problem into parts and finding the relationships between them; Synthesis, thinking about other ways to solve the problem either by incorporating new information or combining the parts in a different way; and finally, Evaluation is making a judgment about the results using the evidence at hand.
GENN305	**Interdisciplinary Project** **Elective (group E-1), Credits: 2 (0+0+0)** **Prerequisite(s): 108 credits** The course aims to give students more space for creativity, out of the box thinking, interdisciplinary /&/or multidisciplinary collaboration and involvement in team work. It's a free specialization course where the subject is to be determined by the student team. The team consists of maximum 6 students and minimum of 4 students. A maximum of two students of the same credit hour program can be members of the same student team. The team shall register the topic of the project with the course coordinator and follow up with him/her at least 3 times during the semester. No mid-term Exam for the course, instead all 60 grades will be allocated on the semester's work and the final Exam jury will be nominated by the course coordinator depending on the project subject, but not necessarily on the student(s) cr. Hr. program. The course is graded as a normal graded course.
GENN310	**Advanced Risk Management** **Elective (group E-1), Credits: 2 (1+1+0)** **Prerequisite(s): GENN210 + MTHN203** Review of the Basic Risk Axioms and Concepts. Evolution of Risk Concepts and Terminology. Financial and Industrial Risk: Comparison and Contrast. Probabilistic Nature of Risk. System Decomposition. Legal and Regulatory Risks. Tools for Risk Assessment: Probability and Consequences: Event Tree, Fault Tree, FMECA, FEMEA, MOSAR (The French Approach), Simulation, Optimization and Operations Research. HACCP: principles and applications. HAZOP. Qualitative and Quantitative Risk Assessments (QRA). Quantitative Risk Assessment: Qualitative Aspects of System Analysis (Quantification of Basic Events. Confidence Interval. Quantitative Aspects of System Analysis. System Quantification for Dependent Events. Human Reliability. Uncertainty Quantification). Operational Risk. Reporting Risk Operations. Sectoral Risk Management. Specific Risk Topics: Risk Specific to Confined Spaces. The Special Case of BLEVE and Explosive Mixtures. Social and Psychological Risk. Social Risk Management and Social Protection. Disaster Risk Management and Vulnerability Reduction. Can Risk be a Management Style?

GENN311	**Technical Writing in Arabic** **Elective (group E-1), Credits: 2 (1+1+0)** **Prerequisite(s): GENN101 + 80 credits** Review of the Basics of Arabic Grammar and Mechanics. Writing Effective Sentences and Paragraphs Using Arabic Language. Discovering and Outlining Ideas. Writing Abstracts, Summaries, and Conclusions of Long Reports. The thesis Statement. Writing Technical Forms Using Arabic Language: Letters, Memos, Reports, Scientific Articles, Job Description, CV. Writing References and Footnotes. Selection of Key Words, Titles and Subtitles. Editing, Revising and Proofreading Techniques. Electronic Word Processing and Technical Writing. Integrating Graphs, Tables and Charts in Technical Documents. Vocabulary Building. Basic Types and Patterns of Argument: Terminology, Building Sub-Arguments of Fact and Policy. مراجعة أسس القواعد النحوية و ميكانيكيات اللغة العربية - الأخطاء الشائعة فى استخدامات اللغة العربية - كتابة جمل وفقرات صحيحة وفعالة باستخدام اللغة العربية - خلق الأفكار (التفاكر) - كتابة مقدمات، ملخصات و خاتمات التقارير - كتابة الأبحاث - أشكال الكتابة باللغة العربية: الرسائل، المذكرات، التقارير، المقالات العلمية، الوصف الوظيفي، كتابة السيرة الذاتية وتوثيق المراجع - اختيار الكلمات المفتاحية و كذلك العناوين الرئيسية والفرعية - التعرف على تقنيات التحرير و المراجعة و القراءة الاحترافية - إمكانية معالجة النصوص والكتابة الإليكترونية - الرسوم و الجداول و المخططات البيانية في الوثائق الفنية - بناء حصيلة لغوية من الكلمات والمفردات - تعلم الانماط و الأساليب الأساسية والمبدئية للنقاش من حيث المنهجية والبناء.
GENN321	**Foreign Language** **Elective (group E-1), Credits: 2 (1+1+0)** **Prerequisite(s): GENN201** Emphasizing the development of student's communicative skills to speak, listen, read and write in languages other than Arabic and English, such as French, German, Spanish, Italian, Japanese, Chinese, etc, and to study cultural characteristics of such foreign languages from historical, geographical, literature, economic, and social viewpoints. Topics include, but not limited to, the basics of language grammar and mechanics, writing effective sentences and paragraphs, vocabulary building, writing technical engineering documents and writing technical forms: letters, memos, reports, scientific articles, job description, resumes and curriculum vitas.
GENN326	**Marketing** **Elective (group E-1), Credits: 2 (1+1+0)** **Prerequisite(s): GENN102 + 80 credits** Introduction. The Field of Sales; Strategic Sales Force Management. The Personal Selling Process and Sales Force Organization. Profiling and Recruiting Salespeople; Selecting and Hiring Applicants, Developing the Sales Program, Sales Force Motivation, Sales Force Compensation, Expenses and Transportation; Leadership of a Sales Force, Forecasting Sales and Developing Budgets; Sales Territories, Analysis of Sales Volume, Marketing Cost & Profitability Analysis, Performance Evaluation; Ethical and Legal Responsibilities tender writing.
GENN327	**Selections of Life-Long Skills** **Elective (group E-1), Credits: 2 (1+1+0)** **Prerequisite(s): GENN201** Communicating Clearly - Managing Time and Resources - Making Decisions - Delegating Successfully - Motivating People - Managing Teams - Negotiating Successfully - Minimizing Stress - Getting Organized - Managing Changes - Interviewing People - Managing Your Career - Balancing Work and Life - Thinking Creativity and Innovation - Influencing People – Systems Thinking – Interpersonal Management Skills – Entrepreneurial Skills.

GENN328	**Scientific Research Methods** **Elective (group E-1), Credits: 2 (0+0+0)** **Prerequisite(s): 108 credits** Course covers the process of scientific knowledge and practical implementation, underlying research methodology issues. To develop a critical and questioning mindset, critical understanding of issues related to research questions, literature review, methodological design, data collection, analysis and conclusion. Moving you toward fulfillment of the publication and dissertation requirements, perhaps will turn you into a 'Researcher'. All of which to use content to solve technical, practical, and life problems.
GENN331	**Business Communication** **Elective (group E-1), Credits: 2 (1+1+0)** **Prerequisite(s): GENN201** Skills for effective communication in the workplace; constructing and delivering persuasive business presentations; theoretical and experiential knowledge of argumentation and debate for informal and formal presentations; style, layout, and convention of business writing; writing business proposals, progress reports, and feasibility reports; common areas of miscommunication.
GENN332	**Service Management** **Elective (group E-1), Credits: 2 (1+1+0)** **Prerequisite(s): GENN102 + 80 credits** Role of services in the economy, the nature of services, Service quality, Service Strategy, developing new services, the role of technology in supporting service delivery, Design of services, Capacity planning and managing queues, Quantitative methods for service management.

