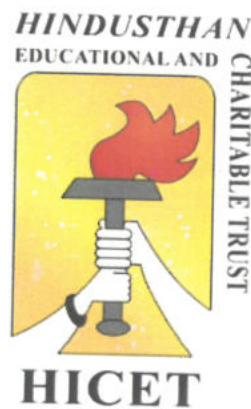


HINDUSTHAN COLLEGE OF ENGINEERING AND TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University, Chennai)
(Approved by AICTE, New Delhi, Accredited by NAAC with 'A' Grade)
Coimbatore - 641 032.

B.E. BIOMEDICAL ENGINEERING



Common to all B.E. / B.Tech. Degree Programmes
(CHOICE BASED CREDIT SYSTEM)

Curriculum & Syllabus
2021-2022

VISION AND MISSION OF THE INSTITUTION

VISION

To become a premier institution by producing professionals with strong technical knowledge, innovative research skills and high ethical values.

MISSION

IM1: To provide academic excellence in technical education through novel teaching methods.

IM2: To empower students with creative skills and leadership qualities.

IM3: To produce dedicated professionals with social responsibility.

VISION AND MISSION OF THE DEPARTMENT

VISION

To evolve into a center of excellence in biomedical engineering by nurturing and training interested minds in this diverse technology, thereby striving towards ensuring quality healthcare to the society.


MISSION

M1: To establish the best learning environment that helps the students to face the challenges of Biomedical Engineering field

M2: To inspire the students to drive the next generation innovation to come up with quality solutions to current healthcare needs.


**Chairman BoS
BME - HICET**




**Dean (Academics)
HICET**

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

- PO 1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- PO 2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- PO 3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- PO 4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- PO 5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- PO 6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- PO 7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- PO 8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- PO 9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- PO10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- PO11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- PO12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

**Chairman BoS
BME - HiCET**



**Dean (Academics)
HiCET**

PROGRAM SPECIFIC OUTCOMES (PSOs)

Biomedical Engineering Graduates will have ability to:

- PSO1: Design and develop biomedical devices to meet the needs of people by applying the Fundamentals of Biomedical Engineering.
- PSO2. Understand and implement various software skills for accurate diagnostic and Therapeutic applications.
- PSO3. Innovate new ideas and solutions for the healthcare field by integrating various Biomedical Technology.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

- PEO1. To create a strong foundation in engineering and biology for solving the existing Challenges in the healthcare sector.
- PEO2. To acquire knowledge in the cutting edge technologies of Biomedical Engineering field and an ability to identify, analyze and solve problems in the field.
- PEO3. To instill ethical values, communicative skills, teamwork and leadership skills necessary to function productively and professionally.


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CURRICULUM



Hindusthan College of Engineering and Technology

(An Autonomous Institution, Affiliated to Anna University, Chennai
Approved by AICTE, New Delhi & Accredited by NAAC with 'A' Grade)
Coimbatore, Tamil Nadu.



DETAILS OF CHANGES CARRIED OUT IN CURRICULUM & SYLLABUS

CBCS PATTERN

UNDERGRADUATE PROGRAMMES

B.E. BIOMEDICAL ENGINEERING (UG)

REGULATION-2016 & 2019

REGULATION-2019

For the students admitted during the academic year 2021-2022 and onwards

SEMESTER I														
S.No	CourseCode	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL				
THEORY														
1	21HE1101	Technical English	HS	2	1	0	3	40	60	100				
2	21MA1103	Calculus and Differential Equations	BS	3	1	0	4	40	60	100				
THEORY WITH LAB COMPONENT														
3	21PH1151	Applied Physics	BS	2	0	2	3	50	50	100				
4	21CY1151	Chemistry for Engineers	BS	2	0	2	3	50	50	100				
5	21CS1151	Python Programming and Practices	ES	2	0	2	3	50	50	100				
6	21EE1155	Basics of Electrical Engineering	ES	2	0	2	3	50	50	100				
PRACTICAL														
7	21HE1071	Value Added Course I: Language Competency Enhancement Course-I	HS	0	0	2	1	100	0	100				
MANDATORY COURSES														
8	21HE1072	Career Guidance Level - I	ES	2	0	0	0	100	0	100				
9	21HE1073	Entrepreneurship & Innovation	EEC	1	0	0	0	100	0	100				
				Total:				15	2	10	20	580	320	900
As Per AICTE Norms 3 Weeks Induction Programme is Added in the first Semester as an Audit Course														

SEMESTER II										
S.No	CourseCode	Course Title	Category	L	T	P	C	CIA	ESE	TOT
THEORY										
1	21HE2101	Business English for Engineers	HS	2	1	0	3	40	60	100
2	21MA2102	Complex Variables and Transform Calculus	BS	3	1	0	4	40	60	100
THEORY WITH LAB COMPONENT										
3	21PH2151	Material Science	BS	2	0	2	3	50	50	100
4	21CY2151	Environmental Studies	BS	2	0	2	3	50	50	100
5	21CS2152	Essentials of C&C++ Programming	ES	2	0	2	3	50	50	100
6	21ME2154	Engineering Graphics	ES	1	0	4	3	50	50	100



PRACTICAL										
7	21ME2001	Engineering Practices	ES	0	0	4	2	60	40	100
8	21HE2071	Language Competency Enhancement Course-II	HS	0	0	2	1	100	0	100
MANDATORY COURSES										
9	21HE2072	Career Guidance – Level II	EEC	2	0	0	0	100	0	100
10	21HE2073	Entrepreneurship & Innovation	EEC	1	0	0	0	100	0	100
Total:				15	2	16	22	640	360	1000

For the students admitted during the academic year 2020-2021 and onwards

SEMESTER III											
S.No	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL	
THEORY											
1	19MA3102	Fourier Analysis and Transforms	BS	3	1	0	4	25	75	100	
2	19BM3201	Electron Devices and Circuits	PC	3	1	0	4	25	75	100	
3	19BM3202	Medical Biochemistry	PC	3	0	0	3	25	75	100	
4	19BM3203	Human Anatomy and physiology	PC	3	0	0	3	25	75	100	
THEORY WITH LAB COMPONENT											
5	19BM3251	Digital Electronics	PC	2	0	2	3	50	50	100	
PRACTICAL											
6	19BM3001	Electron Devices and Circuits Laboratory	PC	0	0	3	1.5	50	50	100	
7	19BM3002	Biochemistry Laboratory	PC	0	0	3	1.5	50	50	100	
MANDATORY COURSES											
8	19MC3191	Indian Constitution	MC	2	0	0	0	100	0	100	
9	19HE3072	Career Guidance Level – III Personality, Aptitude and Career Development	EEC	2	0	0	0	100	0	100	
10	19HE3073	Leadership Management Skills	EEC	1	0	0	0	100	0	100	
Total				19	2	8	20	550	450	1000	

SEMESTER IV

S.No	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	19BM4201	Linear Integrated Circuits	PC	3	1	0	4	25	75	100
2	19BM4202	BioMEMS and Nanotechnology	PC	3	1	0	4	25	75	100
3	19BM4203	Pathology and Microbiology	PC	3	0	0	3	25	75	100
THEORY WITH LAB COMPONENT										
4	19MA4152	Statistics and Numerical Methods	BS	3	0	2	4	50	50	100
5	19BM4251	Sensors and Measurement	PC	2	0	2	3	50	50	100
PRACTICAL										
6	19BM4001	Integrated Circuits Lab	PC	0	0	3	1.5	50	50	100
7	19BM4002	Human Physiology Laboratory	PC	0	0	3	1.5	50	50	100
MANDATORY COURSES										
8	19MC4191	Value education- Essence of Indian Traditional Knowledge	MC	2	0	0	0	100	0	100
9	19HE4072	Career Guidance Level – IV:	EEC	2	0	0	0	100	0	100



		Personality, Aptitude and Career Development								
10	19HE4073	Ideation skills	EEC	1	0	0	0	100	0	100
Total				17	2	10	21	575	425	1000

For the students admitted during the academic year 2019-2020 and onwards

SEMESTER V

S.No.	CourseCode	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	19BM5201	Bio control systems	PC	3	1	0	4	25	75	100
2	19BM5202	Biomechanics	PC	3	0	0	3	25	75	100
3	19BM5203	Microprocessors and Microcontrollers	PC	3	0	0	3	25	75	100
4	19BM5204	Biomedical Instrumentation	PC	3	0	0	3	25	75	100
5	19BM53XX	Professional Elective-I	PE	3	0	0	3	25	75	100
THEORY WITH LAB COMPONENT										
6	19BM5251	Virtual Instrumentation Using LabVIEW	PC	2	0	2	3	50	50	100
PRACTICAL										
7	19BM5001	Microprocessors and Microcontrollers Lab	PC	0	0	3	1.5	50	50	100
8	19BM5002	Biomedical Instrumentation Lab	PC	0	0	3	1.5	50	50	100
MANDATORY COURSES										
9	19HE5071	Soft Skill	EEC	1	0	0	1	100	0	100
10	19HE5072	Design Thinking	EEC	1	0	0	1	100	0	100
Total				19	1	8	24	475	525	1000

SEMESTER VI

S.No.	CourseCode	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
THEORY										
1	19BM6201	Bio signal Processing	PC	3	1	0	4	25	75	100
2	19BM6202	Radiological Equipment and nuclear Medicine	PC	3	0	0	3	25	75	100
3	19BM63XX	Professional Elective-II	PE	3	0	0	3	25	75	100
4	19XX64XX	Open Elective-I	OE	3	0	0	3	25	75	100
5	19BM6203	Entrepreneurship Development	HS	3	0	0	3	25	75	100
THEORY WITH LAB COMPONENTS										
6	19BM6251	Diagnostic and Therapeutic Equipment-I	PC	3	0	1	3.5	50	50	100
PRACTICALS										
7	19BM6001	Bio signal Processing Laboratory	PC	0	0	3	1.5	50	50	100
MANDATORY COURSES										
8	19BM6701	Industrial Training*	EEC	0	0	0	1	0	100	100
9	19HE6071	Soft Skill	EEC	1	0	0	1	100	0	100
10	19HE6072	Intellectual Property Rights	EEC	1	0	0	1	100	0	100
Total				20	1	5	24	425	575	1000

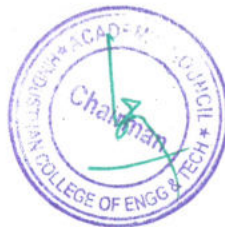


LIST OF PROFESSIONAL ELECTIVES

S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
PROFESSIONAL ELECTIVE I										
1	19BM5301	Medical Physics	PE	3	0	0	3	25	75	100
2	19BM5302	Robotics in Medicine	PE	3	0	0	3	25	75	100
3	19BM5303	Total Quality Management	PE	3	0	0	3	25	75	100
4	19BM5304	Medical Ethics and Standards	PE	3	0	0	3	25	75	100
5	19BM5305	Intellectual Property Rights	PE	3	0	0	3	25	75	100
PROFESSIONAL ELECTIVE II										
1	19BM6301	Biomaterial and Artificial Organs	PE	3	0	0	3	25	75	100
2	19BM6302	Embedded Systems in Medical Devices	PE	3	0	0	3	25	75	100
3	19BM6303	Biomedical Waste Management	PE	3	0	0	3	25	75	100
4	19BM6304	Physiological Modelling	PE	3	0	0	3	25	75	100
5	19BM6305	Artificial Neural Networks	PE	3	0	0	3	25	75	100

LIST OF OPEN ELECTIVES

BIOMEDICAL ENGINEERING										
S.No.	Course Code	Course Title	Category	L	T	P	C	CIA	ESE	TOTAL
1	19BM6401	Applications of Biomedical Engineering	OE	3	0	0	3	25	75	100



REGULATION-2016

**For the students admitted during the academic year 2018-2019 and onwards
SEMESTER VII**

S. No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16BM7201	Medical Image Processing	3	0	0	3	25	75	100
2	16BM7202	Diagnostic and Therapeutic Equipment-II	3	0	0	3	25	75	100
3	16BM73XX	Professional Elective-III	3	0	0	3	25	75	100
4	16BM73XX	Professional Elective-IV	3	0	0	3	25	75	100
5	16XX74XX	Open Elective-II	3	0	0	3	25	75	100
6	16HE7104	Entrepreneurship Development	2	0	0	2	25	75	100
PRACTICAL									
7	16BM7001	Medical Image Processing Laboratory	0	0	4	2	50	50	100
8	16BM7701	Technical Seminar	0	0	4	2	50	50	100
9	16BM7002	Hospital /Industrial Training (Presentations)	0	0	2	1	50	50	100
Total			17	0	10	22	300	600	900

SEMESTER VIII

S. No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
THEORY									
1	16BM83XX	Professional Elective-V	3	0	0	3	25	75	100
2	16BM83XX	Professional Elective-VI	3	0	0	3	25	75	100
PRACTICAL									
3	16BM8901	Project Work	0	0	24	12	50	50	100
Total Credits			6	0	24	18	100	200	300

PROFESSIONAL ELECTIVE III

S. No.	Course	Course Title	L	T	P	C	CIA	ESE	TOTAL
1.	16BM7301	Artificial Organs and Implants	3	0	0	3	25	75	100
2.	16BM7302	VLSI Design	3	0	0	3	25	75	100
3.	16BM7303	Advanced Bio Analytical and Therapeutic Techniques	3	0	0	3	25	75	100
4.	16BM7304	Internet of Things and Its Medical Applications	3	0	0	3	25	75	100
5.	16BM7305	Neural Engineering	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE IV

S. No.	Course	Course Title	L	T	P	C	CIA	ESE	TOTAL
1.	16BM7306	Biofluids and Dynamics	3	0	0	3	25	75	100
2.	16BM7307	Artificial Neural Networks	3	0	0	3	25	75	100
3.	16BM7308	Medical Data Analytics	3	0	0	3	25	75	100
4.	16BM7309	Robotics in Medicine	3	0	0	3	25	75	100
5.	16BM7310	Cancer Biology	3	0	0	3	25	75	100



