Specialized Tracks of Engineering Profession

PART [C]: SPECIALIZED PROGRAMS

(7) BIOMEDICAL AND HEALTHCARE DATA ENGINEERING (BDE)

برنامج هندسة بيانات الرعاية الطبية والصحية

(7) Biomedical And Healthcare Data Engineering (BDE)

برنامج هندسة بيانات الرعاية الطبية والصحية

VISION رؤية البرنامج

Providing the highest levels of excellence in university education in pursuit of continuous quality in the various engineering and administrative aspects in the field of health care.

توفير أرقي درجات التميز في التعليم الجامعي سعيا إلى الجودة المستمرة في النواحي الهندسية والإدارية المختلفة في مجال الرعاية الصحية.

MISSION رسالة البرنامج

We seek to provide:

- A competent graduate capable of employing scientific and technical knowledge to serve health care applications.
- The knowledge and practice necessary to improve and raise the efficiency of health care services in the community.
- Modern and diverse knowledge and practice in the field of health care necessary to develop services and invent creative and innovative solutions through scientific research.

نسعى إلى توفير:

- خريج كفء قادر على توظيف مخزون المعرفة العلمية والتقنية لخدمة تطبيقات الرعاية الصحية.
- المعرفة اللازمة لتحسين ورفع كفاءة خدمات الرعاية الصحية في المجتمع.
- المعارف الحديثة والمتنوعة في مجال الرعاية الصحية واللازمة لتطوير الخدمات وابتكار الحلول الخلاقة والمبتكرة من خلال الأبحاث العلمية.

GRADUATE ATTRIBUTES مواصفات الخريج

A1. Identify, formulate, and solve complex engineering problems by applying engineering fundamentals, basic science and mathematics.
A2. Develop and conduct appropriate experimentation and/or simulation, analyze and interpret data, assess and evaluate findings, and use statistical analyses and objective engineering judgment to draw conclusions.
A3. Apply engineering design processes to produce cost-effective solutions that meet specified needs with consideration for global, cultural, social, economic, environmental, ethical and other aspects as appropriate to the discipline and within the principles and contexts of sustainable design and development.
A4. Utilize contemporary technologies, codes of practice and standards, quality guidelines, health and safety requirements, environmental issues and risk management principles.

A5. Practice research techniques and methods of investigation as an inherent part of learning.
A6. Plan, supervise and monitor implementation of engineering projects, taking into consideration other trades requirements.
A7. Function efficiently as an individual and as a member of multi-disciplinary and multi-cultural teams.
A8. Communicate effectively – graphically, verbally and in writing – with a range of audiences using contemporary tools
A9. Use creative, innovative and flexible thinking and acquire entrepreneurial and leadership skills to anticipate and respond to new situations.
A10. Acquire and apply new knowledge and to practice self, lifelong and other learning strategies.
B1. Design, model and analyze an electrical/electronic/digital system or component for a specific application; and identify the tools required to optimize this design.
B2. Design and implement elements, modules, sub-systems or systems in electrical/electronic/digital engineering using technological and professional tools.
B3. Estimate and measure the performance of an electrical/electronic/digital system and circuit under specific input excitation and evaluate its suitability for a specific application.
B4. Adopt suitable national and international standards and codes to: design, build, operate, inspect and maintain electrical/electronic/digital equipment, systems and services.
C1. Apply principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics and statistics.
C2. Solve bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems.
C3. Analyze, model, design, and realize bio/biomedical engineering systems, components, or processes.
C4. Use the techniques, skills, and modern engineering tools necessary for biomedical engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints.
C5. A recognition of the need for, and an ability to engage in life-long learning.
C6. Understand professional, ethical and moral responsibility.
C7. Understand the impact of biomedical engineering solutions in a global and societal context.
C8. Employ Mathematics, Modeling, Statistics and Machine learning tools to understand/model/build a system by revealing which variables are shared between components of a system.

PROGRAM BENCHMARK مرجعية البرنامج

NARS 2018	LEVEL A	LEVEL B	LEVEL C	LEVEL D
	"Engineering" Totally Adopted P. A11	"Electrical Eng." Partially Adopted	"Biomedical Eng." ABET standards	NA

In addition to the Basic Engineer competencies and the Electrical Engineer competencies, the BDE graduate must be able to:

C LEVEL

C1-Apply principles of engineering, biology, human physiology, chemistry, calculus-based physics, mathematics (through differential equations) and statistics;
C2- Solve bio/biomedical engineering problems, including those associated with the interaction between living and non-living systems;
C-3 Analyze, model, design, and realize bio/biomedical engineering devices, systems, components, or processes.
C4- Make measurements on and interpret data from living systems.

SPECIALIZED COURSES CONTENTS توصيف المقررات

Code	Name	Credit Hours	Category	Pre-requisite
MTHS204	Advanced Probability and Statistics	3	DR	MTHS102
BDES280	Engineering Seminar	1	DR	30 CR HRS + AA APROVAL
BDES281	Industrial Training-1	1	FR	60 CR HRS + AA APROVAL
BDES381	Industrial Training-2	2	DR	BDES281 + AA APPROVAL
BDES481	Graduation Project-1	1	FR	110 CR HRS + AA APROVAL
BDES482	Graduation Project-2	3	DR	BDES481 + AA APROVAL
Total		**9+2**		

COURSES CONTENTS توصيف المقررات

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
Faculty Requirements										
MTHS204	Advanced Probability and Statistics	3								
	Pre-requisites: MTHNS102									
BDES280	Engineering Seminar	1	1							1
	Pre-requisites: 30 CR HRS + AA APRCVAL									
	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.									
BDES281	Industrial Training 1	1	1							1
	Pre-requisites: 60 CR HRS + AA APRCVAL									
	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									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
	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.									
BDES381	Industrial Training 2	2	2							2
	Pre-requisites: BDES281 + AA APPROVAL									
	Training on industrial establishments relevant to the program. Training lasts for total of 180 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.									
BDES481	Graduation Project 1	1			3					3
	Pre-requisites: 110 CR HRS + SOPHOMORE									
	Students – in groups (or individually in some programs) - undertake a final project as part of the program. In GP1, students provide a clear identification of a real-life problem that represents an actual need for the industry or the community and reflects the mission and strategic objective of CUFE. Students are expected to survey the related literature, collect, and interpret market data, and proposed an approach for the solution, using the engineering knowledge and skills acquired. The course is graded as Pass/Fail based upon a report/oral presentation stating the expected cost and required material, tools, and facilities as well as a timed list of deliverables.									
BDES482	Graduation Project 2	3	1	4						5
	Pre-requisites: BDES481 + AA APROVAL									
	Graduation Project-2 is the second phase of the graduation project. The aim is to develop innovative solutions to problems encountered during the implementation process thus fulfilling the deliverables stated in Graduation Project-1. A dissertation on the project is submitted taking into consideration technical, economic, social, and environmental requirements while analysing the major results and presenting direct conclusions.									