8.2 College-Core Courses

CHEN001	**Chemistry** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): None** Gases; Applications to gaseous law; Mass balance and heat balance in combustion processes of fuels; Solutions & separation techniques; Applications to electrochemistry; Corrosion; Water treatment; Building materials; Environmental Engineering; Selected chemical industries: fertilizers, dyes, polymers, sugar, petro-chemicals, semi-conductors, oil and fats, industrial systems; Chemical Vapor deposition.
GENN003	**Basic Engineering Design** **Compulsory, Credits: 2 (2+0+0)** **Prerequisite(s): None** Introduction to Design: Problem description and Introduction to Internet communication - Project Management: Project Management Application, Problem Solving Techniques: Problem Definition, Design Constraints - Creative Thinking and Problem Solving: Introduction to critical and creative thinking, nature of design problems - Brainstorming seminar, list of possible and impossible solutions and generating Ideas - Creative Thinking and Decision making: Product life cycles , Selection of idea (s), Final decision matrix, Justify decision - The Design Matrix: Context, purpose and requirements of engineering design - Analyze selected solution/preliminary design - Automated Design & the Positive Attitudes for Creativity - Systematic generation and evaluation of ideas.
MDPN001	**Engineering Graphics** **Compulsory, Credits: 3 (1+0+4)** **Prerequisite(s): None** Techniques and skills of engineering drawing, normal and auxiliary projections. Solid geometry. Intersections between planes and solids. Development, sectioning. Drawing and joining of steel frames. Assembly drawing of some mechanical parts. Drawing of architectural projections and reading of blueprints.
MDPN002	**Fundamentals of Manufacturing Engineering** **Compulsory, Credits: 3 (2+1+2)** **Prerequisite(s): None** Engineering Materials - Elements of Manufacturing Processes, material flow, energy flow and information flow - Forming in the liquid state, Casting and molding processes - Forming in the solid state, metal forming, forming of plastics and powder metallurgy - Material Joining processes, welding, soldering and brazing, riveting, joining by mechanical elements, assembly processes - Material removal processes, metal cutting and finishing processes - Computer applications in manufacturing - Term mini-project.
MECN001	**Mechanics-1 (Statics)** **Compulsory, Credits: 2 (1+3+0)** **Prerequisite(s): None** Statics of particles, forces in three-dimensions, vector algebra; equivalent systems of forces, resultant of a group of forces, moments of forces, moment of a couple, reduction of a system of forces, wrench; equilibrium of rigid bodies in two dimensions, reactions at supports and connections for a 2D structure, 2D trusses, equilibrium of rigid bodies in three dimensions, reactions at supports and connections for a three dimensional structure; centroids and centers of gravity, center of gravity of 2D bodies, centroids of areas and lines, first moments of areas and lines, composite plates and wires; moments of inertia, moments of inertia of areas, second moment, or moment of inertia of an area, polar moment of inertia, radius of gyration of an area, parallel-axis theorem, moments of inertia of composite areas, product of inertia, principal axes and principal moments of

	inertia, moments of inertia of masses, moment of inertia of a mass, parallel axis theorem, moments of inertia of thin plates, moments of inertia of composite bodies, mass product of inertia, principal axes and principal moments of inertia.
MECN002	**Mechanics-2 (Dynamics)** **Compulsory, Credits: 2 (1+2+1)** **Prerequisite(s): MECN001** Kinematics of particles: rectilinear motion of particles, position, velocity and acceleration, uniform rectilinear motion, uniformly accelerated rectilinear motion, curvilinear motion, derivatives of vector functions, rectangular components of velocity and acceleration, relative motion, tangential and normal components of acceleration, motion of a particle in a circular path, velocity and acceleration of a particle in polar coordinates. Kinetics of particles: Newton's second law, linear momentum of a particle, equations of motion with applications in Cartesian coordinates, tangential and normal directions, polar coordinates, free vibrations of particles, simple harmonic motion; energy & momentum methods, work of a force, kinetic energy of a particle, principle of work and energy, applications, power and efficiency, potential energy, conservation of energy, principle of impulse and momentum, impulsive motion, impact, direct central impact and coefficient of restitution, oblique central impact.
MTHN001	**Introduction to Linear Algebra and Analytic Geometry** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): None** Matrix algebra, determinants, inverse of a matrix, row equivalence, elementary matrices, solutions of linear systems of equations; parabola, ellipse and hyperbola, eccentricity and conic sections; quadratic equations; solid geometry, line, plane, quadratic surfaces.
MTHN002	**Calculus I** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): None** Functions, graphing of functions, combining functions, trigonometric functions; limits and continuity; differentiation; inverse functions; exponential and logarithmic functions; inverse trigonometric functions; hyperbolic and inverse hyperbolic functions; indeterminate forms and L'Hopital's rule; Taylor and Maclaurin expansions.
MTHN003	**Calculus II** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): MTHN002** Anti-derivatives; indefinite integrals; techniques of integration; definite integrals, applications of definite integrals; functions of several variables; partial derivatives, applications for partial derivatives.
MTHN102	**Multivariable Calculus and Linear Algebra** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): MTHN001 + MTHN003** Double integrals, double integrals in polar coordinates; triple integrals, triple integrals in spherical and cylindrical coordinates; applications of double and triple integrals; line and surface integrals; vector analysis, gradient of a scalar function, divergence of a vector, curl of a vector, divergence and Stokes' theorems, vector identities; LU-factorization; vector spaces; inner product spaces; eigenvalues and eigenvectors; diagonalization of matrices; functions of matrices.