PROFESSIONAL ELECTIVE V

S. No.	Course	Course Title	L	T	P	C	CIA	ESE	TOTAL
1.	16BM8301	Artificial Intelligence	3	0	0	3	25	75	100
2.	16BM8302	Machine learning Techniques in Medicine	3	0	0	3	25	75	100
3.	16BM8303	Medical Device Design	3	0	0	3	25	75	100
4.	16BM8304	Telemedicine	3	0	0	3	25	75	100
5.	16BM8305	Wearable Medical Devices	3	0	0	3	25	75	100

PROFESSIONAL ELECTIVE VI

S. No.	Course	Course Title	L	T	P	C	CIA	ESE	TOTAL
1.	16BM8306	Rehabilitation Engineering	3	0	0	3	25	75	100
2.	16BM8307	Physiological Modelling	3	0	0	3	25	75	100
3.	16BM8308	Biometrics	3	0	0	3	25	75	100
4.	16BM8309	Advanced Biosignal Processing	3	0	0	3	25	75	100
5.	16BM8310	Brain Computer Interface	3	0	0	3	25	75	100

LIST OF OPEN ELECTIVES

S. No.	Course Code	Course Title	L	T	P	C	CIA	ESE	TOTAL
SEMESTER VII									
1	16BM7401	First Aid In Emergency Care	3	0	0	3	25	75	100

CREDIT DISTRIBUTION
R2016

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	27	25	24	23	23	25	22	18	187

CREDIT DISTRIBUTION
R2019

Semester	I	II	III	IV	V	VI	VII	VIII	Total
Credits	20	22	20	21	24	24	20	14	165


Chairman, Board of Studies


Dean - Academics


Principal

**Chairman BoS
BME - HiCET**

**Dean (Academics)
HiCET**

PRINCIPAL
Hindusthan College of Engineering & Technology
COIMBATORE - 641 032



SYLLABUS

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	21HE1101	TECHNICAL ENGLISH	2	1	0	3
Course Objectives	1. To facilitate students to communicate effectively with coherence. 2. To train the learners in descriptive communication. 3. To introduce professional communication. 4. To enhance knowledge and to provide the information on corporate environment. 5. To equip the trainers with the necessary skills on critical thinking.					

Unit	Description	Instructional Hours
I	Listening and Speaking – Opening a conversation, maintaining coherence, turn taking, closing a conversation (excuse, general wishes, positive comments and thanks) Reading –Reading articles from newspaper, Reading comprehension Writing Chart analysis, process description, Writing instructions Grammar and Vocabulary - Tenses, Regular and irregular verb, technical vocabulary	9
II	Listening and Speaking - listening to product description, equipment & work place (purpose, appearance, function) Reading - Reading technical articles Writing - Letter phrases, writing personal letters, Grammar and Vocabulary -articles, Cause & effect, Prepositions.	9
III	Listening and Speaking - - listening to announcements Reading - Reading about technical inventions, research and development Writing - Letter inviting a candidate for interview, Job application and resume preparation Grammar and Vocabulary - Homophones and Homonyms.	9
IV	Listening and Speaking - - Practice telephone skills and telephone etiquette (listening and responding, asking questions). Reading - Reading short texts and memos Writing - invitation letters, accepting an invitation and declining an invitation Grammar and Vocabulary - Modal verbs, Collocation, Conditionals, Subject verb agreement and Pronoun-Antecedent agreement.	9
V	Listening and Speaking - listening to technical group discussions and participating in GDs Reading -reading biographical writing - Writing - Proposal writing, Writing definitions, Grammar and Vocabulary - Abbreviation and Acronym, Prefixes & suffixes, phrasal verbs.	9

Total Instructional Hours 45

- Course Outcomes**
- CO1- Trained to maintain coherence and communicate effectively.
 - CO2- Practiced to create and interpret descriptive communication.
 - CO3- Introduced to gain information of the professional world.
 - CO4- acquired various types of communication and etiquette.
 - CO5- Taught to improve interpersonal and intrapersonal skills.

TEXT BOOKS:

- T1- Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2016
- T2- Raymond Murphy, "Essential English Grammar", Cambridge University Press, 2021.

REFERENCE BOOKS:

- R1- Meenakshi Raman and Sangeetha Sharma. "Technical Communication- Principles and Practice", Oxford University Press, 2009.
- R2- Raymond Murphy, "English Grammar in Use"- 4th edition Cambridge University Press, 2004.
- R3- Kamallesh Sadanan "A Foundation Course for the Speakers of Tamil-Part-I &II", Orient Blackswan, 2010.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	21MA1103	CALCULUS AND DIFFERENTIAL EQUATIONS	3	1	0	4

Course Objectives

1. Understand the concept of differentiation.
2. Compute the functions of several variables which are needed in many branches of engineering.
3. Understand the concept of double integrals.
4. Understand the concept of triple integrals.
5. Solve ordinary differential equations of certain types using Wronskian technique.

Unit	Description	Instructional Hours
I	DIFFERENTIAL CALCULUS Rolle's Theorem – Lagrange's Mean Value Theorem- Maxima and Minima – Taylor's and Maclaurin's Theorem.	12
II	MULTIVARIABLE CALCULUS (DIFFERENTIATION) Total derivatives - Jacobians – Maxima, Minima and Saddle points - Lagrange's method of undetermined multipliers – Gradient, divergence, curl and derivatives.	12
III	DOUBLE INTEGRATION Double integrals in Cartesian coordinates – Area enclosed by the plane curves (excluding surface area) – Green's Theorem (Simple Application) - Stoke's Theorem – Simple Application involving cubes and rectangular parallelepiped.	12
IV	TRIPLE INTEGRATION Triple integrals in Cartesian co-ordinates – Volume of solids (Sphere, Ellipsoid, Tetrahedron) using Cartesian co-ordinates. Gauss Divergence Theorem – Simple Application involving cubes and rectangular parallelepiped.	12
V	ORDINARY DIFFERENTIAL EQUATIONS Ordinary differential equations of second order - Second order linear differential equations with constant coefficients – Cauchy – Euler's Equation - Cauchy – Legendre's Equation - Method of variation of parameters.	12
Total Instructional Hours		60

Course Outcomes

- CO1: Apply the concept of differentiation in any curve.
 CO2: Identify the maximum and minimum values of surfaces.
 CO3: Apply double integrals to compute the area of plane curves.
 CO4: Evaluation of triple integrals to compute volume of solids.
 CO5: Develop sound knowledge of techniques in solving ordinary differential equations that model engineering problems

TEXT BOOKS:

- T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018.
 T2 - Veerarajan T, "Engineering Mathematics", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016.

REFERENCE BOOKS:

- R1- Thomas & Finney "Calculus and Analytic Geometry", Sixth Edition,,Narosa Publishing House, New Delhi.
 R2 - Weir,M.D and Joel Hass, ' Thomas Calculus" 12th Edition,Pearson India 2016.
 R3 - Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	21PH1151	APPLIED PHYSICS	2	0	2	3

- Course Objectives**
1. Enhance the fundamental knowledge in properties of matter
 2. Analysis the oscillatory motions of particles
 3. Extend the knowledge about wave optics
 4. Gain knowledge about laser and their applications
 5. Conversant with principles of optical fiber, types and applications of optical fiber

Unit	Description	Instructional Hours
I	PROPERTIES OF MATTER Elasticity – Hooke's law – Stress-strain diagram - Poisson's ratio – Bending moment – Depression of a cantilever – Derivation of Young's modulus of the material of the beam by Uniform bending theory and experiment- Determination of Young's modulus by uniform bending method.	6+3
II	OSCILLATIONS Translation motion –Vibration motion – Simple Harmonic motion – Differential Equation of SHM and its solution – Damped harmonic oscillation - Torsion stress and deformations – Torsion pendulum: theory and experiment. Determination of Rigidity modulus – Torsion pendulum.	6+3
III	WAVE OPTICS Conditions for sustained Interference – air wedge and it's applications - Diffraction of light – Fresnel and Fraunhofer diffraction at single slit –Diffraction grating – Rayleigh's criterion of resolution power - resolving power of grating. Determination of wavelength of mercury spectrum – spectrometer grating. Determination of thickness of a thin wire – Air wedge method.	6+6
IV	LASER AND APPLICATIONS Spontaneous emission and stimulated emission – Population inversion – Pumping methods – Derivation of Einstein's coefficients (A&B) – Type of lasers – Nd:YAG laser and CO2 laser- Laser Applications – Holography – Construction and reconstruction of images. Determination of Wavelength and particle size using Laser.	6+3
V	FIBER OPTICS AND APPLICATIONS Principle and propagation of light through optical fibers – Derivation of numerical aperture and acceptance angle – Classification of optical fibers (based on refractive index, modes and materials) – Fiber optical communication link – Fiber optic sensors – Temperature and displacement sensors.	6
Total Instructional Hours		45

- Course Outcomes**
- CO1: Illustrate the fundamental properties of matter
 CO2: Discuss the Oscillatory motions of particles
 CO3: Analyze the wavelength of different colors
 CO4: Understand the advanced technology of LASER in the field of Engineering
 CO5: Develop the technology of fiber optical communication in engineering field

TEXT BOOKS:

- T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.
 T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2015.

REFERENCE BOOKS:

- R1 - Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill, New Delhi – 2015
 R2 - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Con Ltd., New Delhi, 2016
 R3 - Dr. G. Senthilkumar "Engineering Physics – I" VRB publishers Pvt Ltd., 2016


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Programme	Course Code	Name of the Course	L	T	P	C
BE/B.Tech	21CY1151	CHEMISTRY FOR ENGINEERS (COMMON TO ALL BRANCHES)	2	0	2	3

Course Objective

1. The boiler feed water requirements, related problems and water treatment techniques.
2. The principles of polymer chemistry and engineering applications of polymers and composites.
3. The principles of electrochemistry and with the mechanism of corrosion and its control.
4. The principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
5. The important concepts of spectroscopy and its applications.

Unit	Description	Instructional Hours
I	WATER TECHNOLOGY Hard water and soft water- Disadvantages of hard water- Hardness: types of hardness, simple calculations, estimation of hardness of water – EDTA method – Boiler troubles - Conditioning methods of hard water – External conditioning - demineralization process - desalination: definition, reverse osmosis – Potable water treatment – breakpoint chlorination. Estimation of total, permanent and temporary hardness of water by EDTA.	6 +3=9
II	POLYMER & COMPOSITES Polymerization – types of polymerization – addition and condensation polymerization – mechanism of free radical addition polymerization – copolymers – plastics: classification – thermoplastics and thermosetting plastics, preparation, properties and uses of commercial plastics – PVC, Bakelite – moulding of plastics (extrusion and compression); Composites: definition, types of composites – polymer matrix composites (PMC) –FRP	6
III	ELECTROCHEMISTRY AND CORROSION Electrochemical cells – reversible and irreversible cells - EMF- Single electrode potential – Nernst equation (derivation only) – Conductometric titrations. Chemical corrosion – Pitting – Bedworth rule – electrochemical corrosion – different types –galvanic corrosion – differential aeration corrosion – corrosion control – sacrificial anode and impressed cathodic current methods - protective coatings – paints – constituents and functions. Conductometric titration of strong acid vs strong base (HCl vs NaOH). Conductometric precipitation titration using BaCl₂ and Na₂SO₄. Estimation of Ferrous iron by Potentiometry.	6+9=15
IV	ENERGY SOURCES AND STORAGE DEVICES Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power generator-classification of nuclear reactor- light water reactor- breeder reactor. Batteries and fuel cells: Types of batteries- alkaline battery- lead storage battery- lithium battery- fuel cell H ₂ -O ₂ fuel cell applications.	6
V	ANALYTICAL TECHNIQUES Beer-Lambert's law – UV-visible spectroscopy and IR spectroscopy – principle – instrumentation (block diagram only) – flame photometry – principle – instrumentation (block diagram only) – estimation of sodium by flame photometry – atomic absorption spectroscopy – principles – instrumentation (block diagram only) – estimation of nickel by atomic absorption spectroscopy. Determination of iron content of the water sample using spectrophotometer.(1,10 phenanthroline / thiocyanate method).	6+3
Total Instructional Hours		45

Course Outcome

- CO1: Differentiate hard and soft water and to solve the related problems on water purification and its significance in industries and daily life
- CO2: Acquire the basic knowledge of polymers, composites and FRP and their significance.
- CO3: Develop knowledge on the basic principles of electrochemistry and understand the causes of corrosion, its consequences to minimize corrosion to improve industrial design.
- CO4: Develop knowledge about the renewable energy resources and batteries along with the need of new materials to improve energy storage capabilities.
- CO5: Identify the structure and characteristics of unknown/new compound with the help of spectroscopy.

TEXT BOOKS

- T1 -P. N. Madudeswaran and B.Jeyagowri, "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, Chennai (2019).
T2 - P.C.Jain and Monica Jain, "Engineering Chemistry" Dhanpat Rai Pub, Co., New Delhi (2018).

REFERENCE BOOKS

- R1 - B.Sivasankar "Engineering Chemistry" Tata McGraw-Hill Pub.Co.Ltd, New Delhi (2012).
R2 - S.S.Dara "A Text book of Engineering Chemistry" S.Chand & Co. Ltd., New Delhi (2017).