PROGRAM REQUIREMENTS متطلبات البرنامج

Category		No. of courses	Course Credit Hour	Total Credit Hours
Discipline Requirements (DR)	core/ compulsory	15	3	45
		8	2	16
Total DR courses		24		61
Program Requirement (PR)	core/ compulsory	7	3	21
		2	2	4
	Elective	7	3	21
Total PR courses		16		46
Total Elective courses (DR & PR)		40		107

- **Discipline Requirements (DR) core/compulsory courses list**

Code	Name	Credit Hours	Pre-requiste
MTHS102	Linear Algebra and Multivariable Integrals	3	MTHS002
MTHS104	Differential Equations	3	MTHS003
ELCS103	Circuit Analysis	3	PHYS002 + MTHS003
ELCS123	Basic Electronics & Digital Design	3	ELCS103
CMPS102	Programming Techniques	3	INTS005
CMPS103	Data Structures & Algorithms	3	INTS005 + CMPS102
SBES120	Introduction to Biomedical Engineering	2	None
SBES121	Medical Physics	3	None
SBES122	Anatomy & Physiology for Engineers	2	None
SBES130	Basics of Computer Architecture	3	None
SBES131	Clinical Engineering	2	SBES120
SBES140	Computer Graphics & Visualization	3	CMPS102
SBES141	Analytical & Lab Instruments	2	SBES120 + SBES121
SBES150	Database Systems for Medical Data	3	CMPS102
SBES151	Measurements & Quantitative Experimentation	2	MTHS104
SBES152	Biomedical Signal Processing	3	MTHS102
SBES153	Biomedical Transducers	3	SBES121
SBES160	Medical Image Processing & Computer Vision	3	SBES152
SBES161	Medical Monitors & Life Support Equipment	3	SBES153
SBES162	Embedded Systems in Medical Equipment	3	ELCS123 + CMPS102

Code	Name	Credit Hours	Pre-requiste
SBES170	Medical Imaging Modalities 1	2	SBES152 + SBES153
SBES171	HealthCare Information Systems (HCIS)	2	SBES150
SBES180	Medical Imaging Modalities 2	2	SBES152+ SBES153
Total		**61**	

- **Program Requirements (PR) core/compulsory courses list**

Code	Name	Credit Hours	Pre-requiste
MTHS004	Discrete Mathematics	3	MTHS002
CMPS203	Software Engineering	3	CMPS103
SBES240	Requirements Engineering for Digital Health	2	None
SBES250	Operations Research in Healthcare	3	SBES131
SBES251	Entrepreneurship in Healthcare Industry	2	SBES120
SBES252	Algorithms in Medicine	3	CMPS103 + MTHS004
SBES260	Medical Distributed Application Development	3	SBES150
SBES261	Healthcare Facilities Design and Planning	3	SBES131
SBES270	Medical Standards and Accreditation	3	SBES161
Total		**25**	

- **Program Requirements (PR) elective courses list**

Code	Name	Credit Hours	Pre-requiste
SBES309	Selected Topics in Biomedical Engineering	3	SBES131
SBES313	Human Factors Engineering	3	None
SBES316	Telemedicine Technologies	3	SBES240
SBES317	Usability Engineering in Healthcare	3	SBES131
SBES319	Selected Topics in Software Technologies in Medicine	3	CMPS203
SBES328	Selected Topics in Signal Processing in Medicine	3	SBES152
SBES329	Selected Topics in Image Processing in Medicine	3	SBES160
SBES331	Software for Medical Equipment Interfacing	3	SBES162
SBES339	Selected Topics in Embedded Systems in Medicine	3	SBES162
SBES342	Medical Device Technologies	3	SBES121
SBES345	Assistive Technologies	3	SBES153

Code	Name	Credit Hours	Pre-requiste
SBES346	Surgery for Engineers	3	SBES121
SBES348	Introduction to Nano-Biosensors	3	SBES153
SBES349	Selected Topics in Medical Technologies	3	SBES153
SBES359	Selected Topics in Technology Management in Healthcare	3	SBES240
SBES361	Machine learning in Medicine	3	SBES252
SBES362	Big Data I	3	SBES252
SBES365	Natural language Processing (NLP) in Medical Applications	3	CMPS102 + SBES252
SBES366	Medical Expert Systems	3	MTHS003+ SBES252
SBES367	Clinical Decision Support Systems	3	CMPS102+ SBES252
SBES368	Selected Topics in Data Science in Medicine	3	CMPS203
SBES369	Selected Topics in Artificial Intelligence in Medicine	3	SBES252
SBES371	Biomechanics I	3	EMCS001 + EMCS002
SBES372	Medical Robotics I	3	SBES240
SBES374	Selected Topics in Robotics in Medicine	3	SBES345
SBES375	Bioinformatics I	3	CMPS102+MTHS204
SBES376	Biomedical Systems Modeling & Simulation	3	MTHS104+SBES121
SBES378	Selected Topics in Systems in Medicine	3	SBES376
SBES379	Selected Topics in Computational Biology	3	SBES252
SBES409	Advanced Topics in Biomedical Engineering	3	SBES309
SBES413	Virtual Reality in Medical Applications	3	SBES140
SBES419	Advanced Topics in Software Technologies in Medicine	3	SBES319
SBES424	Advanced Topics in Image Processing & Computer Vision	3	SBES329
SBES425	Medical Image Analysis	3	SBES160
SBES426	Medical Pattern Recognition	3	SBES160
SBES428	Advanced Topics in Signal Processing in Medicine	3	SBES328
SBES429	Advanced Topics in Image Processing in Medicine	3	SBES329
SBES431	Coding Practice for Embeddec Medical Systems	3	SBES162
SBES432	Real-time Embedded Medical Devices	3	SBES162
SBES435	Internet of Medical Things (IoMT)	3	SBES240
SBES436	Technology Management in Healthcare	3	SBES240
SBES439	Advanced Topics in Embedded Systems	3	SBES339

Code	Name	Credit Hours	Pre-requiste
SBES443	Point-Of-Care Equipment	3	SBES153
SBES446	Quantitative Functional Imaging	3	SBES160
SBES447	Medical Optics	3	SBES121
SBES449	Advanced Topics in Medical Technologies	3	SBES349
SBES452	Advanced Topics in Healthcare Facilities Design and Planning	3	SBES261
SBES455	Introduction to Health Care and Public Health in Egypt	3	SBES131
SBES456	Business Process Mining and Enterprise Architecture	3	SBES131
SBES459	Advanced Topics in Technology Management in Healthcare	3	SBES359
SBES461	Deep Learning in Medicine	3	SBES361
SBES462	Big Data II	3	SBES361+SBES362
SBES466	Biomedical Data Analytics	3	MTHS104 + SBES121
SBES468	Advanced Topics in Data Science in Medicine	3	SBES368
SBES469	Advanced Topics in Artificial Intelligence in Medicine	3	SBES369
SBES471	Biomechanics II	3	SBES371
SBES472	Medical Robotics II	3	SBES372
SBES473	Rehabilitation Robotics	3	SBES371
SBES474	Advanced Topics in Robotics in Medicine	3	SBES374
SBES475	Bioinformatics II	3	SBES375
SBES477	Neuroengineering	3	SBES121
SBES478	Advanced Topics in Systems in Medicine	3	SBES378
SBES479	Advanced Topics in Computational Biology	3	SBES379

Proposed Study Plan - 8 semesters - Including Freshman Level

S	Code	Name	Credit Hours	Contact Hours							
				Lec	Tut (2)	App Tut	Lab	Stud	Off Tut	OffHr	Total
SEMESTER 1	INTS005	Information Technology	2	1			3				4
	PHYS001	Mechanical Properties of Matter and Thermodynamics	3	2		2	1				5
	MTHS002	Calculus I	3	2	2						4
	EMCS001	Engineering Mechanics - Dynamics	3	1	2		1				4
	CHES001	Chemistry for Engineers	2	1	2						3
	PHYS002	Electricity and Magnetism	3	2		2	1				5
	E-A (GENS004)	Proficiency and Capacity Building	1	1							1
	GENS002	Critical and Creative Thinking	2	2							2
		Sub-Total	**19**	**13**	**6**	**4**	**5**	**0**	**0**	**0**	**28**