MTHN203	**Probability and Statistics** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): MTHN102** Probability axioms; probability laws; conditional probability; random variables; discrete and continuous distributions; joint distribution; computer simulation; sampling; measures of location and variability; parameter estimation, testing of hypothesis.
PHYN001	**Mechanics, Oscillations, Waves and Thermodynamics** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): None** Physics and measurements; elastic properties of solids; universal gravitation and motion of planets; fluid mechanics (statics and dynamics); oscillatory motion; wave motion, sound waves; thermo-dynamics, temperature, heat and the first law of thermodynamics, the kinetic theory of gases, heat engines, entropy and the second law of thermodynamics. Laboratory experiments on course topics.
PHYN002	**Electricity and Magnetism** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): None** Electric field; Gauss' law; electrostatic potential; capacitance and dielectrics; current and resistance; direct current circuits; magnetic fields, sources of magnetic field; Faraday's law; Maxwell's equations; inductances; magnetic properties of matter. Laboratory experiments.
HEMN280	**Engineering Seminar** **Compulsory, Credits: 1 (1+0+0)** **Prerequisite(s): 72 credits + AA Approval** Talks and presentations are invited from industrial establishments relevant to the program. The guest speaker should discuss the organization, management, and recent technologies implemented in his/her industrial establishment. Students exercise writing brief technical reports on the guest presentation and deliver their own presentation about the topic. *The course is graded as Pass/Fail grade-system.*
HEMN281	**Industrial Training-1** **Compulsory, Credits: 1 (0+0+0)** **Prerequisite(s): 72 credits + AA Approval** Training on industrial establishments relevant to the program. Training lasts for total of 90 hours, during a period about three weeks. The program-training advisor schedules at least one follow up visit to the training venue and formally report on performance of trainee(s). A Mentor in the industrial establishment provides a formal report on the student's performance during training. The student submits a formal report and presentation to be evaluated by a panel of three members with one member being an external examiner appointed from industry or other colleges of engineering. *The course is graded as Pass/Fail grade-system.*
HEMN381	**Industrial Training-2** **Compulsory, Credits: 2 (0+0+0)** **Prerequisite(s): HEMN281 + AA Approval** Training on industrial establishments relevant to the program. Training lasts for total of 175 hours, during a minimum period of six weeks. The program-training advisor schedules at least two follow-up visits to the training venue and formally report on performance of trainee(s). A Mentor in the industrial establishment provides a formal report on the student's performance during training. The student submits a formal report and presentation to be evaluated by a panel of three members with one member being an external examiner appointed from industry or other colleges of engineering. *The course is graded as Pass/Fail grade-system.*

HEMN480	**Graduation Project-1** **Compulsory, Credits: 1 (0+0+3)** **Prerequisite(s): 130 credits + AA Approval** Students undertake a major project as part of the program. The aim of the project is to provide the students, who work in groups, with an opportunity to implement appropriate concepts and techniques to a particular design. Students are required to select and research the expected project to be designed and implemented in the following course Graduation Project-2. The student should give an oral presentation to be approved. *The course is graded as Pass/Fail grade-system.*
HEMN481	**Graduation Project-2** **Compulsory, Credits: 3 (1+0+6)** **Prerequisite(s): HEMN480 + AA Approval** All students undertake a major project as part of the program. The aim of the project is to provide the students, who work in groups, with an opportunity to implement the appropriate concepts and techniques to a particular design. A dissertation on the project is submitted on which the student is examined orally.

8.3 Discipline Courses

ELCN103	**Circuit Analysis** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): MTHN003** Electric Circuit Elements- Electric Circuit Variables- Resistive circuits and methods of Analyzing – Circuit Theorems- The Operational Amplifier Circuits - Energy Stored Elements- Response of RL, RC, and RLC Circuits- Response of Two Storage Elements. Sinusoidal Steady State Analysis - AC Steady State Power - Frequency Response - Two Port Networks. Magnetism - Transformers: Principles of Operation, and Analysis- DC Motors Analysis - Speed Control of DC Motors - earthing – protection of electric equipment.
CMPN102	**Data Structures & Algorithms** **Compulsory, Credits: 3 (2+1+2)** **Prerequisite(s): CMPN103** Data types and representation - file structures- data structures representation in storage media and memory allocation- linear lists -stacks - queues - memory allocation - trees - graphs - Hashing - searching, sorting algorithms and their analysis - programming project.
CMPN103	**Programming Techniques** **Compulsory, Credits: 3 (2+1+2)** **Prerequisite(s): MTHN003 + GENN004** Introduction to software design - evolution and comparison of programming languages - types and characteristics of translators - structured programming - function versus object-oriented programming- introduction to parallel programming- program maintenance & testing - documentation - numerical and non-numerical examples- programming project.
HEMN130	**Basics of Computer Architecture** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): None** Basic Structure of Computers - Data Representation - Boolean Algebra - Combinational and Sequential circuits - Basic Structure of Microprocessor - Instruction Sets and Assembly Language - Control Unit - memory architectures - timing diagrams - interrupt circuits - bus synchronization - I/O devices.
HEMN113	**Anatomy & Physiology for Engineers** **Compulsory, Credits: 2 (2+0+0)** **Prerequisite(s): None** Human muscular-skeletal system explored in relation to engineering principles, focusing on torso, back, hip, neck and shoulder, hand, wrist, elbow, and knee. Emphasis is placed on function, biomechanics, and modeling. Basic principles of human physiology presented from the engineering perspective. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models where feasible.

HEMN115	**Introduction to Biomedical Engineering** **Compulsory, Credits: 2 (1+2+0)** **Prerequisite(s): None** The aim of this course is to introduce the students to biomedical engineering profession. This course will provide an insight into multidisciplinary areas of biomedical engineering and design. The course is primarily concerned with professional practice and a starting point for your ongoing professional development that you will undertake as a professional biomedical engineer throughout your career.
MTHN103	**Differential Equations** **Compulsory, Credits: 3 (2+1+2)** **Prerequisite(s): MTHN003** First-order differential equations, separable, exact, linear, homogeneous and Bernoulli equations; modeling with first order differential equations; higher-order differential equations; method of undetermined coefficients; variation of parameters; modeling with higher order differential equations; series solutions; Laplace transform; properties and applications, shifting theorems, convolution theorem; solutions of differential equations using Laplace transform; Fourier series; Fourier transform.
HEMN121	**Biosignals and Systems** **Compulsory, Credits: 3 (2+2+0)** **Prerequisite(s): MTHN002** Characteristics of medical signals. Mathematical, engineering and computer techniques for describing and analyzing biomedical signals, including ECG, EEG, EMG, blood pressure. Principles of biosignal processing - Linear time invariant systems - Continuous Time Signals - Continuous Time Systems - Laplace Transform - Fourier Transform - Frequency Analysis - Analog Filtering - wavelet transforms, and joint-time frequency analysis Sampling Theory. Models of biological and physiological systems, and analysis of dynamic and feedback systems. Basic techniques for analyzing medical signals, including ECG, EEG, EMG, etc. Curve fitting, Classification of signals. Extracting features out of the signal for diagnosis and prediction, including QRS detection, Heart rate variability, and seizure detection, among others.
ELCN123	**Basic Electronics & Digital Design** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): PHYN002 + ELCN103** Basics of Diode and transistor circuits - Standard Logic Families: BJT and MOSFET, Circuit Analysis and Design, Computer Simulation. Multistage amplifiers and composite circuits - High frequency analysis and frequency response – Operational Amplifier - Differential amplifiers - Feedback amplifiers - Digital logic gates – Sequential circuits (flip-flops, shift registers, counters) – Decoders, Encoders, Multiplexers, and Demultiplexers. Structure, Operation, Applications, and Interface of different types of Digital Memories. Application Specific Integrated Circuits (ASICs) Categories, Advantages and Disadvantages. Programmable Logic Devices (PLDs), Categories, Fundamentals, Architecture and Programming. Hardware Description Languages (HDL). Practical Assignments: Developing a rectifier circuit using diodes, developing an amplifier circuit using two transistors schemes, developing a circuit amplify the input with a controllable gain, developing an electronic storage memory that can be accessed programmatically.