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Programme B.E.	Course Code 21CS1151	Name of the Course PYTHON PROGRAMMING AND PRACTICES	L 2	T 0	P 2	C 3
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- Course Objectives**
1. To know the basics of algorithmic problem solving
 2. To read and write simple Python programs
 3. To develop Python programs with conditionals and loops and to define Python functions and call them
 4. To use Python data structures — lists, tuples, dictionaries
 5. To do input/output with files in Python

Unit	Description	Instructional Hours
I	ALGORITHMIC PROBLEM SOLVING Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation(pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.	9
II	DATA, EXPRESSIONS, STATEMENTS Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments. Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.	7+2
III	CONTROL FLOW, FUNCTIONS Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.	5+4
IV	LISTS, TUPLES, DICTIONARIES Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.	3+6
V	FILES, MODULES, PACKAGES Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages. Illustrative programs: word count, copying file contents.	5+4
Total Instructional Hours		45

- Course Outcomes**
- CO1: Develop algorithmic solutions to simple computational problems
 - CO2: Read, write, execute by hand simple Python programs
 - CO3: Structure simple Python programs for solving problems and Decompose a Python program into functions
 - CO4: Represent compound data using Python lists, tuples, dictionaries
 - CO5: Read and write data from/to files in Python Programs.

TEXT BOOKS:

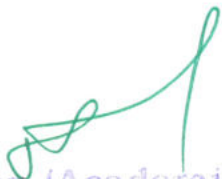
- T1 - Guido van Rossum and Fred L. Drake Jr, An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2017.
- T2 - S. Annadurai, S. Shankar, I. Jasmine Selvakumari Jeya, M. Revathi, Fundamentals of Python Programming, McGraw Hill Publications, 2021.

REFERENCE BOOKS:

- R1 - Charles Dierbach, —Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
- R2 - Timothy A. Budd, —Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	21EE1155	BASICS OF ELECTRICAL ENGINEERING	2	0	2	3

- Course Objective**
1. To introduce the fundamental concepts of electrical circuits and theorems.
 2. To understand the basic theory, operational characteristics of AC and DC machines.
 3. To study the operating principles of measuring instrument.
 4. To observe the electrical power supply sources and understand electrical wiring basics.
 5. To create awareness on the methods for electrical safety and protection.

Unit	Description	Instructional Hours
I	UNIT I : ELECTRICAL CIRCUITS AND ANALYSIS Ohm's law, DC and AC circuits fundamentals, Kirchhoff's laws, Mesh and Nodal analysis- Theorems and simple problems: Superposition, Thevenins, Maximum power transfer theorem- Experimental analysis of super position theorem.	6+3
II	UNIT II : ELECTRICAL MACHINES DC Machines: D.C generators & D.C motors: Principle of operation, constructions, types, Applications - A.C Motors: -Single Phase induction motors: principle of operation, Types and Applications-Single phase Transformers: Principles of operation, Constructional Details, Types and Applications- Implementation of no load test on single phase induction motor and Transformer.	6+3
III	UNIT III : BASIC ELECTRICAL INSTRUMENTATION Introduction, classification of instruments, operating principles, essential features of measuring instruments (elementary Treatment only) - Moving coil, permanent magnet (PMMC) instruments, Moving Iron of Ammeters and Voltmeters - Energy meter- Experimental measurement of voltage, current and power in single phase circuit.	6+3
IV	UNIT IV : BASICS OF POWER SUPPLY AND ELECTRICAL WIRING Introduction to Power supply circuits: Half wave, Full wave Rectifier – SMPS, UPS (online & offline). Wiring types and applications. Service mains, meter board and distribution board - Brief discussion on concealed conduit wiring. One way and two way control- implementation of simple wiring circuit for a household appliance.	6+3
V	UNIT V: ELECTRICAL SAFETY Need for Electrical safety - Electric shock, precautions against shock -Elementary discussion on Circuit protective devices: fuse and Miniature Circuit Breaker (MCB's). Objectives for Neutral and Earthing, types of earthing; pipe and plate earthing, Residual current circuit breaker- Experimental measurement of insulation resistance of electrical equipment.	6+3
Total Instructional Hours		45

- Course Outcome**
- CO1: Understand the fundamental concepts of electrical circuits and theorems.
 CO2: Understand the basic theory, operational characteristics of AC and DC machines
 CO3: Understand the operating principles of measuring instrument.
 CO4: Understand the electrical power supply sources and electrical wiring basics
 CO5: Understand the importance for electrical safety and protection.

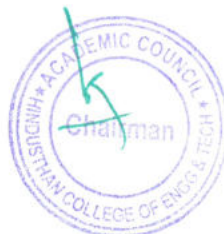
TEXT BOOKS:

- T1 Dr. D P Kothari, Prof I J Nagrath, "Basic Electrical Engineering", 3rd Edition, Tata McGraw-Hill, 2009.
 T2 K. S. Dhogal "Basic Practical In Electrical Engineering", 2nd, Reprint 2017, Standard Publishers Distributors

REFERENCE BOOKS:

- R1 P.C. Sen, "Principles of Electrical Machines and Power Electronics", Wiley, 2016(Reprint)
 R2 Vijay kumar Garg, "Basic Electrical Engineering (A complete Solution)", Wiley Reprint 2015.
 R3 Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford press 2005.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	21HE1071	LANGUAGE COMPETENCY ENHANCEMENT COURSE-I	0	0	2	1
Course Objective	1. To enhance student language competency 2. To train the students in LSRW skills 3. To develop student communication skills 4. To empower the trainee in business writing skills. 5. To train the students to react to different professional situations					
Unit	Description					Instructional Hours
I	Listening Listening to technical group discussions and participating in GDs. listening to TED talks. Listen to Interviews & mock interview. Listening short texts and memos.					3
II	Reading Reading articles from newspaper, magazine. Reading comprehension. Reading about technical inventions, research and development. Reading short texts and memos.					3
III	Writing E-mail writing: Create and send email writing (to enquire about some details, to convey important message to all, to place an order, to share your joy and sad moment). Reply for an email writing.					3
IV	Speaking To present a seminar in a specific topic (what is important while choosing or deciding something to do). To respond or answer for general questions (answer for your personal details, about your family, education, your hobbies, your aim etc..).					3
V	Speaking Participate in discussion or interactions (agree or disagree express your statement with a valid reason, involve in discussion to express your perspective on a particular topics).					3
Total Instructional Hours					15	

Course Outcome CO1- Trained to maintain coherence and communicate effectively.
 CO2- Practiced to create and interpret descriptive communication.
 CO3- Introduced to gain information of the professional world.
 CO4- acquired various types of communication and etiquette.
 CO5- Taught to improve interpersonal and intrapersonal skills.

TEXT BOOKS:

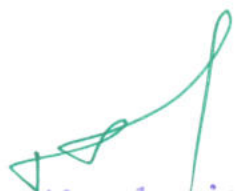
T1- Norman Whitby, "Business Benchmark-Pre-intermediate to Intermediate", Cambridge University Press, 2016.
 T2- Raymond Murphy, "Essential English Grammar", Cambridge University Press, 2019.

REFERENCE BOOKS :

R1- Meenakshi Raman and Sangeetha Sharma. "Technical Communication- Principles and Practice", Oxford University Press, 2009.


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Programme	Course code	Course title	L	T	P	C
B.E.	21HE1072	CAREER GUIDANCE LEVEL I Personality, Aptitude and Career Guidance	2	0	0	0

Course Objectives
 Introduce students to building blocks of Logical reasoning and Quantitative Aptitude [SLO 1]
 Train students on essential grammar for placements [SLO 2]
 To develop Python programs with conditionals and loops and to define Python functions and call them
 To use Python data structures — lists, tuples, dictionaries
 To do input/output with files in Python

Course Objectives:

- Introduce students to building blocks of Logical reasoning and Quantitative Aptitude [SLO 1]
- Train students on essential grammar for placements [SLO 2]
- Introduce students on scientific techniques to pick up skills [SLO 3]
- Provide an orientation for recruiter expectation in terms of non-verbal skills, and for how to build one's career with placements in mind [SLO 4]

Expected Course Outcome:

Enable students to approach learning Aptitude with ease, and understand recruiter expectation.

Student Learning Outcomes (SLO): 1, 2, 3 and 4

Module:1 Lessons on excellence 2hours SLO:3

Skill introspection, Skill acquisition, consistent practice

Module:2 Logical Reasoning 11 hours SLO:1

Thinking Skill

Problem Solving

Critical Thinking

Lateral Thinking

Taught through thought-provoking word and rebus puzzles, and word-link builder questions

Coding & decoding, Series, Analogy, Odd man out and Visual reasoning

Coding and Decoding

Series

Analogy

Odd Man Out

Visual Reasoning

Sudoku puzzles

Solving introductory to moderate level sudoku puzzles to boost logical thinking and comfort with numbers

Attention to detail

Picture and word driven Qs to develop attention to detail as a skill

Module:3 Quantitative Aptitude 11 hours SLO:1

Speed Maths

Addition and Subtraction of bigger numbers, Square and square roots

Cubes and cube roots, Vedic maths techniques

Multiplication Shortcuts, Multiplication of 3 and higher digit numbers

Simplifications, Comparing fractions

Shortcuts to find HCF and LCM

Divisibility tests shortcuts

Algebra and functions

Module:4 Recruitment Essentials 2hours SLO:4

Looking at an engineering career through the prism of an effective resume

Importance of a resume - the footprint of a person's career achievements

How a resume looks like?

An effective resume vs. a poor resume: what skills you must build starting today and how?

Impression Management

Getting it right for the interview: Grooming, dressing

Body Language and other non-verbal signs

Displaying the right behaviour

Module:5 Verbal Ability 4hours SLO:2

Essential grammar for placements:

Nouns and Pronouns, Verbs

Subject-Verb Agreement, Pronoun-Antecedent Agreement

Punctuations

Verbal Reasoning

Total Lecture hours:30 hours

Mode of Evaluation: Assignments, 3 Assessments with End Semester (Computer Based Test)


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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	21HE1073	ENTREPRENEURSHIP & INNOVATION	1	0	0	0

- Course Objective**
1. To acquire the knowledge and skills needed to manage the development of innovation.
 2. To recognize and evaluate potential opportunities to monetize these innovations.
 3. To plan specific and detailed method to exploit these opportunities.
 4. To acquire the resources necessary to implement these plans.
 5. To make students understand organizational performance and its importance.

Module	Description	Instructional Hours
1.	Entrepreneurial Thinking	
2.	Innovation Management	
3.	Design Thinking	
4.	Opportunity Spotting / Opportunity Evaluation	
5.	Industry and Market Research	
6.	Innovation Strategy and Business Models	
7.	Financial Forecasting	
8.	Business Plans/ Business Model Canvas	
9.	Entrepreneurial Finance	
10.	Pitching to Resources Providers / Pitch Deck	
11.	Negotiating Deals	
12.	New Venture Creation	
13.	Lean Start-ups	
14.	Entrepreneurial Ecosystem	
15.	Velocity Venture	

Total Instructional Hours 15

- Course Outcome**
- CO1: Understand the nature of business opportunities, resources, and industries in critical and Creative aspects.
- CO2: Understand the processes by which innovation is fostered, managed, and commercialized.
- CO3: Remember effectively and efficiently the potential of new business opportunities.
- CO4: Assess the market potential for a new venture, including customer need, competitors, and industry attractiveness.
- CO5: Develop a business model for a new venture, including revenue. Margins, operations, Working capital, and investment.

TEXT BOOKS:

- T1: Arya Kumar "Entrepreneurship – Creating and leading an Entrepreneurial Organization", Pearson, Second Edition (2012).
T2: Emrah Yayici "Design Thinking Methodology", Artbiz tech, First Edition (2016).

REFERENCE BOOKS:

- R1: Christopher Golis "Enterprise & Venture Capital", Allen & Unwin Publication, Fourth Edition 2007
R2: Thomas Lock Wood & Edger Papke "Innovation by Design", Career Press.com, Second (2017).
R3: Jonahan Wilson "Essentials of Business Research", Sage Publication, First Edition, (2010).

WEB RESOURCES:

- W1: <https://blof.forgeforward.in/tagged/startup-lessons>
W2: <https://blof.forgeforward.in/tagged/entrepreneurship>
W3: <https://blof.forgeforward.in/tagged/minimum-viable-product>
W4: <https://blof.forgeforward.in/tagged/minimum-viable-product>
W5: <https://blof.forgeforward.in/tagged/innovation>
W6: <https://www.youtube.com/watch?v=8vEyL7uKXs&list=PLmP9QrmTNPqBEvKbMSXvwlwn7fdnXe6>


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SEMESTER II

PROGRAMME B.E.	COURSE CODE 21HE2101	NAME OF THE COURSE BUSINESS ENGLISH FOR ENGINEERS	L 2	T 1	P 0	C 3
Course Objectives	1. To introduce to business communication. 2. To train the students to react to different professional situations. 3. To make the learner familiar with the managerial skills 4. To empower the trainee in business writing skills. 5. To learn to interpret and expertise different content.					
Unit	Description					Instructional Hours
I	Listening and Speaking – listening and discussing about programme and conference arrangement Reading – reading auto biographies of successful personalities Writing Formal & informal email writing, Recommendations Grammar and Vocabulary - Business vocabulary, Adjectives & adverbs					9
II	Listening and Speaking - listening to TED talks Reading - Making and interpretation of posters Writing - Business letters: letters giving good and bad news, Thank you letter, Congratulating someone on a success” Grammar and Vocabulary - Active & passive voice, Spotting errors (Tenses, Preposition, Articles)					9
III	Listening and Speaking -travel arrangements and experience Reading - travel reviews Writing - Business letters (Placing an order, making clarification & complaint letters). Grammar and Vocabulary - Direct and Indirect speech.					9
IV	Listening and Speaking - Role play - Reading - Sequencing of sentence Writing - Business report writing (marketing, investigating) Grammar and Vocabulary - Connectors, Gerund & infinitive					9
V	Listening and Speaking - Listen to Interviews & mock interview Reading - Reading short stories, reading profile of a company - Writing - Descriptive writing (describing one’s own experience) Grammar and Vocabulary - Editing a passage(punctuation, spelling & number rules)					9
Total Instructional Hours						45
Course Outcomes	CO1- Introduced to different modes and types of business communication. CO2- Practiced to face and react to various professional situations efficiently. CO3- learnt to practice managerial skills. CO4- Familiarized with proper guidance to business writing. CO5- Trained to analyze and respond to different types of communication.					