S	Code	Name	Credit Hours	Contact Hours							
				Lec	Tut (2)	App Tut	Lab	Stud	Off Tut	OffHr	Total
SEMESTER 2	GENS002	Societal Issues	2	2							2
	E-A (GENS005)	Elective E-A (Communication anc Presentation Skills)	2	2							2
	MTHS003	Calculus II	3	2	2						4
	EMCS002	Engineering Mechanics - Statics	2	1	2						3
	INTS001	Engineering Graphics	3	2		2	1				5
	SBES121	Medical Physics	3	2		2	1				5
	SBES122	Anatomy & Physiology for Engineers	2	2							2
	SBES120	Introduction to Biomedical Engineering	2	1	2						3
		Sub-Total	**19**	**14**	**2**	**10**	**2**	**0**	**0**	**0**	**26**

S	Code	Name	Credit Hours	Contact Hours							
				Lec	Tut (2)	App Tut	Lab	Stud	Off Tut	OffHr	Total
SEMESTER 3	MTHS102	Linear Algebra and Multivariable Integrals	3	2	2						4
	CMPS102	Programming Techniques	3	2			3				5
	SBES131	Clinical Engineering	2	2							2
	SBES130	Basics Of Computer Architecture	3	2		2	1				5
	ELCS103	Circuit Analysis	3	2		2	1				5
	MTHS004	Discrete Mathematics	3	2	2						4
	E-A (GENS110)	Elective E-A (Fundamental of Management, Risk and Environment)	2	2							2
		Sub-Total	**19**	**14**	**4**	**4**	**5**	**0**	**0**	**0**	**27**

S	Code	Name	Credit Hours	Contact Hours							
				Lec	Tut (2)	App. Tut	Lab	Stud	Off Tut	Off. Hrs	Total
SEMESTER 4	MTHS104	Differential Equations	3	2	2						4
	MTHS204	Advanced Probability and Statistics	3	2	2						4
	CMPS103	Data Structures & Algorithms	3	2			3				5
	SBES140	Computer Graphics & Visualization	3	2		2					4
	ELCS123	Basic Electronics & Digital Design	3	2		2	1				5
	SBES141	Analytical & Lab Instruments	2	1	2						3
	SBES240	Requirements Eng for Digital Health	2	1	2						3
		Sub-Total	**19**	**12**	**8**	**4**	**4**	**0**	**0**	**0**	**28**

S	Code	Name	Credit Hours	Contact Hours							
				Lec	Tut (2)	App Tut	Lab	Stud	Off Tut	OffHr	Total
SEMESTER 5	SBES150	Database Systems for Medical Data	3	2		2	1				5
	SBES151	Measurements & Quantitative Experiments	2	1		2	1				4
	SBES152	Biomedical Signal Processing	3	2	2						4
	SBES153	Biomedical Transducers	3	2		2	1				5
	SBES250	Operations Research in Healthcare	3	2	2						4
	SBES251	Entrepreneurship in Healthcare Industry	2	2							2
	SBES252	Algorithms in Medicine	3	2		2					4
		Sub-Total	**19**	**13**	**4**	**8**	**3**	**0**	**0**	**0**	**28**

S	Code	Name	Credit Hours	Contact Hours							
				Lec	Tut (2)	App. Tut	Lab	Stud	Off Tut	Off. Hrs	Total
SEMESTER 6	BDES280	Engineering Seminar	1	1							1
	SBES160	Medical Image Processing & Comp Vision	3	2		2	1				5
	SBES161	Medical Monitors & Life Support Equip	3	2		2	1				5
	SBES162	Embedded Systems in Medical Equipment	3	2			2				4
	CMPS203	Software Engineering	3	2			3				5
	SBES260	Medical Distributed App Development	3	2		2	1				5
	SBES261	Healthcare Facilities Planning and Design	3	2	2						4
		Sub-Total	**19**	**13**	**2**	**6**	**8**	**0**	**0**	**0**	**29**

S	Code	Name	Credit Hours	Contact Hours							
				Lec	Tut (2)	App Tut	Lab	Stud	Off Tut	OffHr	Total
SEMESTER 7	E-A (GENS120)	Elective E-A (Fund. of Ecconomics and Accounting)	2	2							2
	BDES481	Graduation Project 1	1			3					3
	SBES170	Medical Imaging Modalities 1	2	2							2
	SBES171	HealthCare Information Systems 'HCIS)	2	2							2
	SBES270	Medical Standards & Accreditations	3	2		2	1				5
	SBES3xx	Major Elective 1	3	2	2						4
	SBES3xx	Major Elective 2	3	2	2						4
	SBES3xx	Major Elective 3	3	2	2						4
		Sub-Total	**19**	**14**	**6**	**5**	**1**	**0**	**0**	**0**	**26**

S	Code	Name	Credit Hours	Contact Hours							
				Lec	Tut (2)	App. Tut	Lab	Stud	Off Tut	Off. Hrs	Total
SEMESTER 8	GENS20X	E-1 (Marketing)	2	2							2
	BDES482	Graduation Project 2	3		6						6
	SBES180	Medical Imaging Modalities 2	2	2							2
	SBES4xx	Major Elective 4	3	2	2						4
	SBES4xx	Major Elective 5	3	2	2						4
	SBES4xx	Major Elective 6	3	2	2						4
	SBES4xx	Major Elective 7	3	2	2						4
		Sub-Total	**19**	**12**	**14**	**0**	**0**	**0**	**0**	**0**	**26**