HEMN123	**Medical Physics** **Compulsory, Credits: 3 (2+2+0)** **Prerequisite(s): None** • Sound (sound as a wave, Doppler effect; absorption, reflection, and scattering of sound; isotropic and collimated sound waves, sonic pulses, Sound and Ultrasonic Waves) • Electromagnetic Radiation (electromagnetic waves and photons; Atomic Spectra; radio waves; visible light, X-Ray Emission; Reflection and refraction, Interference, Diffraction and Applications in Biomedicine, lasers; X-Rays; Basics of Nuclear Physics in Biomedical Applications, Basics of Nuclear Magnetic Resonance (NMR), Interaction of Photons, isotopes, radioactive decay, Nuclear Radiation and Charged Particles with Tissues, Exponential Decay and Growth in Biological Domain) • Thermodynamics (Equations of state, first and second laws of thermodynamics, open/closed systems, Maxwell Relations. Examples of biological applications: the cardiac cycle, respiratory gas exchange, cell potentials). Heat transfer, tissue heating by radiation for cancer therapy. • Fluid mechanics, both statics and dynamics, biomedical applications ranging from blood flow in the human body to drug delivery; basic fluids concepts, cardiovascular & pulmonary anatomy & physiology; hematology; histology and physiology of blood vessels, vascular grafts, natural and prosthetic heart valves, Poiseuille flow, pulsatile flow in rigid tubes, pulsatile flow in large arteries, flow and pressure measurements. • Optics & Bio photonics (basic optical principles, techniques and instruments used in biomedical research and clinical medicine. It includes in-depth coverage of optical imaging and spectroscopy systems for biomedical research and clinical diagnosis, details of light interaction with tissue, and optical therapeutic instruments). Moreover, their impact on the medical equipment.
HEMN230	**Database Systems for Medical Data** **Compulsory, Credits: 3 (2+1+2)** **Prerequisite(s): CMPN102** Overview of database systems and introduction to database design, Basic database concepts – Medical and clinical data structures and operations, Data modeling, Database system architecture, data manipulation languages - query languages including Algebra and SQL, queries, constraints, triggers, Database application development, storage and indexing, query evaluation, evaluating relational operators and relational query optimization, Information retrieval and XML data, Non-relational, distributed and multicopy Databases, Medical database administration: privacy and security, concurrence control and performance monitoring. Practical Assignments: Designing a database schema to a clinic management system, Implementing the CRUD operations using java with DATA ACCESS objects technique. Project: Implement a cloud-based clinic management system.
HEMN216	**Analytical & Lab Instruments** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): HEMN115, HEMN123** Electrolytic Conductivity – Ions in Aqueous Solution – Electrochemical Cells - Radiation and Matter – Absorption of Radiation in Ultraviolet and Visible Regions: Sources and Detectors – Visual Colorimeters – Filter Photometers – Spectrophotometers – Spectrophotometry– Absorption of Radiation in Infrared Region: Sources and Detectors – Infrared Spectrophotometers – Molecular Luminescence – Fluorescence and Phosphorescence – Spectrofluorometry – Spectropolarimetry – Flame Photometry - Atomic Absorption - Chromatography (HPLC & GC) – Water Purification - Balances – Centrifuges - Electrophoresis - Molecular Biology Technique - Scattering of Radiation –

	Laser: Sources, and Applications in Chemistry and Spectroscopy - Chromatography - Automation - Performance Evaluation - Calibration of Analytical Instrumentation - Analytical Laboratory Skills - Practical Training in Clinical Sites. Practical Experiments: Light, infrared, Ultraviolet, Spectrophotometers, Electrochemical cells, Lasers generation and guidance.
CMPN203	**Software Engineering** **Compulsory, Credits: 3 (2+1+2)** **Prerequisite(s): CMPN103** Software life cycle - concepts and methods of analysis - constrained system design - data, functions and relationships specifications - implementation procedures - standard specifications - reliability measures and quality assurance - integral testing - error analysis - software maintenance – documentation - project training.
HEMN223	**Measurements & Quantitative Experimentation** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): HEMN121, ELCN123** Introduction to Measurement methods, Units, Standards - Instrument types and performance characteristics - Measurement dynamics and transient response analysis - Essential electric measuring devices - AC based analysis - Frequency and phase measurements techniques - Characterizing frequency response. Errors of Measurements: Quantization errors - Classifications of errors - Estimation of random errors using Statistical Methods. Performance metrics accounting for particularly, range, accuracy, error of measurements. Practical Assignments: Data acquisition: read data from simple sensors (temp, pressure…etc.), Transient response of an AC circuit, Frequency and phase measurement experiment.
HEMN226	**Medical Monitors & Life Support Equipment** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN121, ELCN123** Analysis, and operation of transducers, sensors, and electrodes, for physiological systems; Instrumentation amplifiers. Principles of operation of selected devices: Blood Pressure, Temperature, Flow and Gas measurements devises, pulse oximeter, incubators, electrodes and insulin pump, Monitoring devises, electrocardiogram (ECG) and electromyography (EMG) devices, pacemaker and Defibrillation, Infant Incubators, ventilator and Anesthesia devices, Dialysis machine, Electrosurgical Unit, Operation Room Unit. Aspects of medical devices performance and accuracy, Patient safety.
HEMN224	**Computer Graphics & Visualization** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): MTHN102** Introduction to Graphic Devices and their Control – Devices Mapping – Building and Drawing Curves – Parameter Representation of Curves – Clipping Algorithms – Modeling and rendering Surfaces – Transformations in 2D – Transformation in 3D – Introduction of Ray Tracing Techniques – Color Theorem. Applications for medical images. Students will use OpenGl, Matlab, vtk as processing tools. Practical Assignments: Transformations and viewing, Curves and surfaces, Ray casting and tracing, Surface rendering for medical data.
HEMN227	**Clinical Engineering** **Compulsory, Credits: 2 (2+0+0)** **Prerequisite(s): HEMN115** The Health Care Environment - A Model Clinical Engineering Department - Engineering of the Clinical Environment - Health Care Strategic Planning Utilizing Technology