TEXT BOOKS:

- T1 - Norman Whitby, “Business Benchmark-Pre-intermediate to Intermediate”, Cambridge University Press, 2016.
 T2- Ian Wood and Anne Willams. “Pass Cambridge BEC Preliminary”, Cengage Learning press 2015.

REFERENCE BOOKS :

- R1 - Michael Mc Carthy, “Grammar for Business”, Cambridge University Press, 2009
 R2- Bill Mascull, “Business Vocabulary in use: Advanced 2nd Edition”, Cambridge University Press, 2009.
 R3- Frederick T. Wood, “Remedial English Grammar For Foreign Students”, Macmillan publishers, 2001.


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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	21MA2102	COMPLEX VARIABLES AND TRANSFORM CALCULUS	3	1	0	4

- Course Objectives**
1. Develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.
 2. Identify effective mathematical tools for the solutions of partial differential equations.
 3. Describe the construction of analytic functions and conformal mapping.
 4. Illustrate Cauchy's integral theorem and calculus of residues.
 5. Analyze the techniques of Laplace and Inverse Laplace transform.

Unit	Description	Instructional Hours
I	MATRICES Eigen values and Eigen vectors of a real matrix – Properties of Eigen values and Eigen vectors (without proof) Cayley - Hamilton Theorem (excluding proof) - Orthogonal matrices – Definition – Reduction of a quadratic form to canonical form by orthogonal transformation.	12
II	PARTIAL DIFFERENTIAL EQUATIONS Formation of partial differential equations by the elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order partial differential equations of the form $f(p,q)=0$, Clairaut's type : $z = px+qy +f(p,q)$ – Lagrange's linear equation.	12
III	COMPLEX DIFFERENTIATION Functions of complex variables – Analytic functions – Cauchy's – Riemann's equations and sufficient conditions (excluding proof) – Construction of analytic functions – Milne –Thomson's method – Conformal mapping $w = A+z$, Az , $1/z$ and bilinear transformations.	12
IV	COMPLEX INTEGRATION Cauchy's integral theorem – Cauchy's integral formula –Taylor's and Laurent's series (statement only) –Residues - Cauchy's Residue theorem.	12
V	TRANSFORM CALCULUS Laplace transform –Basic properties – Transforms of derivatives and integrals of functions - Transform of periodic functions - Inverse Laplace transform - Convolution theorem (with out proof) – Solution of linear ODE of second order with constant coefficients using Laplace transforms.	12
Total Instructional Hours		60

Course Outcomes

- CO1: Calculate Eigen values and Eigen vectors for a matrix which are used to determine the natural frequencies.
CO2: Solve Partial Differential Equations using various methods.
CO3: Infer the knowledge of construction of analytic functions and conformal mapping.
CO4: Evaluate real and complex integrals over suitable closed paths or contours.
CO5: Apply Laplace transform and its properties to solve certain linear differential equations.

TEXT BOOKS:

- T1 -Ravish R Singh, Mukul Bhatt, "Engineering Mathematics", McGraw Hill education (India) Private Ltd.,Chennai,2017.
T2 -Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018

REFERENCE BOOKS :

- R1- Veerarajan T, "Engineering Mathematics", McGraw Hill Education(India) Pvt Ltd, New Delhi, 2016.
R2- Grewal B.S, "Higher Engineering Mathematics", 42nd Edition, Khanna Publications, Delhi, 2012.
R3- Peter V. O'Neil, "Advanced Engineering Mathematics", 7th Edition, Cengage learning,2012.


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PROGRAMME/ SEM B.E.I	COURSE CODE	NAME OF THE COURSE	L	T	P	C
	21PH2151	MATERIAL SCIENCE	2	0	2	3

Course Objectives

1. Acquire fundamental knowledge of semiconducting materials which is related to the Engineering program.
2. Extend the knowledge about the magnetic materials.
3. Explore the behavior of super conducting materials.
4. Gain knowledge about Crystal systems.
5. Understand the importance of ultrasonic waves.

Unit	Description	Instructional Hours
I	SEMICONDUCTING MATERIALS Introduction – Intrinsic semiconductor – Compound and elemental semiconductor - direct and indirect band gap of semiconductors. Carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination. Optical properties of semiconductor – Light through optical fiber(Qualitative)- Determination of band gap of a semiconductor- Determination of acceptance angle and numerical aperture in an optical fiber.	6+6
II	MAGNETIC MATERIALS Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – anti ferromagnetic materials – Ferrites and its applications- B – H curve by Magnetic hysteresis experiment.	6+3
III	SUPERCONDUCTING MATERIALS Superconductivity : properties(Messiner effect, effect of magnetic field, effect of current and isotope effects) – Type I and Type II superconductors – High Tc superconductors – Applications of superconductors –Cryotron and magnetic levitation.	6
IV	CRYSTAL PHYSICS Crystal systems - Bravais lattice - Lattice planes - Miller indices - Interplanar spacing in cubic lattice - Atomic radius, Coordination number and Packing factor for SC, BCC and FCC crystal structures.	6
V	ULTRASONICS Production – Magnetostrictive generator – Piezoelectric generator – Determination of velocity using acoustic grating – Cavitations – Viscous force – co-efficient of viscosity. Industrial applications – Drilling and welding – Non destructive testing – Ultrasonic pulse echo system- Determination of velocity of sound and compressibility of liquid – Ultrasonic wave-Determination of Coefficient of viscosity of a liquid –Poiseuille’s method.	6+6
Total Instructional Hours		45

Course Outcomes

CO1: Understand the purpose of acceptor or donor levels and the band gap of a semiconductor
CO2: Interpret the basic idea behind the process of magnetism and its applications in everyday
CO3: Discuss the behavior of super conducting materials
CO4: Illustrate the types and importance of crystal systems
CO5: Evaluate the production of ultrasonics and its applications in NDT

TEXT BOOKS:

- T1 - Rajendran V, Applied Physics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2017.
T2- Gaur R.K. and Gupta S.L., Engineering Physics, 8th edition, Dhanpat Rai Publications (P) Ltd., New Delhi, 2015.

REFERENCE BOOKS:

- R1 - Arthur Beiser "Concepts of Modern Physics" Tata McGraw Hill, New Delhi – 2015
R2 - M.N Avadhanulu and PG Kshirsagar "A Text Book of Engineering physics" S. Chand and Company Ltd., New Delhi 2016
R3 - Dr. G. Senthilkumar "Engineering Physics – II" VRB publishers Pvt Ltd., 2016.


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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	21CY2151	ENVIRONMENTAL STUDIES	2	0	2	3
Course Objectives	1. The natural resources, exploitation and its conservation 2. The importance of environmental education, ecosystem and biodiversity. 3. The knowledge about environmental pollution – sources, effects and control measures of environmental pollution. 4. Scientific, technological, economic and political solutions to environmental problems. 5. An awareness of the national and international concern for environment and its protection					
Unit	Description					Instructional Hours
I	NATURAL RESOURCES Renewable and Non renewable resources - Forest resources: Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forests and tribal people - Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture – Energy resources: Renewable and non renewable energy sources – Solar energy and wind energy - role of an individual in conservation of natural resources.					6
II	ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY Importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem - energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the forest and ponds ecosystem – Introduction to biodiversity definition: types and value of biodiversity – hot-spots of biodiversity – threats to biodiversity– endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.					6
III	ENVIRONMENTAL POLLUTION Definition – causes, effects and control measures of: Air pollution- Water pollution – Water quality parameters- Soil pollution- Noise pollution- Nuclear hazards – role of an individual in prevention of pollution- Determination of Dissolved Oxygen in sewage water by Winkler’s method-Estimation of alkalinity of water sample by indicator method- Determination of chloride content of water sample by argentometric method.					6+9
IV	SOCIAL ISSUES AND THE ENVIRONMENT From unsustainable to sustainable development – urban problems related to energy- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- Municipal solid waste management. Global issues – Climatic change, acid rain, greenhouse effect and ozone layer depletion – Disaster Management – Tsunami and cyclones- Determination of pH in beverages.					6+3
V	HUMAN POPULATION AND THE ENVIRONMENT Population growth, variation among nations – population explosion – family welfare programme – environment and human health – effect of heavy metals – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- GIS-remote sensing-role of information technology in environment and human health- Estimation of heavy metal ion (copper) in effluents by EDTA.					6+3
Total Instructional Hours						45
Course Outcomes	CO1: Develop an understanding of different natural resources including renewable resources. CO2: Realise the importance of ecosystem and biodiversity for maintaining ecological balance. CO3: Understand the causes of environmental pollution and hazards due to manmade activities. CO4: Demonstrate an appreciation for need for sustainable development and understand the various social issues and solutions to solve the issues. CO5: Gain knowledge about the importance of women and child education and know about the existing technology to protect environment					

TEXT BOOKS:

- T1 - Anubha Kaushik and C. P. Kaushik, "Perspectives in Environmental studies", Sixth edition, New Age International Publishers, New Delhi, 2021.
 T2 – S.Annadurai and P.N. Magudeswaran, "Environmental studies", Cengage Learning India Pvt.Ltd, Delhi, 2018.

REFERENCES:

- R1 - Erach Bharucha, "Textbook of environmental studies" University Press (I) Pvt.ltd, Hyderabad, 2015.
 R2 - G.Tyler Miller, Jr and Scott E. Spoolman "Environmental Science" Thirteenth Edition, Cengage Learning, 2010.
 R3 - Gilbert M. Masters and Wendell P. Ela, "Introduction to Environmental Engineering and Science", 3rd edition, Pearson Education, 2013.


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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	21CS2152	ESSENTIAL OF IN C AND C++ PROGRAMMING	2	0	2	3
Course Objective	1. To Learn and develop basics of C programming. 2. To understand Object Oriented Programming concepts and basic characteristics of C++. 3. Be familiar with the constructors and operator overloading. 4. To understand the concepts of inheritance, polymorphism and virtual function. 5. To learn and define concept of templates and exception handling.					
Unit	Description	Instructional Hours				
I	BASICS OF 'C' PROGRAMMING Fundamentals of 'C' programming – Structure of a 'C' program – Constants - Variables – Data Types – Expressions using operators in 'C' – Managing Input and Output operations-Branching and Looping - Arrays – One dimensional and Two dimensional arrays. Programs: 1. Write a C program to calculate sum of individual digits of a given number. 2. Write a C program to count no. of positive numbers, negative numbers and zeros in the array. 3. Write a C program to find sum of two numbers using functions with arguments and without return type.	3+6				
II	BASICS OF 'C++' PROGRAMMING Introduction to C++ – structures and unions- Object oriented programming concepts-Defining a Class – creating objects - access specifiers – Function in C++ - function and data members default arguments – function overloading – Inline functions - friend functions – constant with class – static member of a class – nested classes – local classes. Program: Write a C++ program to accept the student detail such as name and 3 different marks by get_data() method and display the name and average of marks using display() method. Define a friend class for calculating the average of marks using the method mark_avg().	6+3				
III	CONSTRUCTOR AND OPERATOR OVERLOADING Constructors - Default, Copy, Parameterized, Dynamic constructors, Default argument – Destructor. - Function overloading- Operator overloading-Unary, Binary - Binary operators using friend function. Program: Write a C++ program to calculate the volume of different geometric shapes like cube, cylinder and sphere and hence implement the concept of Function Overloading.	7+2				
IV	INHERITANCE AND POLYMORPHISM Inheritance – Public, Private and Protected derivations– Single– Multiple– Multilevel– Hybrid– Hierarchical - Virtual base class – abstract class – composite objects- Runtime polymorphism – virtual functions – pure virtual functions. Program: Demonstrate Simple Inheritance concept by creating a base class FATHER with data members SurName and BankBalance and creating a derived class SON, which inherits SurName and BankBalance feature from base class but provides its own feature FirstName and DOB. Create and initialize F1 and S1 objects with appropriate constructors and display the Father & Son details. (Hint : While creating S1 object, call Father base class parameterized constructor through derived class by sending values).	7+2				
V	TEMPLATES AND EXCEPTION HANDLING Function and class templates - Exception handling – try-catch-throw paradigm – exception specification – terminate and Unexpected functions – Uncaught exception. Program: Write a C++ program to create a template function for Bubble Sort and demonstrate sorting of integers and doubles.	7+2				
		Total Instructional Hours	45			
Course Outcomes	CO1:Develop simple applications in C using basic constructs. CO2:Apply solutions to real world problems using basic characteristics of C++. CO3:Write object-oriented programs using operator overloading, constructors and destructors. CO4:Develop programs with the concepts of inheritance and polymorphism. CO5:Understand and define solutions with C++ advanced features such as templates and exception handling.					
	TEXT BOOKS: T1 - E.Balagurusamy, "Programming in ANSI C", 7 th Edition, McGraw Hill Publication, 2016. T2 - E.Balagurusamy, "Object Oriented Programming with C++", 7 th Edition, McGraw Hill Publication, 2017.					
	REFERENCE BOOKS: R1 - Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011. R2 - RohitKhurana, "Object Oriented Programming with C++", Vikas Publishing, 2 nd Edition, 2016. R3 - B. Trivedi, "Programming with ANSI C++", Oxford University Press, 2007.					