COURSES CONTENTS توصيف المقررات

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
Discipline Requirements										
MTHS102	Linear Algebra and Multivariable Integrals	3	2	2	0					4
	Pre-requisites: MTHS002									
	Solving Linear Systems, Vector Spaces and Subspaces, Inner Product Spaces and Orthonormal Bases, The Eigenvalue Problem; Diagonalization of Matrices, Computing Functions of Matrices. Functions of Several Variables, The Gradient of a Scalar Function and its Applications, Vector Fields, Curl and Divergence, Double and Triple Integrals with Applications, Line and Surface Integrals with Applications.									
References	• "Calculus Early Transcendentals", by James Stewart, 8th edition, 2015, Cengage Learning. • "Elementary Linear Algebra with Applications" by B. Kolman and D. Hill, 2013, Pearson international edition									
MTHS104	Differential Equations	3	2	2	0					4
	Pre-requisites: MTHS003									
	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.									
References	• "A First Course in Differential Equations with Modeling Applications" 11th Edition 2017, by Dennis G. Zill. • "Fundamentals of Differential Equations", 9th Edition, 2017, by R. Nagle, Edward Saff, Arthur Snider. • "Advanced Engineering Mathematics", John Wiley & Sons, Inc., 10th Edition, 2011, by Erwin Kreyszig.									
ELCS103	Circuit Analysis	3	2		2	1				5
	Pre-requisites: PHYS002 + MTHS003									
	Basic concepts, Kirchhoff's Laws, series and parallel combination - Topology of electrical circuitsSolution of DC circuits using KVL and KCL - Solution of DC circuits using step by step simplification, loop and nodeanalysis - Basic circuit Theorems: Thevenin, Norton, and theory of maximum power transfer - Operational Amplifier Circuits - Time domain transient analysis of simple RC and RL circuits - Phasors and Sinusoidal steady-state analysis of AC circuits - AC complex power analysis - Magnetically coupled circuits (Transformers) - Frequency Response of RL, RC, and RLC circuits (Filters) - Two-port network analysis - DC motors and speed control - Earthing and equipment protection.									
References	• Alexander and M. Sadiku, Fundamental of Electric Circuits, Mc-Graw Hill, 5th Ed, 2013. • J. W. Nilsson and S. A. Riedel, Electric Circuits, Prentice Hall, 8th Edition, 2008.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
ELCS123	Basic Electronics & Digital Design	3	2		2	1				5
	Pre-requisites: ELCS103									
	Operational Amplifiers (OpAmps) - Diode, MOS, BJT - Transistor AC Analysis and Amplifiers - CMOS Digital Integrated Circuits - FF's, Registers, & Counters - MSI Logic Circuits - Programmable Logic Devices.									
References	• Adel S. Sedra & Kenneth C. Smith, Microelectronic Circuits; 8th Edition; Oxford University Press; 2020. • Neal S. Widmer, Gregory L. Moss, and Ronald J. Tocci, Digital Signal Principles and Applications; 12th Edition; Pearson; 2017.									
CMPS102	Programming Techniques	3	2			3				5
	Pre-requisites: INTS005									
	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.									
References	• Programming and Problem Solving with C++: Comprehensive 6th Edition. Jones & Bartlett Learning, 2016. • Programming: principles and practice using C++, 2nd edition. Pearson Education, 2014.									
CMPS103	Data Structures & Algorithms	3	2			3				5
	Pre-requisites: INTS005 + CMPS102									
	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.									
References	• Data Abstraction & Problem Solving with C++, Walls and Mirrors, By Frank M. Carrano, 6th edition, Pearson International Edition, Addison Wesley 2013 • Data Structures, A Pseudocode Approach in C By Richard F. Gilberg & Behrouz A. Forouzan, second edition Thomson Course Technology 2005, 2007 and later editions.									
SBES120	Introduction to Biomedical Engineering	2			1	2				3
	Pre-requisites: None									
	Introducing the students to biomedical engineering profession. Insights into multidisciplinary areas of biomedical engineering and design.									
References	• John Enderle and Joseph Bronzino, Introduction to Biomedical Engineering, 2011. • Laurence J. Street, Introduction to Biomedical Engineering Technology, 2016.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES121	Medical Physics	3	2		2	1				5
	Pre-requisites: None									
	Sound as a wave, absorption, reflection, scattering, Doppler effect - Electromagnetic Radiation and X-Rays - Basics of Nuclear Physics, and Nuclear Magnetic Resonance (NMR) - Thermodynamics, Heat transfer, Fluid mechanics - Optics, Light characterstics, Tissue optics, Light-tissue interaction.									
References	• Raymond A. Serway "Physics for scientists and engineers with modern physics" 9th edition, 2013. • Markolf H. Niemz, Laser-Tissue Interactions, Fundamentals and Applications Third, Enlarged Edition. • The Physics of Sound, 3rd Edition, R chard E Berg; David G Stork.									
SBES122	Anatomy & Physiology for Engineers	2	2							2
	Pre-requisites: None									
	Human muscular-skeletal system explcred 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 oresented from the engineering perspective. Bodily functions, their regulation and control discussed in quantitative terms and illustrated by mathematical models where feasible.									
References	• Atheena Milagi Pandian S, Anatomy and Human Physiology: Biomedical Engineering, Theena Milagi Pandian S; 1st Edition (2016)									
SBES130	Basics of Computer Architecture	3	2			2	1			5
	Pre-requisites: 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.									
References	• M. Morris Mano, Digital Design, 2018, • M. Morris Mano, Computer System Architecture, 1992.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES131	Clinical Engineering	2	2							2
	Pre-requisites: SBES120									
	Scope of Work of the Clinical Engineer and required knowledge - What is a medical device? (Definition, data, nomenclature, classification, certification, others) - Basic information about Health Technology Management lifecycle - Medical equipment inventory management - Medical equipment maintenance - New Applications in healthcare - Accreditation and quality programs (ISO, JCI, GAHAR, others).									
References	• Ernesto Iadanza, Clinical Engineering Handbook, 2nd Edition, Elsevier Inc., 2020. • YADIN DAVID, Clinical Engineering, CRC PRESS, 2005. • Joseph D. Bronzino, The Biomedical Engineering Handbook: 2nd Edition, 2000. • WHO Medical device technical series • ECRI Institute.									
SBES140	Computer Graphics & Visualization	3	2		2	1				5
	Pre-requisites: CMPS102									
	Geometric Modeling, Processing, and Transformation - CG Pipeline - Color Theory - Projection - Ray Casting - Illumination and Shading - Texture Mapping - Fundamentals of data visualization and animation.									
References	• Edward Angel, Dave Shreiner - Interactive Computer Graphics, A Top-Down Approach with Shader-Based OpenGL-Addison-Wesley (2012) • "Computer Graphics using OpenGL" by F. S. Hill, JR and Stephen M. Kelley, Third Edition, Pearson Education, 2007.									
SBES141	Analytical & Lab Instruments	2	1	2						3
	Pre-requisites: SBES120 + SBES121									
	Introduction to analytical instrumentation - UV, visible & IR spectrometry - Light sources - Sample & cuvette - Detectors - Luminescence - Atomic emission & absorption spectrometry - Gas chromatography - High performance liquid chromatography (HPLC) - Electrophoresis - Electrochemical instruments - Hematology									
References	• J.Y. Yoon: "Introduction to Biosensors - From Electric Circuits to Immunosensors". Springer, 2013. • G. McMahon: "Analytical Instrumentation: A Guide to Laboratory, Portable and Miniaturized Instruments". 1st Ed., John Wiley & Sons, 2007. • J.G. Webster: "Medical Instrumentation: Application & Design". 4th Ed., John Wiley & Sons, 2010.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES150	Database Systems for Medical Data	3	2		1	2				5
	Pre-requisites: CMPS102									
	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.									
References	• M. Carlos Coronel and Steven Morris, Database Systems: Design, Implementation, & Management, 2018.									
SBES151	Measurements & Quantitative Experimentation	2	1		2	1				4
	Pre-requisites: MTHS104									
	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.									