	Assessment - Technology Evaluation - Careers, Roles, and Responsibilities - Clinical Engineering at the Bedside - The Clinical Engineer as Consultant - The Clinical Engineer as Investigator and Expert Witness. Patient Safety – Enhancing Patient Safety: The Role of Clinical Engineering - Clinical Engineering and Biomedical Maintenance - Medical Technology Management Practices - Good Management Practice for Medical Equipment - Technology Procurement - Equipment Control and Asset Management - Maintenance and Repair of Medical Devices – Computerized Maintenance Management Systems.
HEMN311	**Biomedical Signal Processing** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN121** Discrete-Time Signals and Systems - Sampling and Recovery of Continuous Time Signals – Shannon's Theorem - Transform Analysis of Linear Time Invariant Systems – Structures for Discrete Time Systems. Fourier series and Fourier transform Discrete Fourier Transform and FFT – Fourier Analysis of Signals using DFT – Hilbert Transform - Power spectrum estimation, Wiener's Theorem, correlation techniques, Z-Transform - Filter Design Techniques - FIR Filter, IIR Filter, and Adaptive Filter – Short-time Processing. Students will use Matlab or Python as Processing Tools. Practical Assignments (Using Matlab or Python): Developing a program that reads and plot an arbitrary biological signal, calculate its FT and plot its magnitude and phase. Developing a digital filter designer using a zero-pole locator. Choosing a biological signal (ECG, EMG…etc.) and research for some signal processing algorithm that perform a specific aim on this signal using filtering techniques. Then, layout your implementation for this algorithm.
HEMN330	**Embedded Systems in Medical Equipment** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): ELCN123** Data acquisition systems - Sensors - Electrodes - Interference - Signal Conditioning - Digitizing - Microprocessor based systems. Fundamentals of embedded system hardware and firmware - embedded processor selection, hardware/firmware partitioning, circuit design and layout, circuit debugging and development tools, firmware architecture, design, and debugging. Intel 8051 architecture and instruction set. IoTs - Design example – Programming project. Practical Assignments: Developing an acquisition system (read from sensors and display). Based on the acquisition system, develop a wireless communication system to transfer the acquired data to a central server via wireless.
HEMN416	**Medical Imaging Modalities** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN213, HEMN311** Introduction to medical imaging - Imaging quality metrics. Basic physics and instrumentation of the four most-important clinical medical imaging modalities: Ultrasound Imaging, Magnetic Resonance Imaging, radiation imaging (X-Ray and CT), nuclear imaging (SPECT and PET, Gamma Camera).

8.4 Major Courses: HEM

HEMN125	**Requirements Engineering for Digital Health** **Compulsory, Credits: 2 (1+2+0)** **Prerequisite(s): None** Digital Health, Requirements Engineering: Best Practice, Laws and Regulations for Digital Health, Ethical Issues in Digital Health, Standards for Interoperability in Digital Health: Selection and Implementation in an eHealth Project, User Experience (UX) Design for Medical Personnel and Patients, Identifying Security Requirements and Privacy Concerns in Digital Health Applications, How to Elicit, Analyze and Validate Requirements for a Digital Health Solution, Barriers and Strategies for Scaling Innovative Solutions in Health Care.
HEMN213	**Biomedical Transducers** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): HEMN123** This course introduces to various types of biomedical sensors including sensors measuring pressure, flow, motion, temperature, heat flow, evaporation, biopotential, biomagnetism, light, photonic and chemical quantities. Underlying measurement principles and design will be emphasized. Various practical applications will be introduced. Analog front-end design for different medical devices - Electrodes, Interference, Isolation Amplifier, and Analog Filters - Interfacing - ADC - Sampling Quantization. Practical Assignments: Developing a circuit to acquire measurements from different sensors, specifically temperature, flow, motion, pressure. For the acquired signals, develop an amplifier and denoising circuits. Digitize the filtered signal, feed and visualize it into your PC.
HEMN215	**Entrepreneurship in Healthcare Industry** **Compulsory, Credits: 2 (1+2+0)** **Prerequisite(s): HEMN125** This course analyzes the unique characteristics and strategies of investing in the healthcare sector from the perspectives of venture capital firms investing in early-stage healthcare enterprises, entrepreneurs creating and managing such business entities, and private equity firms seeking to build value-creating health care platforms. The course is focused on innovative business models of early to mid-stage healthcare services companies (payers, providers, HCIT firms) that improve quality of patient care, lower costs, and facilitate access to such services, as well as the opportunities and challenges of early-stage biotechnology companies discovering and developing novel compounds. It considers how investors and entrepreneurs can assess, value and manage the inherent risks to succeed in this large, complex, and dynamic sector. This course will address these issues through a mixture of lectures, case studies, and guest speakers (investors and entrepreneurs) from the healthcare sector.
HEMN314	**Medical Distributed Application Development** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN130** This course covers the protocols, technologies and issues relevant for development of medical distributed applications. Protocols covered in the course include networking standards and specifications for exchanging data. Development models and architectures including web applications and services, microservices, mobile applications, and cloud computing. While discussing these topics, the emphasis will be on performance, security, and deployment issues specific for developing medical and clinical applications.

HEMN316	**Medical Device Technologies** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN123** Design Considerations for Small Medical Devices - Audiology, Audiometry, hearing-aids, potential evoked - Optics, optical principles, techniques and instruments - Blood Components Measurements, Medical Laser Applications, Cardiac Measurements (Blood Flow, Blood Pressure and Cardiac Output) - Basics of Therapeutic and Prosthetic Devices.
HEMN315	**Quantitative Management** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): MTHN203** The objective of this course is to apply statistical concepts and techniques to business problems, interpret solutions and use MS Excel to make statistical computation easier. The course will cover descriptive statistics, inferential statistics and math models with business applications to analyze management and organizational problems. Specific topics include measures of central tendency and variation, probability distributions, estimation, hypothesis testing, regression and correlation, decision theory, Index numbers and linear programming, transportation and assignment models, and inventory management and queuing theory models.
HEMN328	**Medical Device Standards** **Compulsory, Credits: 3 (2+2+0)** **Prerequisite(s): HEMN216, HEMN226** Definitions, Classification of Medical Devices, Medical device production lifecycle, Device families, Regulatory controls in various countries, GHTF model for conformity assessment procedures, FDA requirements for safety and effectiveness, Standards Organizations, ISO, IEC, ASTM, Risk management, Clinical evaluations, Technical documentation required by medical device regulators, CE Mark, Good Laboratory Practices and; Good Manufacturing practices, Medical Device Directive, Human Factors, Intellectual Properties, Patents, Copyrights, Trademarks.
HEMN323	**HealthCare Information Systems (HCIS)** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN230** Relationships and intersections of Information Technology, Regulations and Standards, Health Cara Data and Health Information Systems. Data and dataflow in hospital, type of data, models of presentation, general ledger, cost accounting, evaluation techniques, budgeting and analysis, material management, inventory control. Hospital Information System (HIS), Electronic Medical Records (EMR), Electronic Health Records (EHR), Reporting. DICOM file format, DICOM Network, Picture Archiving and Communication System (PACS). Fundamentals and management of information systems, planning of projects, attendance of projects, system analysis, system evaluation, selection of systems, implementation of systems, finishing a project. Health care laws (e.g., HIPAA) and professional ethics (e.g., IEEE-ACM Software Engineering Code of Ethics and Professional Practice) to cases involving the use of health information systems. Practical Assignments: Implementing an application to transmit DRUG info using FHIR standard, implementing an application to transmit / receive DICOM images using DICOM standards, implement a library to De-Identify DICOM files.