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	21ME2154	ENGINEERING GRAPHICS	1	0	4	3
Course Objective	1. To gain the knowledge of Engineer's language of expressing complete details about objects and construction of conics and special curves. 2. To learn about the orthogonal projections of straight lines and planes. 3. To acquire the knowledge of projections of simple solid objects in plan and elevation. 4. To learn about the projection of sections of solids and development of surfaces. 5. To study the isometric projections of different objects.					
Unit	Description					Instructional Hours
I	PLANE CURVES Importance of engineering drawing; drafting instruments; drawing sheets – layout and folding; Lettering and dimensioning, BIS standards, scales. Geometrical constructions, Engineering Curves Conic sections – Construction of ellipse, parabola and hyperbola by eccentricity method. Construction of cycloids and involutes of square and circle – Drawing of tangents and normal to the above curves.					12
II	PROJECTIONS OF POINTS, LINES AND PLANE SURFACES Introduction to Orthographic projections- Projection of points. Projection of straight lines inclined to both the planes, Determination of true lengths and true inclinations by rotating line method. Projection of planes (polygonal and circular surfaces) inclined to both the planes by rotating object method (First angle projections only).					12
III	PROJECTIONS OF SOLIDS Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is perpendicular and inclined to one plane by rotating object method.					12
IV	SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES Sectioning of simple solids with their axis in vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other – Obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids, cylinder and cone. Development of lateral surfaces of truncated solids.					12
V	ISOMETRIC AND ORTHOGRAPHIC PROJECTIONS Isometric views and projections simple and truncated solids such as - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions. Free hand sketching of multiple views from a pictorial drawing. Basics of drafting using AutoCAD software.					12
Total Instructional Hours						60
Course Outcome	CO1: Understand and interpret the engineering drawings in order to visualize the objects and draw the conics and special curves. CO2: Draw the orthogonal projections of straight lines and planes. CO3: Interpret the projections of simple solid objects in plan and elevation. CO4: Draw the projections of section of solids and development of surfaces of solids. CO5: Draw the isometric projections and the perspective views of different objects.					

TEXT BOOK:

1. K.Venugopal, V.Prabu Raja, "Engineering Drawing, AutoCAD, Building Drawings", 5th edition New Age International Publishers, New Delhi 2016.
2. K.V.Natarajan, "A textbook of Engineering Graphics", Dhanlaxmi Publishers, Chennai 2016.

REFERENCES:

1. Basant Agrawal and C.M.Agrawal, "Engineering Drawing", Tata McGraw Hill Publishing company Limited, New Delhi 2013.
2. Vela Murali, "Engineering Drawing", Oxford University PRESS, India 2015.


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PROGRAMME B.E.	COURSE CODE 21ME2001	NAME OF THE COURSE ENGINEERING PRACTICES LABORATORY	L 0	T 0	P 4	C 2
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COURSE OBJECTIVE

To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

**GROUP A (CIVIL & MECHANICAL)
CIVIL AND MECHANICAL ENGINEERING PRACTICES**

S.No	Description of the Experiments	Instructional Hours
1	Preparation of Single pipe line and Double pipe line connection by using valves, taps, couplings, unions, reducers and elbows.	
2	Arrangement of bricks using English bond for 1brick thick wall and 11/2 brick thick wall for right angle corner junction.	
3	Arrangement of bricks using English bond for 1brick thick wall and 11/2 brick thick wall for T junction.	
4	Preparation of arc welding of Butt joints, Lap joints and Tee joints.	
5	Practice on sheet metal Models– Trays and funnels	
6	Hands-on-exercise in wood work, joints by sawing, planing and cutting.	
7	Practice on simple step turning, taper turning and drilling.	
8	Demonstration on Smithy operation.	
9	Demonstration on Foundry operation.	
10	Demonstration on Power tools.	

Total Practical Hours 45

**GROUP B (ELECTRICAL)
ELECTRICAL ENGINEERING PRACTICES**

S. No	Description of the Experiments	Instructional Hours
1	Residential house wiring using switches, fuse, indicator, lamp and energy meter.	
2	Fluorescent lamp wiring	
3	Stair case wiring.	
4	Measurement of Electrical quantities – voltage, current, power & power factor in single phase circuits.	
5	Measurement of energy using single phase energy meter.	
6	Soldering practice using general purpose PCB.	
7	Measurement of Time, Frequency and Peak Value of an Alternating Quantity using CRO and Function Generator.	
8	Study of Energy Efficient Equipment's and Measuring Instruments.	

Total Practical Hours 45

Course Outcome

CO1: Fabricate wooden components and pipe connections including plumbing works.
CO2: Fabricate simple weld joints.
CO3: Fabricate different electrical wiring circuits and understand the AC Circuits.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19HE2071	LANGUAGE COMPETENCY ENHANCEMENT COURSE- II	0	0	2	1
Course Objective	1. To introduce to business communication. 2. To train the students to react to different professional situations. 3. To make the learner familiar with the managerial skills 4. To empower the trainee in business writing skills. 5. To learn to interpret and expertise different content.					
Unit	Description	Instructional Hours				
I	Listening and Speaking – listening and discussing about programme and conference arrangement Reading –reading auto biographies of successful personalities Writing Formal & informal email writing, Recommendations Grammar and Vocabulary - Business vocabulary, Adjectives & adverbs.	3				
II	Listening and Speaking - listening to TED talks Reading -Making and interpretation of posters Writing - Business letters: letters giving good and bad news, Thank you letter, Congratulating someone on a success” Grammar and Vocabulary - Active & passive voice, Spotting errors (Tenses, Preposition, Articles).	3				
III	Listening and Speaking -travel arrangements and experience Reading - travel reviews Writing - Business letters (Placing an order, making clarification & complaint letters). Grammar and Vocabulary - Direct and Indirect speech.	3				
IV	Listening and Speaking -Role play- Reading - Sequencing of sentence Writing - Business report writing (marketing, investigating) Grammar and Vocabulary - Connectors, Gerund & infinitive.	3				
V	Listening and Speaking - Listen to Interviews & mock interview Reading - Reading short stories, reading profile of a company - Writing - Descriptive writing (describing one’s own experience) Grammar and Vocabulary - Editing a passage(punctuation, spelling & number rules).	3				
Total Instructional Hours		15				
Course Outcome	CO1- Introduced to different modes and types of business communication. CO2- Practiced to face and react to various professional situations efficiently. CO3- learnt to practice managerial skills. CO4- Familiarized with proper guidance to business writing. CO5- Trained to analyze and respond to different types of communication.					

TEXT BOOKS:

- T1 - Norman Whitby, “Business Benchmark-Pre-intermediate to Intermediate”, Cambridge University Press, 2016.
 T2- Ian Wood and Anne Willams. “Pass Cambridge BEC Preliminary”, Cengage Learning press 2015.

REFERENCE BOOKS :

- R1 - Michael Mc Carthy, “Grammar for Business”, Cambridge University Press, 2009.
 R2- Bill Mascull, “Business Vocabulary in use: Advanced 2nd Edition”, Cambridge University Press, 2009.
 R3-Frederick T. Wood, “Remedial English Grammar For Foreign Students”, Macmillan publishers, 2001.


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PROGRAMME COURSE CODE
B.E. 21HE2072

COURSE TITLE
CAREER GUIDANCE LEVEL II
PERSONALITY, APTITUDE AND CAREER DEVELOPMENT

L T P C
2 0 0 1

Course Objectives:

1. Solve Logical Reasoning questions of easy to intermediate level [SLO 6]
2. Solve Quantitative Aptitude questions of easy to intermediate level [SLO 7]
3. Solve Verbal Ability questions of easy to intermediate level [SLO 8]

Expected Course Outcome:

Enable students to solve questions on Verbal, Logical and Quantitative Aptitude of placement level

Student Learning Outcomes (SLO): 6, 7, 8

Module:1 Logical Reasoning 8 hours SLO:6

Word group categorization questions

Puzzle type class involving students grouping words into right group orders of logical sense

Cryptarithmic

Data arrangements and Blood relations

Linear Arrangement, Circular Arrangement

Multi-dimensional Arrangement, Blood Relations

Module:2 Quantitative Aptitude 12 hours SLO:7

Ratio and Proportion

Ratio, Proportion, Variation

Simple equations

Problems on Ages

Mixtures and alligations

Percentages, Simple and Compound Interest

Percentages as Fractions and Decimals

Percentage Increase / Decrease

Simple Interest, Compound Interest

Relation Between Simple and Compound Interest

Number System

Number system, Power cycle, Remainder cycle

Factors, Multiples

HCF and LCM

Module:3 Verbal Ability 10 hours SLO:8

Essential grammar for placements

Prepositions, Adjectives and Adverbs

Tenses, Forms and Speech and Voice

Idioms and Phrasal Verbs

Collocations, Gerund and Infinitives

Reading Comprehension for placements

Types of questions, Comprehension strategies

Practice exercises

Articles, Prepositions and Interrogatives

Definite and Indefinite Articles, Omission of Articles

Prepositions, Compound Prepositions and Prepositional Phrases

Interrogatives

Vocabulary for placements

Exposure to solving questions of Synonyms

Antonyms Analogy

Confusing words

Spelling correctness

Total Lecture hours:30hours

Mode of Evaluation: Assignments, 3 Assessments with End Semester (Computer Based Test)


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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	21HE2073	ENTREPRENEURSHIP & INNOVATION	1	0	0	1

Course Objective

- 1.To acquire the knowledge and skills needed to manage the development of innovation.
- 2.To recognize and evaluate potential opportunities to monetize these innovations.
- 3.To plan specific and detailed method to exploit these opportunities.
- 4.To acquire the resources necessary to implement these plans.
- 5.To make students understand organizational performance and its importance.

Module

Description

- | | |
|----|---|
| 1 | Entrepreneurial Thinking |
| 2 | Innovation Management |
| 3 | Design Thinking |
| 4 | Opportunity Spotting/Opportunity Evaluation |
| 5 | Industry and Market Research |
| 6 | Innovation Strategy and Business Models |
| 7 | Financial Forecasting |
| 8 | Business Plans/ Business Model Canvas |
| 9 | Entrepreneurial Finance |
| 10 | Pitching to Resources Providers/Pitch Deck |
| 11 | Negotiating Deals |
| 12 | New Venture Creation |
| 13 | Lean Start-ups |
| 14 | Entrepreneurial Ecosystem |
| 15 | Velocity Venture |

Course Outcome

- CO1: Understand the nature of business opportunities, resources, and industries in critical and creative aspects.
CO2: Understand the processes by which innovation is fostered, managed, and commercialized.
CO3: Remember effectively and efficiently the potential of new business opportunities.
CO4: Assess the market potential for a new venture, including customer need, competitors, and industry attractiveness.
CO5: Develop a business model for a new venture, including revenue, Margins, operations, Working capital, and investment

TEXTBOOKS

- T1: AryaKumar“Entrepreneurship– Creating and leading an Entrepreneurial Organization”, Pearson, Second Edition (2012).
T2: EmrahYayici“Design Thinking Methodology”, Artbiztech, First Edition (2016).

REFERENCE BOOKS

- R1: ChristopherGolis“Enterprise & Venture Capital”, Allen & Unwin Publication, Fourth Edition (2007).
R2: Thomas Lock Wood & Edger Papke“Innovation by Design”, Career Press.com, Second Edition (2017).
R3: Jonathan Wilson“Essentials of Business Research”, Sage Publication, First Edition (2010).

WEBRESOURCES

- W1: <https://blof.forgeforward.in/tagged/startup-lessons>
W2: <https://blof.forgeforward.in/tagged/entrepreneurship>
W3: <https://blof.forgeforward.in/tagged/minimum-viable-product>
W4: <https://blof.forgeforward.in/tagged/minimum-viable-product>
W5: <https://blof.forgeforward.in/tagged/innovation>


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SEMESTER III

Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech/III	19MA3102	FOURIER ANALYSIS AND TRANSFORMS	3	1	0	4

- Course Objective**
1. Analyze Fourier series which is central to many applications in engineering.
 2. Apply the effective tools for the solutions of one dimensional boundary value problems.
 3. Apply the effective tools for the solutions of two dimensional heat equations.
 4. Apply Fourier transform techniques in various situations.
 5. Analyze Z transform techniques for discreté time systems.

Unit	Description	Instructional Hours
I	FOURIER SERIES Dirichlet's conditions- General Fourier Series – Odd and Even Functions – Half range sine and cosine series – Change of Interval - Parseval's Identity - Harmonic analysis.	12
II	BOUNDARY VALUE PROBLEMS Classification of PDE - Solutions of one dimensional wave equation - Onedimensional equation of heat conduction (excluding insulated edges).	12
III	TWO DIMENSIONAL HEAT EQUATIONS Steady state solution of two dimensional equation of heat conduction in infiniteplate and semi circular plate.	12
IV	FOURIER TRANSFORMS Fourier Transform Pairs - Fourier sine and cosine transforms – Properties - Transforms of Simple functions – Convolution Theorem (Statement only) – Parseval's identity(Statement only).	12
V	Z- TRANSFORMS AND DIFFERENCE EQUATIONS Z- Transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem(excluding proof)– Solution of difference equations using Z – transform.	12
	Total Instructional Hours	60

- Course Outcome**
- CO1: Understand the principles of Fourier series which helps them to solve physical problems of engineering.
 CO2: Employ Fourier series in solving the boundary value problems.
 CO3: Understand Fourier series in solving the two dimensional heat equations.
 CO4: Apply Fourier transform techniques which extend its applications.
 CO5: Illustrate the Z- transforms for analyzing discrete-time signals and systems.

TEXT BOOKS:


- T1 - Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., Second reprint, New Delhi, 2012.
 T2 - Bali. N.P and Manish Goyal & Watkins, "Advanced Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007 .

REFERENCE BOOKS :

- R1 - C.Roy Wylie " Advance Engineering Mathematics" Louis C. Barret, 6th Edition, Mc GrawHill Education India Private Limited, New Delhi 2003.
 R2 - Kandasamy P., Thilagavathy K. and Gunavathy K., "Engineering Mathematics Volume III", S.Chand & Company Ltd., New Delhi, 1996.
 R3 - Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, Delhi, 2018.
 R4- Ramana. B.V., "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company Limited, New Delhi, 2018.


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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	19BM3201	ELECTRON DEVICES AND CIRCUITS	3	1	0	4
Course Objective	1. To be familiar with the theory, construction, and operation of semiconductor diodes. 2. To impart knowledge on the configurations and operation of transistors. 3. To give an insight of the operation of amplifiers. 4. To be familiar with the concept of multistage amplifiers and differential amplifiers. 5. To impart knowledge on feedback amplifiers and oscillators.					