References	• Alan S Morris, Measurement and Instrumentation: Theory and Application, Academic Press; 3rd edition, 2020. • Patrick F. Dunn, Measurement and Data Analysis for Engineering and Science, 4th Edition, 2018.									
SBES152	Biomedical Signal Processing	3	2		2					4
	Pre-requisites: MTHS102									
	Characteristics of medical signals, Sampling and Recovery of Continuous Time Signals, Quantization and decimation, Signal Transformations and Transformation domains, Discrete Fourier Transform and its applications, Spectrogram, Z-Transform, Realtime Filter Design Techniques.									
References	• Alan Oppenheim and Ronald Schafer, Discrete-Time Signal Processing, Prentice-hall, International Edition, 2010. • Sanjit Mitra, Digital Signal Processing, McGraw-Hill Education, 2010.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES153	Biomedical Transducers	3	2		2	1				5
	Pre-requisites: SBES121									
	Error Types - Temperature sensors - Strain Sensors - Mechanical Sensors - Flow Sensors - Optical Sensors - Introduction to Nano-Biosensor.									
References	• Vibhav Kumar Sachan, Principles of Transducers & Biomedical Instrumentation: Designs and Applications, 2019.									
SBES160	Medical Image Processing & Computer Vision	3	2		2	1				5
	Pre-requisites: SBES152									
	Digital image fundamentals - Intensity transformation - Spatial filtering - Image in Frequency domain - Frequency domain filtering - Image restoration - Image reconstruction - Color image processing - Image compression - Morphological image processing - Image segmentation.									
References	• Digital Image Processing, R. C. Gonzalez, R. E. Woods, Global Edition, 2018.									
SBES161	Medical Monitors & Life Support Equipment	3	2		2	1				5
	Pre-requisites: SBES153									
	Medical Equipments Introduction - Infant Incubator - Defibrillator - Infusion Pump - Blood Oxygen Measurement - Electrosurgery - Hemodialysis - Phototherapy unit - Ventilators - ECG, EEG, EMG - Cardiac Output Measurement - 3D Printing in Medicine.									
References										
SBES162	Embedded Systems in Medical Equipment	3	2			2				4
	Pre-requisites: ELCS123 + CMPS102									
	Basic Structure Of An Embedded System - System Architecture and Assembly Language Programming - I/O Port - Branch, Call, and Time Delay Loop - Arithmetic, Logic Instructions, and Programs - ADC and Sensor Interfacing - LCD and Keypad Interfacing - Interrupts - Timer - Serial Port - Acquisition systems.									
References	• Better Embedded System Software by Philip Koopman, 2021									
SBES170	Medical Imaging Modalities 1	2	2							2
	Pre-requisites: SBES152, SBES153									
	Introduction to medical imaging - Imaging quality metrics. Basic physics and instrumentation of the clinical medical imaging modalities: X-Ray, CT, and nuclear imaging (SPECT and PET, Gamma Camera).									
References	• Principles of radiographic Imaging., 5th edition, By Richard R. Carlton et al. • Diagnostic Radiology Physics; A Handbook for teachers and students, By D.R. Dance et al.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES171	HealthCare Information Systems (HCIS)	2	2							2
	Pre-requisites: SBES150									
	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.									
References	• Health Care Information Systems: A Practical Approach for Health Care Management by Karen A. Wager, Frances W. Lee, et al., 2017									
SBES180	Medical Imaging Modalities 2	2	2							2
	Pre-requisites: SBES152, SBES153									
	Basic physics and instrumentation of the clinical medical imaging modalities: Ultrasound Imaging, Magnetic Resonance Imaging, Introduction to PACS, communication Principles.									
References	• Diagnostic ultrasound physics and equipment, by Peter R. Hoskins et al. • MRI Physics for Physicians, Alfred L. Horowitz et al. • Digital Radiology and PACS, By Christi E. Carter and Beth L. Vea.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
Program Requirements										
MTHS004	Discrete Mathematics	3	2	2						4
	Pre-requisites: MTHS002									
	Propositional Logic- First-Order Predicate Logic - Proof Techniques - Fundamentals of Set Theory-Relations-Functions - Complexity - An Introduction to Number Theory - Mathematical Induction - Introduction to Combinatorics - Permutations and Combinations - Introduction to Graph Theory - Introduction to Languages and Automata.									
References	• Discrete mathematics and its applications" 8th Edition 2019, by Kenneth H. Rosen.									
CMPS203	Software Engineering	3	2			3				5
	Pre-requisites: CMPS103									
	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.									
References	• Software Engineering by Ian Sommerville - 10th Edition 2015 • Engineering Software Products: An Introduction to Modern Software Engineering by Ian Sommerville 2019.									
SBES240	Requirements Engineering for Digital Health	2	1	2						3
	Pre-requisites: None									
	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.									
References	• Requirements Engineering for Digital Health, Samuel A. Fricker, Christoph Thümmler, et al., 2014.									
SBES250	Operations Research in Healthcare	3	2	2						4
	Pre-requisites: SBES131									
	Introduction to Operations Research and linear programming - Modeling with Linear Programming and the Graphical solution method - Computer solution with Solver and OR-Tools - Linear Programming applications - Introduction to the Simplex method and Sensitivity Analysis - Sensitivity analysis using Excel Solver - Goal programming and multi-objective optimization models - Review of basic probability theory and distribution functions and introduction to queuing theory - Classification of queuing models and the role of the exponential distribution - The birth-and-death process - M/M/1 queuing model - M/M/s queuing model - Queuing networks									
References	• Hamdy A. Taha, "Operations Research: An Introduction", 9th edition, 2011, Pearson.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES251	Entrepreneurship in Healthcare Industry	2	1	2						3
	Pre-requisites: SBES120									
	Introduction to entrepreneurial ecosystem. Special aspects of healthcare industry. How to build teams and start building them practically - Pick a healthcare project and go through building a business process - Compiling and presenting the sales pitch - Swot, BMC, VPC - Financial statements.									
References	• Entrepreneurship starting and operating a small business by Steve M. • Entrepreneurship successfully launching new ventures by Bruce R. Barringer and R. Duane Ireland. • Effective Small Business Management.									
SBES252	Algorithms in Medicine	3	2		2					4
	Pre-requisites: CMPS103, MTHS004									
	Time and space complexity analysis, worst, best, and average running time, growth functions. Divide and conquer strategy. Dynamic programming, Greedy algorithms. Priority Queues, Dynamic Arrays, Heap trees, Disjoint sets, Hash tables, Binary search trees, AVL trees, splay trees, Graph algorithms - Biomedical Applications.									
References	• Alexander Kulikov and Pavel Pevzner, Learning Algorithms through Programming and Puzzle Solving, 2020.									
SBES260	Medical Distributed Application Development	3	2		2	1				5
	Pre-requisites: SBES150									
	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.									
References	• Distributed Computing: Principles and Applications, M.L. Liu, 2019.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES261	Healthcare Facilities Design and Planning	3	2	2						4
	Pre-requisites: SBES131									
	Complexity in healthcare facilities and buildings, hospital project phases - Medical Equipment Planner deliverables - Understand and Apply International Standards for engineering systems in hospital like Medical Gases System, HVAC & Power Systems and Nurse call system - The main departments like inpatient departments and its types The intensive care Departments (ICU, Paediatric ICU, Neonatal ICU, cardiac CU, Burn ICU) Emergency department and The operating theatre & CSSD - Use CAD and Excel to prepare the Equipment list, Room By Room List, BOQ. Medical gases distribution table, NCS required table, Room data sheet tables - Review and asses the design of some studied department in hospital, Loading plans of some studied department in hospital.									