HEMN324	**Medical Image Processing & Computer Vision** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): HEMN311** Imaging sensors and their principles; Image representation and storage, coding and compression techniques, lossy versus lossless; Techniques for noise reduction. Image enhancement including contrast manipulation, histogram equalization, edge highlighting; Filtering and transform techniques for medical image processing including two dimensional Fourier transforms, wavelets and convolution; Spatial transformations and image registration. Segmentation and thresholding techniques; Applications of morphology to medical image processing including erosion, dilation and hit-or-miss operations for binary and grey scale images; Image feature estimation such as edges, lines, corners, texture and simple shape measures. Object classification, template matching techniques and basic image-based tracking will also be examined. Fundamentals of image formation, camera imaging geometry, features, edges, tracking, boundary detection and matching, stereo, motion estimation and tracking, image classification, scene understanding, Image recognition, Image registration.
HEMN325	**Biomedical Systems Modeling & Simulation** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): MTHN103, HEMN123** Techniques and computer tools for modelling, predicting, analyzing and understanding dynamic behavior in biomedical systems. The five steps of the modeling and simulation process: requirements, conceptual models, mathematical models, software implementation, and simulation results and validation. Finite-element models of devices and physiological systems incorporating realistic anatomy and function, Models validation. Practical examples to provide the student with the skills to evaluate and adapt existing physiologic models or create new ones for specific applications. Develop physically based dynamic models of biomedical systems, Use analytical techniques to assess the qualitative behavior of biomedical systems models, Contextualize and evaluate the role and use of continuous systems simulation in Biomedical Systems Modelling, Derive biomedical systems models from experimental data using different methods. Computer-aided modelling and simulation: application of continuous system simulation tools, e.g. MATLAB, Simulink, symbolic computation; application of appropriate control strategies. Data driven modelling of biomedical systems: mass balance principles. Identifiability of system parameters: introduction via compartmental modelling; identifiability of the parameters of linear systems using theoretical approaches; comparison with practical problems; extension to the identifiability of nonlinear systems. Parameter estimation: modelling of experimental data using linear and nonlinear regression/system identification; least squares approaches to parameter estimation. Applications, to be taken from: pharmacokinetics/pharmacodynamics; tumor targeting; epidemiological modelling and control; modelling of the heart and circulation; heart rate variability; lung function modelling; biomechanics and the modelling of human motion; modelling using imaging data (PET, MRI etc.); muscle mechanics; control of cell volume and nerve impulses; neural systems (biological clocks); modelling and control of diabetes.

HEMN417	**Healthcare Facilities Planning and Design** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN328** Identifying and Addressing the Needs of the Community - Incorporating changes in Technology - Environmental Considerations - Background on the Standards - Schedule and Budget - Emergency Management Designing - Designing for Security - Infection Prevention and Control - Proactive Risk Assessment - Enhancing Patient and Staff Safety and Satisfaction - Document the Plan. Schematic Design - Construction Documents - Implementing and Monitoring ILSMs and Other Safety Measures – Making the Process Manageable - Punch List - Documenting the Process - Budgeting for Commissioning - Design of Laboratories - Pharmacies - Storage - Inpatients – ICU – Outpatients – Operating Rooms – Radiology – Sterilization – Records - Dietary – Laundry – Medical gases – Flooring – Field visits.
HEMN419	**Operations Research in Healthcare** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN323, HEM315** Analyzing and improving healthcare systems and processes to make them more productive, effective, patient-centered, and pleasant for patients and healthcare workers, and with higher safety and quality and lower costs by integrating systems analysis, health systems engineering, quality management, and operations research techniques. Emphasis is placed on the use of organizational data, especially time-stamp data, to study processes and outcomes of care, particularly as it relates to flow analysis and improving flow. The course relies heavily on hands-on use of computer-based modeling tools, including spreadsheets and spreadsheet add-ins. Emphasis will be placed on formulating, designing, and constructing models, drawing conclusions from model results, and translating results into written end-user reports to support process improvement and quality improvement efforts.
HEMN428	**Medical QA and Accreditation** **Compulsory, Credits: 3 (2+2+0)** **Prerequisite(s): HEMN328** Testing and calibration, why medical equipment calibration is needed, medical equipment calibration devices for hospital departments such as intensive care units, operating theaters, radiology, etc. Uncertainty calculations during calibration procedures, medical equipment electrical safety, and International standard ISO/IEC 17025 accreditation.
HEMN429	**Biomedical Data Analytics** **Compulsory, Credits: 3 (2+2+1)** **Prerequisite(s): HEMN323** Major economic and policy shifts in healthcare are driving a profound change in the availability and use of data. These include (1) the shift from volume-driven to value-driven healthcare; (2) the translation of genomic and other molecular testing into clinical practices; and (3) the increased availability of electronic medical record data. Furthermore, the heterogeneity and complexity of these data are increasing at astonishing rates. Our ability to make clinical decisions in the face of growing volumes of complex, heterogeneous data will increasingly rely on new analytical methods from the fields of personalized medicine, data science and healthcare analytics. Assignments will draw from a wide range of computational and applied mathematical concepts required for biomedical data analytics, including probability, statistics, linear algebra, optimization, data manipulation, visualization, linear modeling, and model diagnostics.

8.5 Elective Courses: HEM

HEMN331	**Bioinformatics I** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN230** Fundamental concepts and methods in bioinformatics, including computational sequence analysis, sequence homology searching and motif finding, gene finding and genome annotation, protein structure analysis and modeling, genomics and SNP analysis, DNA microarrays and gene expression analysis, Proteomics, network/systems biology, and biological knowledge discovery.
HEMN332	**Biomechanics I** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): None** Relationship between forces, moments, mass, and acceleration for human body and body segment motions. Centroids, center of mass, mass moment of inertia, and relative motion, mechanics of tissues, joints, and human movement. Basic anatomy and physiology of limb and joint defects, biomechanics, motion analysis, and current device designs. Application of mechanical engineering and biomaterial selection principles in the design of artificial limbs and joints.
HEMN333	**Human Factors Engineering** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): None** General Considerations and Principles of Human Factors Engineering, Managing the Risk of Use Error , Basic Human Skills and Abilities, Anthropometry and Biomechanics, Environmental Considerations, Usability Testing, Signs, Symbols, and Markings, User Documentation, Packaging Design, Design for Post-Market Issues, Cross-Cultural/Cross-National Design, Alarm Design, Accessibility Considerations, Research-Based Design Guidelines for Patient-Support Surfaces, Design Elements, Integrated Solutions, Examples: Hand Tool Design, Design of Mobile Medical Devices, Workstations, Home Health Care.
HEMN334	**Usability Engineering in Healthcare** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): None** Basic principles of usability engineering methods for the design and evaluation of software systems. Includes the study of human-machine interactions, user interface characteristics and design strategies, software evaluation methods, and related guidelines and standards.
HEMN335	**Medical Expert Systems** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): MTHN203** Comparison of Artificial Intelligence and Artificial Expertise Systems – Representation of Knowledge Development of the structure of parts systems – Non-accurate decision making – Confused logic – Structure of systems of expertise – Knowledge base systems and knowledge engineering – Help tools and languages – Engineering and engineering applications – Applications in analytical and measuring devices Medical electronics and medical equipment.
HEMN336	**Telemedicine Technologies** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN125** Introduction to eHealth and mHealth – Communication Applications/Services in