Unit	Description	Instructional Hours
	PN JUNCTION	
I	PN junction diode –structure, operation and V-I characteristics, diffusion and transient capacitance – Rectifiers – Half Wave and Full Wave Rectifier,– Display devices- LED, Laser diodes- Zener diode- characteristics-Zener Reverse characteristics – Zener as regulator	12
	TRANSISTORS	
II	BJT, JFET, MOSFET- structure, operation, characteristics and Biasing UJT, Thyristor and IGBT – Structure and characteristics	12
	AMPLIFIERS	
III	BJT small signal model – Analysis of CE amplifiers- Gain and frequency response – MOSFET small signal model– Analysis of CS and Source follower – Gain and frequency response- High frequency Model	12
	DIFFERENTIAL AMPLIFIER AND POWER AMPLIFIER	
IV	BIMOS cascade amplifier, Differential amplifier – Common mode and Difference mode analysis – FET input stages – Single tuned amplifiers – Gain and frequency response – Neutralization methods, power amplifiers –Types (Qualitative analysis).	12
	FEEDBACK AMPLIFIERS AND OSCILLATORS	
V	Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback – Condition for oscillations, phase shift –Wien bridge, Hartley, Colpitts and Crystal oscillators	12
	Total Instruction hours 60	
Course Outcome	CO1: Ability to explain the theory, construction, and operation of PN junction diodes. CO2: Ability to demonstrate the theory, construction, and operation of transistors. CO3: To understand the working of amplifiers. CO4: To understand the working multistage amplifiers and differential Amplifiers. CO5: To differentiate different types of feedback amplifiers and oscillators.	

TEXT BOOKS:

- David A. Bell, "Electronic Devices and Circuits", Fifth edition, Prentice Hall of India, 2008.
- Sedra and Smith, "Microelectronic Circuits", Seventh Edition, Oxford University Press, 2017.

REFERENCES:

- Floyd, "Electron Devices" Pearson Education India, 9th Edition, 2015.
- Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd Edition, 2006.
- Robert L. Boylestad, "Electronic Devices and Circuit theory", 11th Edition, Pearson Education India, 2015.
- Robert B. Northrop, "Analysis and Application of Analog Electronic Circuits to Biomedical Instrumentation", 2nd Edition, CRC Press, 2017


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PROGRAMME	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	19BM3202	MEDICAL BIOCHEMISTRY	3	0	0	3

Course Objective

- To study the basic fundamentals of biochemistry
- To study structural and functional properties of carbohydrates
- To study structural and functional properties of lipids.
- To study structural and functional properties of proteins, and nucleic acids
- To emphasize the role of enzymes in human body.

Unit	Description	Instructional Hours
I	INTRODUCTION TO BIOCHEMISTRY Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson - Hasselbalch equation, physiological buffers in living systems, Energy in living organism. Properties of water and their applications in biological systems. Introduction to Biomolecules, Biological membrane, Clinical application of Electrolytes and radioisotopes	9
II	CARBOHYDRATES Classification of carbohydrates - mono, di, oligo and polysaccharides. Structure, physical and chemical properties of carbohydrates Isomerism, racemisation and mutarotation. Digestion and absorption of carbohydrates. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain. Oxidative phosphorylation. Biochemical aspect of Diabetes mellitus and Glycogen storage Disease.	9
III	LIPIDS Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat. Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, Biosynthesis of Cholesterol. Disorders of lipid metabolism	9
IV	NUCLEIC ACID & PROTEIN Structure of purines and pyrimidines, nucleoside, nucleotide, DNA act as a genetic material, charge off rule. Watson and crick model of DNA. Structure of RNA and its type. Metabolism and Disorder of purines and pyrimidines nucleotide Classification, structure and properties of proteins, structural organization of proteins, classification and properties of amino acids. Separation of protein, Inborn Metabolic error of amino acid metabolism.	9
V	ENZYME AND ITS CLINICAL APPLICATION Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes - Michaelis-Menten equation. Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non-competitive, irreversible.	9
Total Instructional Hours		45

Course Outcome

After the completion of the course, the learner will be able to:

CO1: Explain the fundamentals of biochemistry
 CO2: Explain structural and functional properties of carbohydrates
 CO3: Explain structural and functional properties of lipids.
 CO4: Explain structural and functional properties of proteins, and nucleic acids
 CO5: Discuss the role of enzymes in human body.

TEXT BOOKS:

1. RAFI MD —Text book of biochemistry for Medical Student I Second Edition, University Press, 2014
2. Victor. W. Rodwell, David A Bender et al —Harper's Illustrated Biochemistry, 31st edition, LANGEMedical Publications, 2018

REFERENCES:

1. Keith Wilson & John Walker, —Practical Biochemistry - Principles & Techniques I, Seventh Edition, Oxford University Press, 2010.
2. Pamela.C.Champe & Richard.A.Harvey, —Lippincott Biochemistry Lippincott's Illustrated Reviews, Raven publishers, 1994.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM3203	HUMAN ANATOMY ANDPHYSIOLOGY	3	0	0	3

1 To identify all the organelles of an animal cell and their function.
2: To understand structure and functions of the skeletal, muscular and respiratorysystems.
3: To understand structure and functions of the cardiovascular and lymphaticsystems.
Course Objective 4: To understand structure and functions nervous and endocrine systems.
5: To understand structure and functions of the digestive and urinary systems.

Unit	Description	InstructionalHours
I	CELL AND TISSUE STRUCTURE Structure of Cell – structure and functions of sub organelles – Cell Membrane – Transport of Across Cell Membrane - Action Potential – Cell to Cell Signaling – Cell Division. Types of Specialized tissues– Functions SKELETAL, MUSCULAR AND RESPIRATORY SYSTEMS Skeletal: Types of Bone and function – Physiology of Bone formation	9
II	CARDIOVASCULAR AND LYMPHATIC SYSTEMS Cardiovascular: Components of Blood and functions.- Blood Groups and importance – Structure of Heart – Conducting System of Heart – Properties of Cardiac Muscle - Cardiac Cycle - Heart Beat – Types of Blood vessel – Regulation of Heart rate and Blood pressure. Lymphatic: Parts and Functions of Lymphatic systems – Types of Lymphatic organs and vessels	9
III	NERVOUS AND ENDOCRINE SYSTEMS AND SENSE ORGANS Nervous: Cells of Nervous systems – Types of Neuron and Synapses – Mechanisms of Nerve impulse – Brain : Parts of Brain – Spinal Cord – Tract and Pathways of Spines – Reflex Mechanism – Classification of Nerves - Autonomic	9
IV	Nervous systems and its functions. Endocrine - Pituitary and thyroid gland, Sense Organs: Eye and Ear	9
V	DIGESTIVE AND URINARY SYSTEMS Digestive: Organs of Digestive system – Digestion and Absorption. Urinary: Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulationof Blood pressure by Urinary System – Urinary reflex	9
Total Instructional Hours		45

- Course Outcome**
- CO1: Explain the basic structure and functions of cell
 - CO2: Learn about the structure and functions of the skeletal, muscular and respiratorysystems
 - CO3: Understand about the cardiovascular and lymphatic systems
 - CO4: Learn about the nervous and endocrine systems.
 - CO5: Explain about the structure and functions of the digestive and urinary systemsurinary systems

TEXT BOOKS:

1. Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publsiher. 2014
2. Elaine.N. Marieb , —Essential of Human Anatomy and Physiology, Ninth Edition, Pearson Education, New Delhi, 2016.

REFERENCES:

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomyand Physiology. Eleventh edition, Pearson Publishers, 2017
 2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction forBiomedical and Health Sciences, Oxford University Press, USA, 2013
 3. William F.Ganong, —Review of Medical Physiologyl, 22nd Edition, Mc Graw Hill,New Delhi, 2010
 4. Eldra Pearl Solomon, —Introduction to Human Anatomy and Physiologyl, W.B.Saunders Company, 2015
- Guyton & Hall, —Medical Physiologyl, 13th Edition, Elsevier Saunders, 2015


Chairman BoS
BME - HiCET




Dean (Academics)
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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM3251	DIGITAL ELECTRONICS	2	0	2	3
Course Objective	1.	To understand different methods used for the simplification of Boolean functions.				
	2.	To study combinational circuits.				
	3.	To learn synchronous sequential circuits.				
	4.	To understand asynchronous sequential circuits.				
	5.	To study the fundamentals of HDL.				
Unit	Description					Instructional Hours
I	MINIMIZATION TECHNIQUES Number systems: Decimal, Binary, Octal, Hexadecimal-Number-Base conversion- Complements of Numbers: 1's and 2's complements- Boolean algebra and laws-De- Morgan's Theorem-Principle of Duality-Minimization of Boolean expressions – Minterm – Maxterm – Sum of Products (SOP) – Product of Sums (POS) – Karnaugh map Minimization – Don't care conditions (2variable,3variable&4-variable)-Tabulation method.					6
II	COMBINATIONAL CIRCUITS Circuits for arithmetic operations: adder: Half adder, Full adder, subtractor: Half subtractor, Full subtractor-BCD adder-Magnitude comparator-Encoders, Decoders-Multiplexers, Demultiplexers, Code converters: Binary to Gray, Gray to Binary 1.Experimental Design and implementation of Half Adder & Half Subtractor. 2. Experimental Design and implementation of Binary to Gray and Gray to Binary Conversion. 3. Experimental Design and implementation of Multiplexers and Demultiplexers					9+6(P)
III	SYNCHRONOUS SEQUENTIAL CIRCUITS Flip flops:SR,JK,D,T - Design of synchronous sequential circuits: State diagram - State table – State minimization - State assignment. Shift registers:SISO,SIPO,PIPO,PISO –Counters:BCD,Up down counter. 1.Experimental Design and implementation of Synchronous and Asynchronous Counters					6+3(P)
IV	ASYNCHRONOUS SEQUENTIAL CIRCUITS Analysis and design of asynchronous sequential circuits-Reduction of state and flow tables– Race-free state assignment–Hazards.					6
V	MEMORY DEVICES AND HDL ROM-PROM-EPROM-EEPROM-RAM-FPGA-Programmable Logic Device-Introduction to Hardware Description Language (HDL)- HDL for combinational circuits- Half adder, Full adder, Multiplexer, De-multiplexer, Counters 1.Coding Combinational/Sequential circuits using HDL					6+3(P)
Total Instructional Hours						45

Course Outcome

- CO1: Simplify Boolean functions using different methods.
- CO2: Analyze, design and implement combinational logic circuits.
- CO3: Analyze, design and implement Synchronous sequential logic circuits.
- CO4: Analyze, design and implement Asynchronous sequential logic circuits
- CO5: Simulate and implement combinational and sequential circuits using HDL.

TEXT BOOKS:

T1 Morris Mano M. and Michael D. Ciletti, "Digital Design with an Introduction to the Verilog HDL", V Edition, Pearson Education, 2013. ISBN-13: 978-0-13-277420-8

REFERENCE BOOKS :

- R1-S. Salivahanan and S. Arivazhagan, "Digital Circuits and Design", Fourth Edition, Vikas Publishing House Pvt. Ltd, New Delhi, 2012. ISBN: 978-93-259-6041-1
- R2-Thomas L. Floyd, "Digital Fundamentals", Pearson Education, Inc, New Delhi, 2013 ISBN:978-1-292-07598-


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**Dean (Academics)
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Programme B.E.	Course Code 19BM3001	Name of the Course ELECTRON DEVICES AND CIRCUITS LABORATORY	LTP C 0031.5
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Course Objective

1. To learn the characteristics of PN junction diode.
2. To understand the characteristics of Zener diode.
3. To learn the characteristics of Transistors and frequency response of amplifiers.
4. To learn the basic laws and network reduction theorems.
5. To learn the working of oscillators.

S.No	Description Of The Experiments
1	PN Junction Diode Characteristics
2	Zener Diode Characteristics
3	Common Emitter transistor, Input-Output Characteristics
4	JFET Characteristics
5	Frequency Response analysis of CE amplifier
6	RC Phase shift oscillator
7	Verification Of Thevenin's and Norton's Theorem
8	Verification of KVL & KCL
9	Verification of Super Position Theorem
10	Verification of Maximum Power Transfer

Total Instructional Hours 45

Course Outcome	CO1: To understand the characteristics of PN junction diode, Zener diode and transistors.
	CO2: To understand the concept of amplifiers and Oscillators.
	CO3: Apply the concept of basic laws and network reduction theorems.



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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM3002	BIOCHEMISTRY LABORATORY	0	0	3	1.5

Description of Experiments

1. General guidelines for working and functional component of biochemistry lab
2. Units of volume, weight, density and concentration measurements and their range in biological measurements. Demonstration of proper use of volume and weight measurement devices.
3. Preparation of buffer-titration of a weak acid and a weak base..
4. Qualitative tests for carbohydrates-distinguishing reducing from non-reducing sugars and keto from aldo sugars
5. Spectroscopy: Determination of absorption maxima (λ_{max}) of a given solution
6. Estimation of blood glucose.
7. Estimation of Haemoglobin
8. Estimation of creatinine.
9. Estimation of urea.
10. Estimation of cholesterol.
11. Preparation of serum and plasma from blood.
12. Separation of proteins by SDS electrophoresis(Demo)
13. Separation of amino acids by thin layer chromatography (Demo).

Course Outcome

- CO1: Understand the Biochemistry laboratory functional components
CO2: Understand the basics knowledge of Biochemical parameter and their interpretation in Blood sample.
CO3: Understand the basics principle of preparation of buffers


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19MC3191	INDIAN CONSTITUTION	2	0	0	0

COURSE OBJECTIVES

1. Sensitization of student towards self, family (relationship), society and nature.
2. Understanding (or developing clarity) of nature, society and larger systems, on the basis of human relationships and resolved individuals.
3. Strengthening of self reflection.
4. Development of commitment and courage to act.