References	• FGI – Facility guidelines institute book • National Health services – Health care memorandums • Planning, Design, and Construction of Health Care Facilities, 4th Edition, by Joint Commission Resources and Carolyn Schierhorn, 2020									
SBES270	Medical Standards and Accreditation	3	2	2						4
	Pre-requisites: SBES161									
	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.									
References	• 2021 Hospital Accreditation Standards by JCR, 2020.									
Program Requirements – Elective										
SBES309	Selected Topics in Biomedical Engineering	3	2	2						4
	Pre-requisites: SBES131									
	Selected topics related to the state of the art in Biomedical Engineering.									
References	NA									
SBES409	Advanced Topics in Biomedical Engineering	3	2	2						4
	Pre-requisites: SBES309									
	Selected advanced topics related to the state of the art in Biomedical Engineering.									
References	NA									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES313	Human Factors Engineering	3	2	2						4
	Pre-requisites: 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.									
References	• Designing for People: An Introduction to Human Factors Engineering by John D Lee , Christopher D. Wickens, et al., 2017									
SBES317	Usability Engineering in Healthcare	3	2	2						4
	Pre-requisites: SBES131									
	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.									
SBES366	Medical Expert Systems	3	2	2						4
	Pre-requisites: MTHS003+ SBES252									
	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.									
References	• Expert Systems: Principles and Programming, Fourth Edition, by Joseph C. Giarratano and Gary D. Riley, 2004									
SBES316	Telemedicine Technologies	3	2	2						4
	Pre-requisites: SBES240									
	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.									
References	• Telemedicine Technologies: Information Technologies in Medicine and Digital Health by Bernard Fong, A. C. M. Fong, et al., 2020									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES413	Virtual Reality in Medical Applications	3	2	2						4
	Pre-requisites: SBES140									
	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.									
References	• Virtual Reality for Psychological and Neurocognitive Interventions (Virtual Reality Technologies for Health and Clinical Applications) by Rizzo, Albert "Skip" Rizzo, et al., 2019 • Virtual Reality for Physical and Motor Rehabilitation (Virtual Reality Technologies for Health and Clinical Applications) by Patrice L. (Tamar) Weiss, E nily A. Keshner, et al., 2014									
SBES319	Selected Topics in Software Technologies in Medicine	3	2	2						4
	Pre-requisites: CMPS102									
	Selected topics related to the state of the art in Software Technologies in Medicine.									
References	NA									
SBES419	Advanced Topics in Software Technologies in Medicine	3	2	2						4
	Pre-requisites: SBES319									
	Selected advanced topics related to the state of the art in Software Technologies in Medicine.									
References	NA									
SBES424	Advanced Topics in Image Processing & Computer Vision	3	2	2						4
	Pre-requisites: SBES324									
	State-of-art techniques and applications in computer vision and medical image processing. Review of Image Processing Fundamentals - Computer-Aided Diagnosis - Image Segmentation (I) - Image Segmentation (II) - Image Characterization - Features Detection Algorithms - Wavelet Transform - Image Classification (I) - Image Classification (II).									
References	• Digital Image Processing, Fourth Edition by Rafael C. Gonzalez and Richard E. Woods, 2018 . • Digital Image Processing and Analysis Applications with MATLAB® and CVIPtools, Third Edition, by Scott E Umbaugh, 2018 . • Computer Vision. L. Shapiro, and G. Stockman, Prentice Hall. 2001 . • Computer Vision: A modern approach. D. Forsyth, J. Ponce. Prentice Hall, 2002 . • Pattern classification. R.O. Duda, P.E. Hart, G. Stork. New York, John Wiley & Sons. 2001.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES425	Medical Image Analysis	3	2	2						4
	Pre-requisites: SBES160									
	State-of-art techniques and applications in medical image processing.									
References	• Digital Image Processing, Fourth Edition by Rafael C. Gonzalez and Richard E. Woods, 2018 . • Digital Image Processing and Analysis Applications with MATLAB® and CVIPtools, Third Edition, by Scott E Umbaugh, 2018 . • Computer Vision. L. Shapiro, and G. Stockman, Prentice Hall. 2001 . • Computer Vision: A modern approach. D. Forsyth, J. Ponce. Prentice Hall, 2002 . • Pattern classification. R.O. Duda, P.E. Hart, G. Stork. New York, John Wiley & Sons. 2001.									
SBES426	Medical Pattern Recognition	3	2	2						4
	Pre-requisites: SBES160									
	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.									
References	• Pattern Recognition and Signal Ana ysis in Medical Imaging by Anke Meyer-Baese and Volker J Schmid, 2014									
SBES328	Selected Topics in Signal Processing in Medicine	3	2	2						4
	Pre-requisites: SBES152									
	Selected topics related to the state of the art in signal processing in Medicine.									
References	NA									
SBES428	Advanced Topics in Signal Processing in Medicine	3	2	2						4
	Pre-requisites: SBES328									
	Selected advanced topics related to the state of the art in signal processing in Medicine.									
References	NA									
SBES329	Selected Topics in Image Processing in Medicine	3	2	2						4
	Pre-requisites: SBES160									
	Selected topics related to the state of the art in Image Processing in Medicine.									
References	NA									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES429	Advanced Topics in Image Processing in Medicine	3	2	2						4
	Pre-requisites: SBES160									
	Selected advanced topics related to the state of the art in Image Processing in Medicine.									
References	NA									
SBES439	Advanced Topics in Embedded Systems	3	2	2						4
	Pre-requisites: SBES339									
	State-of-art techniques and applications in embedded systems and its medical applications.									
References	NA									
SBES331	Software for Medical Equipment Interfacing	3	2	2						4
	Pre-requisites: SBES162									
	The general architecture and hardware programming for interfacing with and within medical devices and equipments.									
References	• ARM Microcontroller Interfacing: Hardware and Software by Warwick A. Smith, 2011									
SBES431	Coding Practice for Embedded Medical Systems	3	2	2						4
	Pre-requisites: SBES162									
	Developing code that handles the different constraints of embedded systems like coding guidelines, hardware, real-time and architecture constraints. Coding guidelines for embedded software - Software layered architecture - Hardware proxy pattern implementation - Polling pattern implementation - Observer pattern implementation - State machine pattern implementation - Real time constraints and CPU load calculations - Cyclic executive pattern implementation - Static priority pattern - Critical Region pattern - Research topics: General Purpose Timers, MISRA Rules, Real Time Operating Systems, UML Diagrams.									
References	NA									
SBES432	Real-time Embedded Medical Devices	3	2	2						4
	Pre-requisites: SBES162									
	Satisfying hard and soft real-time constraints when developing medical hardware applications. Introduction to Real time concepts - Task management - Time and evet Management - Semaphore Management - Queues - porting – Medical Applications.									
References	• Embedded and Real-Time Operating Systems by K.C. Wang, 2017									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES435	Internet of Medical Things (IoMT)	3	2	2						4
	Pre-requisites: SBES240									
	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 ICE - 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 (SP) - Health care industry, current technologies and IoMT's evolving role.									
References	• Internet of Medical Things: Remote Healthcare Systems and Applications (Internet of Things) by D. Jude Hemanth, J. Anitha, et al., 2021									
SBES339	Selected Topics in Embedded Systems in Medicine	3	2	2						4
	Pre-requisites: SBES162									
	Selected topics related to the state of the art in Embedded Systems in Medicine.									
References	NA									
SBES342	Medical Device Technologies	3	2	2						4
	Pre-requisites: SBES121									