	Medicine – Telemedicine Techniques in Patient Monitoring and Medical Information Processing – Telemedicine System Deployment – Tele-caring for the Community – Telemedicine Security Issues.
HEMN337	**Clinical Decision Support Systems** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): MTHN203** Introduction to the use of computers and computer methods to support healthcare provisioning in general and clinical diagnostic decision making in particular. Drivers and challenges for building and adopting CDSS are studied. Types, features, and design criteria for CDSS are covered together with examples of such systems.
HEMN370	**Introduction to Nano-Biosensors** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN213** Introduction to Nano-biosensors, Introductory Concepts: Biomolecules, Basic Concepts: Types of Biosensors, Shape of a Surface, Simulation of diffusion of biomolecules, Study parameters: Sensitivity, Selectivity and Settling Time, Optical Biosensors, Label Free Impedance Biosensor, Cantilever-based Biosensors.
CMPN405	**Computer Networks-1** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN130 - ELCN123** Seven-layer communication model - network architecture and protocols routing techniques and algorithms - network planning and design - Network layers, TCP / IP Network protocol, Routing protocols, Network Design, Network Management, Congestion, Examples of LAN's and WAN's, High Speed Networks, Other Network Protocols.
CMPN405	**Computer Networks-2** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): CMPN405** Theoretical foundations for building next generation Internet. To provide a detailed introduction to advanced topics in computer net-works including advanced transport layer concepts, adaptive queue management, Quality of Service fundamentals, packet scheduling, multimedia networking, content distribution networks and network measurements. Methodologies and tools in undertaking research in networking - Performance issues and QoS mechanisms in the Internet. Expertise in network programming and computer network simulation.
CMPN426	**Computer System Security** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): 100 Credits** Digital signature – Introduction to cryptography – ciphering algorithms – principles of data security – hardware and software security techniques – software protection – computer viruses – worms – Trojans – Spy wares – networks security and firewalls.
HEMN431	**Bioinformatics II** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN331** Advanced Bioinformatics equips the student with the interdisciplinary knowledge and skills necessary to meet the data-centered challenges of modern-day biology. Methods and algorithms for uncovering patterns in genomic data of different forms are discussed, and in several cases developed, implemented and applied to representative problems. Development and analysis of string matching, graph theoretic and dynamic

	programming techniques applied to systems and computational biology problems such as multiple sequence alignment, alignment of DNA and protein sequences, genome rearrangements, and phylogeny and haplotypes.
HEMN432	**Biomechanics II** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN332** Biomechanics for the design and evaluation of artificial devices intended to restore or improve movement lost due to injury or disease. Measurement technique in movement biomechanics, including motion analysis, electromyography, and gait analysis. Design and use of upper and lower limb prostheses. Principle of neuro-prostheses with applications to paralyzed upper and lower extremities.
HEMN433	**Virtual & Augmented Reality** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN224, HEMN325** Algorithms and techniques required to develop and deploy virtual reality and augmented reality applications. The course will cover VR and AR hardware, stereoscopic vision, VR software development, 3D user interfaces and presence. OpenGL and WebGL, real-time rendering, 3D display systems, display optics & electronics, IMUs and sensors, tracking, haptics, rendering pipeline, multimodal human perception and depth perception, stereo rendering, presence. Emphasis on VR technology. Hands-on programming assignments. Graphics Pipeline (Projections, Transformations, Textures and Meshes), Introduction to Unity3D, Generating Virtual Worlds, Human Perception and the VR Pipeline, Tracking: Head, Hands, and Bodies, Eye tracking and Visual saliency, User Interaction, Tracking and Registration for AR, Haptics Rendering.
HEMN434	**Introduction to Big Data** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN314** The capability of collecting and storing vast amounts of versatile data necessitate the development and use of new techniques and methodologies for processing and analyzing big data. This course provides a comprehensive coverage of number of technologies that are at the foundation of the Big Data movement. The Hadoop architecture and ecosystem of tools will be of special focus to this course.
HEMN435	**Introduction to Deep Learning** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN324** Deep Learning helps solve complex problems and that is why it is at the heart of Artificial intelligence. This course ‘s objectives are learning the foundations of Deep Learning, understanding how to build neural networks, and learn how to lead successful machine learning projects. This course will also teach getting deep learning to work well, how to drive performance, effectively use the common neural network, including initialization, L2 and dropout regularization, Batch normalization, gradient checking.
HEMN436	**Medical Robotics I** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): MTHN203** Robot’s applications, Introductory concepts, Kinematics: forward and inverse kinematics, instantaneous kinematics, Rotation, Homogeneous transformation, Differential motion & the Jacobbian, Denavit Hartenberg foundational convention, Screw Motion: Plücker coordinates, Motion invariants, Pose, Instantaneous Screw axis

	(Screw Velocity): screw, twist, Acceleration, Dynamics: wrench, wrench axis, mass, center of mass, 1st moment of mass, Inertia, Kinetic energy, Newton Euler equations, Dynamics canonical equation.
HEMN437	**Medical Robotics II** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN436** Motion Planning: Workspace vs joint space planning, Slew, interpolated, & linear motions, Path Planning, Trajectory Planning: Point-to-point, splines, Motion Control: General Control Approach: Joint Space vs Operational (work) space control, Independent joint control, Multi-joint control, Joint Space. Control (PD position Control, PD position Control with gravity Compensation, Inverse dynamics Control), External Space Control, (Transposed Jacobian matrix-based Control, Inverse Jacobian matrix-based Control, PD position control with gravity compensation in external coordinates, Inverse dynamics Control in external space, Inverse dynamics control with contact, Force Control). Physical human robot interaction (HRI), HRI and safety, human machine interface (HMI), human computer interface (HCI), brain computer interface (BCI), cognitive HRI, HRI necessary design fundamentals, examples and case studies: surgical robots, upper and lower limb prostheses (hand, arm, leg, knee, and ankle), upper and lower limb exoskeletons, wheelchairs, Advanced Topics.
HEMN438	**Rehabilitation Robotics** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN436** Revision of robotic kinematics, dynamics, motion planning, and control, physiological and biological concepts, impairment and rehabilitation, prosthetics and orthotics, rehabilitation and disability management of patients with: motor disorders, pathological tremor, amputation & paralysis , needs advantages and challenges of rehabilitation robotics, The role of robotics in rehabilitation, physical human robot interaction (HRI), HRI and safety, human machine interface (HMI), human computer interface (HCI), brain computer interface (BCI), cognitive HRI, HRI necessary design fundamentals, examples and case studies: upper and lower limb prostheses (hand, arm, leg, knee, and ankle), upper and lower limb exoskeletons, wheelchairs, Advanced Topics.
HEMN439	**Stochastic Processes** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): MTHN203** Conditional Probability and Conditional Expectation - Markov Chains in discrete time - The Poisson Process - Markov Processes in continuous time. Markov chain models, martingale theory, basic presentation of Brownian motion, as well as delusion and jump processes. Convergence stability analysis of (discrete generation) Markov chains. Variety of applications including statistical machine learning, operation research, mathematical biology, computational physics, as well as engineering sciences and financial mathematics.