UNIT	DESCRIPTION	INSTRUCTIONAL HOURS
UNIT I : BASIC FEATURES AND FUNDAMENTALE PRINCIPLES		4
	Meaning of the constitution law and constitutionalism – Historical perspective of the constitution of India – salient features and characteristics of the constitution of India.	
UNIT II : FUNDAMENTAL RIGHTS		4
	Scheme of the fundamental rights – fundamental duties and its legislative status – The directive principles of state policy – its importance and implementation - Federal structure and distribution of legislative and financial powers between the union and states.	
UNIT III : PARLIAMENTARY FORM OF GOVERNMENT		4
	The constitution powers and the status of the president in India. – Amendment of the constitutional powers and procedures – The historical perspective of the constitutional amendment of India – Emergency provisions : National emergency, President rule, Financial emergency.	
UNIT IV: LOCAL GOVERNANCE		4
	Local self government -constitutional scheme of India – Scheme of fundamental right to equality – scheme of fundamental right to certain freedom under article 19 – scope of the right to life and personal liberty under article 21.	
UNIT V : INDIAN SOCIETY		4
	Constitutional Remedies for citizens – Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.	
Total instructional hours : 20		

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

1. Understand the functions of the Indian government
2. Understand and abide the rules of the Indian constitution.

TEXT BOOKS:

- T1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, NewDelhi.
- T2. R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.
- T3. Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.
- T4. K.L.Sharma, (1997) "Social Stratification in India: Issues and Themes", Jawaharlal

REFERENCE BOOKS:

- R1. Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.
- R2. U.R.Gahai, "Indian Political System ", New Academic Publishing House, Jalaendhar.
- R3. R.N. Sharma, "Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd


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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
B.E.	19HE3073	LEADERSHIP MANAGEMENT	1	0	0	0

SKILLS

- Course Objective**
1. To know about the leadership skills that is to be acquired for success.
 2. To become a teamwork expert, real world problem solver, your views will be challenged
 3. To gain global perspective and becoming an effective communicator
 4. To understand about learning, negotiation and decision making
 5. To get first hand information about the skills we possess and to work on improvement.

Module	Description	Instructional Hours
1.	Strategic thinking skills	
2.	Planning and Delivery skills	
3.	People management skills (Delegation)	
4.	Change management and Innovation skills	
5.	Communication skills	
6.	Persuasion and influencing skills	
7.	Learning Agility	
8.	Motivation	
9.	Personality	
10.	Emotions	
11.	Perception	
12.	Negotiation	
13.	Decision making	
14.	Problem solving	
15.	Building trust	

Total Instructional Hours

15

Course Outcome

- CO1: To practice essential leadership skills in day to day operations
 CO2: To work on leadership skills in the study environment
 CO3: To understand and develop the skills consciously.
 CO4: To know about the real worth of all the skills for success
 CO5: To Analyze the real worth of the person and suggestion for improvement

TEXT BOOKS

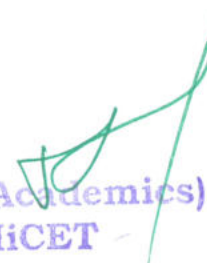
- T1: A REVIEW OF LEADERSHIP THEORY AND COMPETENCY FRAMEWORKS, Bolden, R., Gosling, J., Marturano, A. and Dennison, P. June 2003
 T2: LEADING FROM WITHIN: Building Organizational Leadership Capacity-David R. Kolzow, PhD, 2014

REFERENCE BOOKS

- R1: Seven habits of highly effective people – Stephen R. Covey
 R2: The Art of Business Leadership: Indian Experiences – G. Balasubramaniam
 R3: DEVELOPING the LEADER WITHIN YOU-JOHN C. MAXWELL


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SEMESTER IV

Programme B.E.	Course Code	Name of the Course	L	T	P	C
	19MA4152	STATISTICS & NUMERICAL METHODS	3	0	2	4
Course Objective Unit		<ol style="list-style-type: none"> 1. Illustrate the relation between two random variables by using correlation concepts along with R studio 2. Employ some basic concepts of statistical methods for testing the hypothesis together with R studio. 3. Analyze the design of experiment techniques to solve various engineering problems accompanying with R studio 4. Apply various methods to find the intermediate values for the given data 5. Explain concepts of numerical differentiation and numerical integration of the unknown functions. 				
		Description				Instructional Hours
I		CORRELATION AND REGRESSION Correlation – Karl Pearson’s correlation coefficient – Spearman’s Rank Correlation – Regression lines (problems based on Raw data only) Introduction to R programming ,Applications of Correlation and Regression				9+3
II		HYPOTHESIS TESTING Tests based on t (for single mean and difference of means) - F distribution –for testing difference of variance, Chi – Square test for Contingency table (Test for Independency) – Goodness of fit Application of F test , Application of Chi – square test				9+6
III		ANALYSIS OF VARIANCE Introduction, analysis of variance, completely randomized design, randomized block design, Latin square design. ANOVA – completely randomized design ANOVA – randomized block design				9+6
IV		INTERPOLATION Interpolation: Newton’s forward and backward difference formulae Lagrangian interpolation for unequal intervals – Divided differences- Newton’s divided difference formula.				9
V		NUMERICAL DIFFERENTIATION AND INTEGRATION Differentiation using interpolation formula – Newton’s forward and backward interpolation formulae for equal intervals – Newton’s divided difference formula for unequal intervals - Numerical integration by Trapezoidal and Simpson’s 1/3 rules.				
						Total Instructional Hours 45+15=60
Course Outcome		CO1: Compute correlation and predict unknown values using regression together with R studio. CO2: Understand the concepts of statistical methods for testing the hypothesis along with R studio. CO3: Apply Design of Experiment techniques to solve various engineering problems in addition with R studio. CO4: Understand the concept of interpolation in both cases of equal and unequal intervals. CO5: Identify various methods to perform numerical differentiation and integration.				

TEXT BOOKS:

T1 - Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India Private Ltd., New Delhi, 2018.

T2 - Medhi J, "stochastic Processes", New Age International Publishers, New Delhi, 2014

REFERENCE BOOKS :

R1 - Walpole. R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 8th Edition, Pearson Education, Asia, 2007.

R2 - Grewal B.S. and Grewal J.S. "Numerical Methods in Engineering and Science ", 6th Edition, Khanna publishers, New Delhi 2004.

R3 - S.K.Gupta, Numerical Methods for Engineers", New Age International Pvt.Ltd Publishers, 2015.9


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Programme B.E.	Course Code 19BM4201	Name of the Course LINEAR INTEGRATED CIRCUITS	L 3	T 1	P 0	C 4
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- Course Objective**
- CO1. To introduce the basic concepts of OPAMP.
 - CO2. To impart knowledge on various applications of OPAMP.
 - CO3. To understand the working of comparators and waveform generators.
 - CO4. To learn the design concepts of ADC and DAC.
 - CO5. To understand the working of PLL and voltage regulators.

	Description	Instructional Hours
I	BASICS OF OPERATIONAL AMPLIFIERS Basic information about op-amps – Ideal Operational Amplifier – General operational amplifier stages, DC and AC performance characteristics, slew rate, Open and closed loop configurations.	12
II	APPLICATIONS OF OPERATIONAL AMPLIFIERS Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithm clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters..	12
III	COMPARATORS AND WAVEFORM GENERATORS Comparators, Schmitt trigger, Sine-wave generators, Multivibrators, Triangular wave generator, Saw-tooth wave generator, Frequency to Voltage and Voltage to Frequency converters.	12
IV	ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS Analog and Digital Data Conversions, D/A converter – specifications - weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode -R - 2R Ladder types -switches for D/A converters, high speed sample and hold circuits, A/D Converters –specifications - Flash type - Successive Approximation type - Single Slope type – Dual Slope	12
V	SPECIALISED ICs AND APPLICATIONS IC regulators - 723 (block diagram, typical low voltage regulator circuit), 78XX, 79XX, 317 – applications. Timers - 555 – Functional block diagram- Astable and monostable multivibrators using 555 - applications. VCO – 566. PLL - Block diagram and derivation of capture range, lock range and pull in time capture and lock Range-565 applications.	12
Total Instructional Hours 60		

- Course Outcome**
- CO1. To analyse the characteristics of opamp.
 - CO2. To design various applications of opamp.
 - CO3. To design various wave generating and shaping circuits.
 - CO4. To select ADC and DAC for various applications.
 - CO5. To design PLL and voltage regulators.

TEXT BOOKS:

T1 - D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", 4th Edition, New Age International Pvt. Ltd., 2010.

T2 - Ramakant A. Gayakwad, "OP-AMP and Linear ICs", 4th Edition, Pearson Education, 2015.

REFERENCE BOOKS :

R1 - S.Salivahanan & V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", 2nd edition McGrawHill, 2014.

R2 - Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tata Mc Graw-Hill, 2007.

R3 - Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, 2001


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**Dean (Academics)
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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
B.E. / B.Tech./IV	19BM4202	BioMEMS AND NANOTECHNOLOGY	3	1	0	4

Course Objectives

1. Learn about MEMS and Nanotechnology.
2. Learn various MEMS and Nanotechnology fabrication techniques.
3. Understand different types of sensors and actuators and their principles of operation.
4. Learn about Microfluidic systems.
5. Know the application of MEMS and Nanotechnology in different field of medicine.

Unit	Description	Instructional Hours
I	INTRODUCTION TO MEMS & NANOTECHNOLOGY Introduction to BioMEMS and Nanotechnology, Development of MEMS technology- Comparison of microsystems and microelectronics – Materials for MEMS-Smart Materials and Structures- Applications of MEMS	9
II	MICRO AND NANOFABRICATION TECHNIQUES Nanotechnology, Bottom up and top down methods of synthesis- Self-assembly- lithography techniques, etching - Ion implantation, surface micromachining- LIGA process-CVD technique	9
III	MEMS SENSORS AND ACTUATORS Sensing and Actuation- Piezoresistive and Capacitive sensing -Electrostatic actuation -Pressure sensors - Accelerometers, Gyroscopes- Interfacing with Sensors and Actuators-Nanoporesensors-magnetic sensors,Thermal sensors and actuators	9
IV	MICRO-OPTO ELECTROMECHANICAL SYSTEMS & MICROFLUIDICS Fundamental principle of MOEMS Technology - Light Modulators, Beam splitter , Micro-lens, Micro-mirrors - Digital Micro-mirror Device, Light detectors – Important Consideration on Micro-scale fluid, Properties of fluid - Fluid Actuation Methods Micro-pumps - Typical Micro-fluidic Channel, Micro-fluid Dispenser	9
V	APPLICATIONS OF MEMS AND NANOTECHNOLOGY IN MEDICINE Biochip-Micro Total Analysis Systems detection and measurement methods-DNA sensor-Drug delivery system, Ampero-metric Biosensor - Multi-analyte measurement, Micro-dialysis - Monitoring of Glucose & Lactate with a micro-dialysis probe , Ammonia Monitoring - Electronic Nose, Biomolecular sensing for cancer diagnostics using carbon nanotubes, Carbon nanotube biosensors, Magnetic nanoparticles for MR Imaging, Nano-devices in biomedical applications	9
Total Instructional Hours		45

Course Outcomes:

- | | |
|-----|---|
| CO1 | Explain fabrication techniques of micro and nanotechnology |
| CO2 | Learn about different types of MEMS sensor and actuators |
| CO3 | Discuss about the Micro-Opto Electromechanical Systems & Micro fluidics |
| CO4 | Describe the recent applications of MEMS and Nanotechnology in Medicine |

TEXT BOOKS:

- T1. Tai Ran Hsu, —MEMS and Microsystems Design and Manufacture, Tata McGraw Hill Publishing Company, New Delhi, 2002. (Unit I, II, III & IV).
T2. Wanjun Wang, Stephen A.Soper, IBioMEMS: Technologies and Applications, CRC Press, New York, 2007.(Unit V).

REFERENCES:

- R1. Marc J. Madou —Fundamentals of Microfabrication: the Science of Miniaturization, CRC Press, 2002.
R2. Nadim Maluf, Kirt Williams. —An introduction to Microelectro Mechanical Systems Engineering, Second Edition, Artech House Inc, MA, 2004.


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**Dean (Academics)
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Programme/ Sem	Course Code	Name of the Course	L	T	P	C
B.E. / B.Tech./IV	19BM4203	PATHOLOGY AND MICROBIOLOGY	3	0	0	3
Course Objective		1. Gain a knowledge on the structural and functional aspects of living organisms. 2. Know the etiology and remedy in treating the pathological diseases. 3. To study the structure of disease causing organisms. 4. To study about the working of microscope. 5. Empower the importance of public health.				
Unit	Description					Instructional Hours
I	CELL DEGENERATION, REPAIR AND NEOPLASIA Cell injury - Reversible cell injury and Irreversible cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification- Dystrophic and Metastatic. cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours Autopsy and biopsy.					9
II	FLUID AND HEMODYNAMIC DERANGEMENTS Edema, Hyperemia/Ischemia, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock, Chronic venous congestion. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas Haemorrhage.					9
III	MICROBIOLOGY Structure of Bacteria and Virus. Routes of infection and spread; endogenous and exogenous infections, Morphological features and structural organization of bacteria and virus, growth curve, identification of bacteria, culture media and its types, culture techniques and observation of culture. Disease caused by bacteria, fungi, protozoal, virus and helminthes					9
IV	MICROSCOPES Light microscope – bright field, dark field, phase contrast, fluorescence, Electron microscope (TEM & SEM). Preparation of samples for electron microscope. Staining methods – simple, gram staining and AFB staining.					9
V	IMMUNOPATHOLOGY Natural and artificial immunity, types of Hypersensitivity, antibody and cell mediated tissue injury: opsonization, phagocytosis, inflammation, Secondary immunodeficiency including HIV infection. Auto-immune disorders: Basic concepts and classification, SLE. Antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies					9
Total Instructional Hours						45
Course Outcome	CO1: Analyze structural and functional aspects of living organisms. CO2: Analyze the structure of disease causing organism. CO3: Describe methods involved in treating the pathological diseases. CO4: Explain the function of microscope CO5: Discuss the importance of public health.					