	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. Introduction to Nanotechnology - Nanotechnology Design Aspects - Nanoparticles & Nanodevices - Nanomedicine - Audiology - Audiometry & Hearing Aids - Optics & Optical Principles - Optical Techniques & Instruments - Medical Laser Applications - Cardiac Measurements - Therapeutic & Prosthetic Devices									
References	• Gail D. Baura: "Medical Device Technologies – A Systems Based Overview Using Engineering Standards". Elsevier, 2012 . • J.G. Webster: "Medical Instrumentation: Application & Design". 4th Ed., John Wiley & Sons, 2010 . • J. Ramdsen: "Essentials of Nanotechnology". BookBoon. 2009.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES345	Assistive Technologies	3	2	2						4
	Pre-requisites: SBES153									
	Introduction to Assistive Technology - Assistive technologies development considerations: a clinical perspective - Deciding on patients' needs for Assistive technologies - Emerging technologies (Wearable sensors, 3D printing, Virtual reality - Assistive mobility technologies (Exoskeletons, prosthetics, wheelchairs) - Assistive technologies for elderly - Assistive technologies for visually impaired individuals - Assistive technologies in sports - Emerging technologies: Engineering solutions for COVID-19.									
References	• Moritz, E. C. K. E. H. A. R. D. Assistive technologies for the interaction of the elderly. Springer, Berlin, 2014 . • Lancioni, G. E., & Singh, N. N. (Eds.). (2014). Assistive technologies for people with diverse abilities. Springer Science & Business Media .									
SBES348	Introduction to Nano-Biosensors	3	2	2						4
	Pre-requisites: SBES153									
	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.									
References	Nanobiosensors: From Design to Applications by Aiguo Wu and Waheed S. Khan, 2020									
SBES443	Point-Of-Care Equipment	3	2	2						4
	Pre-requisites: SBES153									
	Technical aspects of the specific diagnostic and therapeutic equipment used in outpatient clinics. This includes Cardiology clinics, Ophthalmology clinics, Hearing and Balance clinics, clinics of Ear, Nose and Throat, Urology clinic, Pediatric clinics, Dental clinics and Cosmetic Clinic.									
References	• Point-of-Care Technologies Enabling Next-Generation Healthcare Monitoring and Management by Sandeep Kumar Vashist and John H.T. Luong, 2019.									
SBES446	Quantitative Functional Imaging	3	2	2						4
	Pre-requisites: SBES160									
	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.									
References	• Quantitative Imaging in Medicine, Background and Basics, By Robert J. Nordstrom, 2022									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES346	Surgery for Engineers	3	2	2						4
	Pre-requisites: SBES121									
	Fundamental skills and principles of surgery devices. Operating rooms design and sterilization. Computer assisted surgery technologies, including surgical navigation, image guidance and robotic surgery.									
References	• Surgical Equipment and Supplies by Colleen J. Rutherford RN MSN, 2016									
SBES447	Medical Optics	3	2	2						4
	Pre-requisites: SBES121									
	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.									
References	• Geometrical and Visual Optics, Third Edition, by Steven Schwartz, 2019 • Advanced Medical Optics, Inc. Business Background Report by ChoiceLevel Books, 2009									
SBES349	Selected Topics in Medical Technologies	3	2	2						4
	Pre-requisites: SBES153									
	Selected topics related to the state of the art in Medical Technologies.									
References	NA									
SBES449	Advanced Topics in Medical Technologies	3	2	2						4
	Pre-requisites: SBES349									
	Selected advanced topics related to the state of the art in Medical Technologies.									
References	NA									
SBES455	Introduction to Health Care and Public Health in Egypt	3	2	2						4
	Pre-requisites: SBES131									
	This course is a survey of how health care and public health are organized and services delivered in 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 Egypt.									
References	NA									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES435	Technology Management in Healthcare	3	2	2						4
	Pre-requisites: SBES240									
	business and management aspects applied in healthcare technologies companies and hospitals for a diversified perspective of real-life work. Organizational Structure - Strategic Management - Change Management - Case study - Industry expert - Human Resources Management - Enterprise Resource Planning - Clinical Engineering in Hospitals.									
References	• Leading Change, J. Kotter 2012 • The Strategic Management Process, by Samuel C. Certo and, Peter J. Paul, ISBN-13: 978-0256181494									
SBES456	Business Process Mining and Enterprise Architecture	3	2	2						4
	Pre-requisites: SBES131									
	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.									
References	• Enterprise Architecture for Digital Business: Integrated Transformation Strategies by Tushar K. Hazra and Bhuvan Unhelkar, 2020									
SBES452	Advanced Topics in Healthcare Facilities Design and Planning	3	2	2						4
	Pre-requisites: SBES352									
	Understand and Apply International Standards for the following departments: Outpatient Clinics, Rehabilitation, Haemodialysis, Radiology, Laboratories, Blood Bank, Pharmacy, Sterile compounding, Endoscopy , Cath lab, Morgue, Stores Medical Records - Using BIM (Revit) and Excel to prepare the Equipment list, Room By Room List, BOQ. Room data sheet tables and also layout, Review and asses the design of some studied department in hospital, Loading plans of some studied department in hospital.									
References	• Planning, Design, and Construction of Health Care Facilities, 4th Edition, by Joint Commission Resources and Carolyn Schierhorn, 2020									
SBES359	Selected Topics in Technology Management in Healthcare	3	2	2						4
	Pre-requisites: SBES240									
	Selected topics related to the state of the art in Technology Management in Healthcare.									
References	NA									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES459	Advanced Topics in Technology Management in Healthcare	3	2	2						4
	Pre-requisites: SBES359									
	Selected advanced topics related to the state of the art in Technology Management in Healthcare.									
References	NA									
SBES466	Biomedical Data Analytics	3	2	2						4
	Pre-requisites: MTHS104 + SBES121									
	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. Growing volumes of complex, heterogeneous data, 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.									
References	• Data Analytics in Biomedical Engineering and Healthcare by Kun Chang Lee, Sanjiban Sekhar Roy, et al., 2020.									
SBES365	Natural language Processing (NLP) in Medical Applications	3	2	2						4
	Pre-requisites: CMPS102 + SBES252									
	Fundamentals of clinical (NLP), basic linguistic principals underlying NLP, regular expressions, handling text data, text processing, extracting information from clinical notes. Introduction - Estimation Techniques, and Language Modelling - Parsing and Syntax - The EM Algorithm in NLP - Stochastic Tagging, and Log-Linear Models - Probabilistic Similarity Measures and Clustering - Machine Translation - Discourse Processing: Segmentation, Anaphora Resolution - Dialogue Systems - Natural Language Generation/Summarization - Unsupervised Methods in NLP									
References	• Biomedical Natural Language Processing by Kevin Bretonnel Cohen and Dina Demner-Fushman, 2014									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES367	Clinical Decision Support Systems	3	2	2						4
	Pre-requisites: CMPS102 + SBES252									
	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.									
References	• Clinical Decision Support Systems: Theory and Practice (Health Informatics) by Eta S. Berner, 2016.									
SBES361	Machine learning in Medicine	3	2	2						4
	Pre-requisites: SBES252									
	Introduction to Machine Learning - Regression - Learning strategies for basic classification algorithms (logistic regression, …) - Learning strategies for more advanced classification algorithms (Support vector machines, …) - Probabilistic models (Bayes Theory, Decision trees)- Learning strategies for more advanced classification algorithms (SVM, …) - Dimensionality Reduction (Principal component analysis)- Clustering (Subspace, Hierarchical, …) - Reinforcement Learning -Recommender Systems - Overfitting, underfitting, and the generalization gap - Machine Learning Algorithms testing and evaluation									