HEMN440	**Magnetic Resonance Imaging** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN411** This course will first introduce the basic physics of MRI, including magnetic moments and resonance, nuclear spin interactions with applied magnetic fields, and magnetic relaxation. The second portion of the course will discuss basic concepts of image formation, including radiofrequency pulse excitation, magnetic field gradients, imaging equation, Fourier Transform, and two-dimensional spatial encoding. The final portion of the course will introduce practical imaging methods and applications, such as image artifacts, fast imaging methods, signal-to-noise, contrast-to-noise, resolution, MR imaging of heart and blood vessels, and MR imaging of the neural system.
HEMN441	**X-Ray Imaging Modalities** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN411** Physics and fundamentals of X-Rays, conventional X-Ray modality, Computerized Tomography CT modality. Principles of 3D reconstruction from projections in medicine. The mathematics of reconstruction from projections. Application of X-Ray's modalities in human body scanning.
HEMN442	**Ultrasound Imaging** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN411** Physics and fundamentals of Ultrasound. Propagation of ultrasound in heterogeneous media such as tissue, Ultrasound Imaging principles and basic of tissue characterization. Ultrasound Modality including details of A- and B- mode scanners. Simple tissue models based on ultrasound wave absorption and scattering. Ultrasound transducer models, advantages and disadvantages of various transducer configurations. The principles of acoustic output measurements and instrumentation requirements. Electrical and biological effects of ultrasound diagnostics algorithms.
HEMN443	**Nuclear Medicine** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN411** To provide the student with the theoretical principles as well as the application of instrumentation and radiation detection equipment used for procedures in nuclear medicine. This course will focus on the theory and lab application of the Quality Control procedures specific to each instrument, the lab application of imaging parameters, patient positioning and the views acquired during imaging. Radiotherapy and Imaging.
HEMN444	**Point-Of-Care Equipment** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN316** Medical diagnostic testing at or near the point of care—that is, at the time and place of patient care.
HEMN448	**Quantitative Functional Imaging** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN324** This course emphasizes the technical aspects of making quantitative measurements of structure and function using different imaging methods, including special imaging methods as well as approaches to image analysis algorithms, and the use of modeling or data analytic techniques for assessing function.

HEMN450	**Neuroengineering** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN123** Introduces the theory of neural signaling. Students will learn the fundamental theory of cellular potentials and chemical signaling, the Hodgkin Huxeley description of action potential generation, circuit representations of neurons and be able to derive and integrate equations describing the circuit as well as design computer models.
HEMN451	**Medical Pattern Recognition** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN324** Bayes theory of decision making: characterization using two categories, the smallest error rate, specifications, characteristic function and surfaces of excellence - characteristic of normal distribution - Bayes theory of intermittent state - nonparametric methods: probability function estimation, Analysis using the multi-characteristic function - the characteristic linear function: the characteristic linear function with the least square error, linear programming method.
HEMN452	**Neural Networks for Biomedical Engineering** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN325** Comparison of Neural System with Man and Neural Networks - Neural Networks Models - Multi-layer Neural Networks Models - Neural Networks and Diffusion Systems - Cohnon-Hopfeld Networks - Human Memory Models - Automatic Response Networks - Shared Memory. Applications in medical fields.
HEMN453	**Surgery for Engineers** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN123, HEMN412** Fundamental skills and principles of surgery devices. Operating rooms design and sterilization. Computer assisted surgery technologies, including surgical navigation, image guidance and robotic surgery.
HEMN454	**Data Mining and Machine Learning in Healthcare** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN123, HEMN412** Introduction to Machine Learning. Univariate linear regression. (Optional: Linear algebra review.) Multivariate linear regression. Practical aspects of implementation. Octave tutorial. Logistic regression, One-vs-all classification, Regularization. Neural Networks. Practical advice for applying learning algorithms: How to develop, debugging, feature/model design, setting up experiment structure. Support Vector Machines (SVMs) and the intuition behind them. Unsupervised learning: clustering and dimensionality reduction - Biomedical Applications.
HEMN455	**Introduction to Health Care and Public Health in Egypt** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN328, HEMN323** This course is a survey of how health care and public health are organized and services delivered in the Egypt. It covers public policy, relevant organizations and their interrelationships, professional roles, legal and regulatory issues, and payment systems. It also addresses health reform initiatives in the Egypt.

HEMN460	**BioStatistics** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): MTHN203** Through simulation studies conducted in R and STATA, students will explore questions such as: What are the true coverage rates of commonly used confidence interval methods for proportions? What is the impact of sampling from various non-normal distributions on the true Type I Error rate for hypothesis testing methods? How do various testing methods compare in terms of power in a variety of settings? How do traditional hypothesis testing methods compare and contrast with methods in the Bayesian and Likelihoodist paradigms? Medical applications.
HEMN465	**Internet of Medical Things (IoMT)** **Compulsory, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN314** The Internet of Things, Definitions, implications, perspectives, and some stats - Acquiring Data (Sensors), The Embedded Platforms (Microcontrollers and Processors) - The Intel Galileo Platform, The Intel Arduino IDE - Industry Markets and Applications, Issues and Challenges, Planning a Deployment - Networking, IP Addressing, Implementing a basic webserver, Data Encoding - Driving digital outputs like a bus, Communicating with a computer (UART) - Acquiring information from analog sensors (temperature and luminosity), Reading a digital sensor (temperature and relative humidity), I2C Master-Slave scheme between the Intel Galileo and an Arduino Mega, Controlling a servo-motor (PWM) Industry and academic trends, Business models and projected growth, Micro Sensors and Wearable Applications, Medical Sensors - Serial Communications Protocols, Inter-Integrated Circuit (I2C), Serial Peripheral Interface (SPI) - Health care industry, current technologies and IoMT's evolving role.
HEMN466	**Business Process Mining and Enterprise Architecture** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN315** Administration and Information Technology, incorporating tools and techniques for designing, implementing, controlling, and analyzing Operational Business Processes. Event logs for analyzing business processes. Process mining beyond data storage and data analysis; data with processes, trends, and patterns that affect process efficiency.
HEMN470	**Medical Optics** **Elective, Credits: 3 (2+3+0)** **Prerequisite(s): HEMN370** Introduction to light, Medical Laser, Tissue Optics, Simulation of light tissue propagation, Application of Lasers in therapy and diagnosis, Application of Lasers in surgery, Application of Laser in Dentistry, Laser applications in nanotechnology.