References	• Rogers S and Girolami M, A first course in Machine Learning, CRC Press, 2011.									
SBES461	Deep Learning in Medicine	3	2	2						4
	Pre-requisites: SBES361									
	Brief Introduction to Neural Networks - Historical Background - How Neural Networks Work - How Neural Networks Learn - Linear Separability - Back propagation of Errors – different types Autoencoders - Convolution Neural networks- Evolution of CNN - Adversarial Networks - Transfer learning - Federated Learning - Word2Vec, Skip grams - Reinforcement Learning									
References	• Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press, 2016.									
SBES362	Big Data I	3	2	2						4
	Pre-requisites: SBES252									
	Big Data Fundamentals - Big Data Analysis Methodologies - Big Data Storage - Database Presentations - Concurrent and Distributed Functional Programming using Scala - Big Data Processing Frameworks (Hadoop, Spark, Fink).									
References	• Big Data: Principles and best practices of scalable realtime data systems by Nathan Marz and James Warren, 2015 • Big Data Fundamentals: Concepts, Drivers & Techniques (The Pearson Service Technology Series from Thomas Erl) by Thomas Erl, Wajid Khattak, et al., 2016.									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES462	Big Data II	3	2	2						4
	Pre-requisites: SBES361 + SBES362									
	Data Mining Using Spark MLLib, Frequent Pattern Mining - Advanced Concepts of Big Data - Large Scale Data Processing - ETL and Data Ingestion - NoSQL Databases - Hive and Querying - Additional Features of upGrad's Big Data Course.									
References	• Big Data: Principles and best practices of scalable realtime data systems by Nathan Marz and James Warren, 2015 • Big Data Fundamentals: Concepts, Drivers & Techniques (The Pearson Service Technology Series from Thomas Erl) by Thomas Erl, Wajid Khattak, et al., 2016.									
SBES368	Selected Topics in Data Science in Medicine	3	2	2						4
	Pre-requisites: CMPS203									
	Selected topics related to the state of the art in Data Science in Medicine.									
References	NA									
SBES468	Advanced Topics in Data Science in Medicine	3	2	2						4
	Pre-requisites: SBES368									
	Selected advanced topics related to the state of the art in Data Science in Medicine.									
SBES369	Selected Topics in Artificial Intelligence in Medicine	3	2	2						4
	Pre-requisites: SBES252									
	Selected topics related to the state of the art in Artificial Intelligence in Medicine.									
References	NA									
SBES469	Advanced Topics in Artificial Intelligence in Medicine	3	2	2						4
	Pre-requisites: SBES369									
	Selected advanced topics related to the state of the art in Artificial Intelligence in Medicine.									
References	NA									
SBES371	Biomechanics I	3	2	2						4
	Pre-requisites: 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.									
References	• Biomechanics of Movement: The Science of Sports, Robotics, and Rehabilitation by Thomas K. Uchida, Scott L Delp, et al., 2021 • Biomechanics of Sport and Exercise by Peter M. McGinnis, 2020									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES471	Biomechanics II	3	2	2						4
	Pre-requisites: SBES371									
	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.									
References	• Biomechanics of Movement: The Science of Sports, Robotics, and Rehabilitation by Thomas K. Uchida, Scott L Delp, et al., 2021 • Biomechanics of Sport and Exercise by Peter M. McGinnis, 2020									
SBES372	Medical Robotics I	3	2	2						4
	Pre-requisites: SBES240									
	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.									
References	• Medical Robotics by Schweikard, 2015 • Medical Robots (Robotics in Our World) by Nadia Higgins, 2017 • Latest Developments in Medical Robotics Systems by Serdar Küçük, 2021 • Advanced Robotics for Medical Rehabilitation: Current State of the Art and Recent Advances by Shane (S.Q.) Xie, 2015									
SBES472	Medical Robotics II	3	2	2						4
	Pre-requisites: SBES372									
	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.									
References	• Medical Robotics by Schweikard, 2015 • Medical Robots (Robotics in Our World) by Nadia Higgins, 2017 • Latest Developments in Medical Robotics Systems by Serdar Küçük, 2021 • Advanced Robotics for Medical Rehabilitation: Current State of the Art and Recent Advances by Shane (S.Q.) Xie, 2015									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES473	Rehabilitation Robotics	3	2	2						4
	Pre-requisites: SBES371									
	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.									
References	• Medical Robotics by Schweikard, 2015 • Medical Robots (Robotics in Our World) by Nadia Higgins, 2017 • Latest Developments in Medical Robotics Systems by Serdar Küçük, 2021 • Advanced Robotics for Medical Rehabilitation: Current State of the Art and Recent Advances by Shane (S.Q.) Xie, 2015									
SBES374	Selected Topics in Robotics in Medicine	3	2	2						4
	Pre-requisites: SBES345									
	Selected topics related to the state of the art in Robotics in Medicine.									
References	NA									
SBES474	Advanced Topics in Robotics in Medicine	3	2	2						4
	Pre-requisites: SBES374									
	Selected advanced topics related to the state of the art in Robotics in Medicine.									
References	NA									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES376	Biomedical Systems Modeling & Simulation	3	2	2						4
	Pre-requisites: MTHS104, SBES121									
	Techniques and computer tools for modelling, predicting, analyzing and understanding dynamic behavior in biomedical systems. Requirements, conceptual models, mathematical models, software implementation, and simulation results and validation. Finite-element models of devices and physiological systems. Physics-based dynamic models of biomedical systems. Analytical techniques to assess the qualitative behavior of biomedical systems models. Computer-aided modelling and simulation. Data driven modelling, compartmental modelling; 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.									
References	• Angela B. Shiflet and George W. ShiletIntroduction to Computational Science: Modeling and Simulation for the Sciences. • Alan Garfinkel, Jane Shevtsov, Yina GuoModeling Life: The Mathematics of Biological SystemsSpringer, 2017.									
SBES375	Bioinformatics I	3	2	2						4
	Pre-requisites: CMPS102 + MTHS204									
	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.									
References	• Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis, Gary D. Bader, et al., 2020 • BIOINFORMATICS ALGORITHMS by Phillip Compeau, 2018									
SBES475	Bioinformatics II	3	2	2						4
	Pre-requisites: SBES375									
	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.									
References	• Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis, Gary D. Bader, et al., 2020 • BIOINFORMATICS ALGORITHMS by Phillip Compeau, 2018									

Code	Name/Content	Credit Hours	Contact Hours							
			Lec	Tut (2)	App. Tut	Lab	Stud	Off. Tut	Off. Hrs	Total
SBES477	Neuroengineering	3	2	2						4
	Pre-requisites: SBES121									
	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.									
References	• Neuroengineering by Daniel J. DiLorenzo and Joseph D. Bronzino, 2007 • Neuroengineering by Evelyn Page, 2020									
SBES378	Selected Topics in Systems in Medicine	3	2	2						4
	Pre-requisites: SBES376									
	Selected topics related to the state of the art in Systems in Medicine.									
References	NA									
SBES478	Advanced Topics in Systems in Medicine	3	2	2						4
	Pre-requisites: SBES378									
	Selected advanced topics related to the state of the art in Systems in Medicine.									
References	NA									
SBES379	Selected Topics in Computational Biology	3	2	2						4
	Pre-requisites: SBES252									
	Selected topics related to the state of the art in Computational Biology.									
References	NA									
SBES479	Advanced Topics in Computational Biology	3	2	2						4
	Pre-requisites: SBES379									
	Selected advanced topics related to the state of the art in Computational Biology.									
References	NA									