TEXT BOOKS:

- Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, —Pathologic Basis of Diseases, 7th edition, WB Saunders Co. 2005.
- Ananthanarayanan & Panicker, —Microbiology| Orientblackswan, 2017 10th edition

REFERENCES:

- Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
- Dubey RC and Maheswari DK. —A Text Book of Microbiology| Chand & Company Ltd, 2007
- Prescott, Harley and Klein, —Microbiology|, 10th edition, McGraw Hill, 2017


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Programme	Course Code	Name of the Course	L	T	P	C
B.E. / B.Tech./IV	19BM4251	SENSORS AND MEASUREMENT	2	0	2	3

Course Objective The student should be conversant with

1. Understand the purpose of measurement, the methods of measurements, errors associated with measurements.
2. Know the principle of transduction, classifications and the characteristics of different transducers
3. Know the different bridges for measurement.
4. Know the different display and recording devices.

Unit	Description	Instructional Hours
	SCIENCE OF MEASUREMENT	
I	Measurement System – Instrumentation - Classification and Characteristics of Transducers - Static and Dynamic - Errors in Measurements and their statistical analysis – Calibration - Primary and secondary standards.	9
	DISPLACEMENT, PRESSURE, TEMPERATURE SENSORS	
II	Strain Gauge: Gauge factor, sensing elements, configuration, and unbounded strain gage. Capacitive transducer - various arrangements, Inductive transducer, LVDT, Passive types: RTD materials & range, relative resistance vs. temperature characteristics, thermistor characteristics, Active type: Thermocouple - characteristics. Experiments: 1. Characteristics of various temperature sensors – RTD, Thermistor and Thermocouple 2. Displacement measurement using LVDT.	6+(3)P
	PHOTOELECTRIC AND PIEZO ELECTRIC SENSORS	
III	Phototube, scintillation counter, photo multiplier tube (PMT), photovoltaic, photo conductive cells, photo diodes, phototransistor, comparison of photoelectric transducers. Optical displacement sensors and optical encoders. Piezoelectric active transducer- Equivalent circuit and its characteristics. Experiments: Characteristics of various light sensors – LDR, Photodiode and Phototransistor	6+(3)P

SIGNAL CONDITIONING CIRCUITS

IV	Functions of signal conditioning circuits, Preamplifiers, Concepts of passive Impedance filters, matching circuits, AC and DC Bridges - wheat stone bridge, Kelvin ,Maxwell, Hay, Schering Experiments: 1. <i>Measurement of resistance using DC bridges</i> 2. <i>Measurement of inductance using Maxwell bridge</i> 3. <i>Measurement of capacitance using Schering bridge</i>	6+3(P)
V	Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servorecorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermalrecorder.	6+3(P)

Total Instructional Hours 45

COURSE OUTCOME:

- CO1:After the completion of the course, the learner will be able to Measure various electrical parameters with accuracy, precision, resolution.
CO2:Select appropriate passive or active transducers for measurement of physical phenomenon.
CO3:Select appropriate light sensors for measurement of physical phenomenon.
CO4:Use AC and DC bridges for relevant parameter measurement.
CO5:Employ Multimeter, CRO and different types of recorders for appropriate measurement.

TEXT BOOKS:

1. A.K.Sawhney, —Electrical & Electronics Measurement and Instrumentation,10th edition,DhanpatRai& Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2. John G. Webster, —Medical Instrumentation Application and Design, 4th edition, WileyIndia Pvt Ltd,New Delhi, 2015.

REFERENCES:

1. Ernest O Doebelin and Dhanesh N Manik, Measurement systems, Application and design, 6thedition, McGraw-Hill, 2012.
2. Khandpur R.S, —Handbook of Biomedical InstrumentationI, 3rdedition,Tata McGraw-Hill,New Delhi, 2014.
3. Leslie Cromwell, —Biomedical Instrumentation and measurementI, 2nd edition, Prentice hallof India, New Delhi, 2015.
- 4 Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement TechniquesI, Prentice Hall of India, 1stedition, 2016.


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**Dean (Academics)
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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19MC4191	VALUE EDUCATION-ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2	0	0	0

Course Objectives:

1. The course aims at imparting basic principles of thought process, reasoning and inferencing.
2. Sustainability is at the core of Indian Traditional Knowledge Systems connecting society and nature.
3. Holistic life style of Yogic-science and wisdom capsules in Sanskrit literature are also important in modern society with rapid technological advancements and societal disruptions.
4. The course focuses on introduction to Indian Knowledge System, Indian perspective of modern scientific world-view, basic principles of Yoga and holistic health care system, Indian philosophical traditions, Indian linguistic tradition and Indian artistic tradition.

UNIT HOURS	DESCRIPTION	INSTRUCTIONAL
UNIT I :	Basic Structure of Indian Knowledge System	4
UNIT II :	Modern Science and Indian Knowledge System	4
UNIT III :	Yoga and Holistic Health care	4
UNIT IV :	Philosophical tradition	4
UNIT V :	Indian linguistic tradition (Phonology, Morphology, Syntax and semantics), Indian artistic tradition and Case Studies	4

TOTAL INSTRUCTIONAL HOURS : 20

Course Outcomes:

CO1: Ability to understand the structure of Indian system of life.

CO2: Connect up and explain basics of Indian Traditional knowledge in modern scientific perspective.

Reference Books:

- R1. V. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014
- R2. Swami Jitmanand, Modern Physics and Vedant, Bharatiya Vidya Bhavan
- R3. Fritzof Capra, Tao of Physics
- R4. Fritzof Capra, The wave of Life.
- R5. V N Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay Foundation, Velliarnad, Amakum
- R6. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta.
- R7. GN Jha (Eng. Trans.) Ed. R N Jha, Yoga-darshanam with Vyasa Bhashya, VidyanidhiPrakasham, Delhi, 2016.
- R8. RN Jha, Science of Consciousness Psychotherapy and Yoga Practices, VidyanidhiPrakasham, Delhi, 2016.
- R9. P R Sharma (English translation), Shodashang Hridayam.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM4001	INTEGRATED CIRCUITS LABORATORY	0	0	3	1.5

Description of the Experiments

- 1 .Design and Testing of Voltage Follower, Inverting & Non inverting amplifiers using 741 op-amp.
- 2 .Design and Testing of Active low-pass, High-pass and band-pass filters using 741 opamp.
- 3 .Design and Testing of Astable multivibrator , Monostable multivibrator and Schmitt Trigger using 741 op-amp.
- 4 .Design and Testing of Phase shift and Wien bridge oscillators using 741 op-amp.
- 5 . Design and Testing of Astable and Monostable multivibrators using NE555 Timer.
- 6 .Design Function Generator using ICL8038.
- 7 .Simulate Integrator and Differentiator using SPICE.
- 8 .Simulate Astable & Monostable multivibrators with NE555 Timer using SPICE.
- 9 .Simulate Phase shift and Wien bridge oscillators with op-amp using SPICE.
- 10 .Simulate D/A and A/D converters using SPICE.

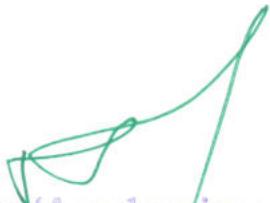
Total Practical Hours: 45

Course Outcome

- CO1: Design oscillators using operational amplifiers.
 CO2: Design amplifiers using operational amplifiers.
 CO3: Design filters using Op-amp and plot frequency response.
 CO4: Analyse the performance of oscillators using SPICE.
 CO5: Analyse the performance of multivibrators using SPICE


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM4002	HUMAN PHYSIOLOGY LABORATORY	0	0	3	1.5

Description of Experiments

- i. Study of parts of compound microscope
- ii. Peripheral smear study
- iii. Estimation of RBC count.
- iv. Estimation of WBC count.
- v. Estimation of ESR.
- vi. Hemoglobin estimation.
- vii. Blood grouping.
- viii. Bleeding time/ clotting time.
- ix. Hearing test using Audiometer.
- x. Respiratory parameter measurement.
- xi. Manual paraffin tissue processing and section cutting (demonstration)
- xii. Cryo processing of tissue and cryosectioning (demonstration)

Total Practical Hours: 45

REFERENCES:

1. Ghai C L, —Textbook of Practical Physiology, Eight edition, Jaypee Brothers, Medical Publisher's Pvt. Ltd., New York, 2013.
2. Stuart Ira Fox, —Laboratory Guide to Human Physiology, Tata McGraw Hill, 2002.
3. Richard G P Flanzer, —Experimental and Applied Physiology Laboratory Manual, Tata McGraw Hill, Columbus, 2005.

Course Outcome
 CO1: Identification and enumeration of blood cells
 CO2: Enumeration of haematological parameters


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19HE4073	IDEATION SKILLS	1	0	0	0

Course Objectives:

1. To study the importance of ideation.
2. To learn about the various tools for Ideation.
3. To provide an insight in Prototyping and its significance.

UNIT I IDEATION: INTRODUCTION TO DESIGN THINKING METHODOLOGY (4)

Design Thinking Methodology and how it can be used as a powerful tool for developing new and innovative solutions - Inspiration – Implementation - Disruptive technology.

UNIT II IDEATION: TOOLS FOR IDEATION (4)

Various resources to kindle new ideas for innovation. Explore the types of ideas in the past – Effect of the ideas and innovation of past on the world – Innovation Thinking – Case studies.

UNIT III IDEATION: INTRODUCTION TO CUSTOMER DISCOVERY (4)

Intro to Customer Discovery - development of customer discovery plan that can lead to powerful business innovation - Customer Discovery Plan

UNIT IV PROTOTYPING AND PRODUCT IDEATION (3)

Introduction to Prototyping - minimum viable product - High fidelity prototype vs low fidelity prototype – Prototyping tools

TOTAL: 15 PERIODS

Course Outcomes

At the end of this course students will be able to:

CO1: Develop a strong understanding and importance of ideation

CO2: Learn about the different kinds of tools for Ideation.

CO3: Learn the need and significance of prototyping and its significance.

Text Books

T1 Mark Baskinger and William Bardel, "Drawing Ideas: A Hand-Drawn Approach for Better Design", 2013

T2 Nigel Cross, "Design Thinking", Kindle Edition


References

R1 Kurt Hanks and Larry Belliston, "Rapid Viz : A New Method for the Rapid Visualization of Ideas", 2008.

R2 Kathryn McElroy , "Prototyping for Designers: Developing the Best Digital and Physical Products", 2017.


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SEMESTER V

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM5201	BIOCONTROL SYSTEMS	3	1	0	4

Course Objectives

- To understand the concept behind feedback and continuum in various systems and subsystems.
- To analyse the systems in time and frequency domain and to understand the concept of stability
- To apply mathematical modelling principles in understanding the various fundamental biological systems
- To understand biological system models
- To analyse biological control systems.

Unit	Description	Instructional Hours
I	INTRODUCTION Open and Closed loop Systems, Block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph.	12
II	TIME RESPONSE ANALYSIS Standard test signals, time response of first order and second order systems, time domain specifications, steady State errors.	12
III	FREQUENCY RESPONSE ANALYSIS Determination of closed loop response from open loop response, Bode plot, Nichol's chart, Polar plot.	12
IV	STABILITY ANALYSIS Characteristic equation, Location of roots in s-plane for stability, Routh Hurwitz criterion, Root locus techniques - Construction, Gain margin and phase margin, Nyquist stability criterion.	12
V	PHYSIOLOGICAL CONTROL SYSTEM ANALYSIS Difference between engineering and physiological control system- Model development of Cardiovascular system- Heart model-circulatory model - Simple models of muscle stretch reflex action- Stability analysis of Pupillary light reflex -Regulation of cardiac output, Regulation of ventilation.	12

Total Instructional Hours **60**

Course Outcomes

CO1: Understand the need for mathematical modeling of various systems, representation of systems in block diagrams and signal flow graphs and are introduced to biological control systems
 CO2: Analyze the time response of various systems and discuss the concept of system stability
 CO3: Analyze the frequency response characteristics of various systems using different charts
 CO4: Understand the concept of modeling basic physiological systems
 CO5: Comprehend the application aspects of time and frequency response analysis in physiological control systems.

TEXT BOOKS:

- T1. I.J. Nagarath and M. Gopal —Control Systems Engineering", Fifth Edition, Anshan Publishers, 2008.(UNIT)
- T2. Michael C K Khoo, —Physiological Control SystemsI, IEEE Press, Prentice Hall of India, 2005

REFERENCES:

- R1. Benjamin C. Kuo, —Automatic Control SystemsI, Prentice Hall of India, 1995.
- R2. John Enderle Susan Blanchard, Joseph Bronzino —Introduction to Biomedical EngineeringI, second edition, Academic Press, 2005.
- R3. Richard C. Dorf, Robert H. Bishop, —Modern control systemsI, Pearson, 2004.


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Programme B.E.	Course Code 19BM5202	Name of the Course BIOMECHANICS	L T P C 3 0 0 3
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Course Objectives

Upon completion of this course, the students will be familiar with

- Explain the principles of mechanics.
- Discuss the mechanics of physiological systems.
- Explain the mechanics of joints.
- Illustrate the mathematical models used in the analysis of biomechanical systems.
- Describe biomechanics of joints

Unit	Description	Instructional Hours
	INTRODUCTION	
I	Scope of mechanics in medicine, mechanics of bone structure, determination of in-vivo elastic modulus. Bio fluid mechanics, flow properties of blood. Anthropometry.	9
	MECHANICS OF PHYSIOLOGICAL SYSTEMS	
II	Heart valves, power developed by the heart, prosthetic valves. Constitutive equations for soft tissues, dynamics of fluid flow in cardiovascular system and effect of vibration - shear stresses in extra-corporeal circuits..	9
	ORTHOPAEDIC MECHANICS	
III	Mechanical properties of cartilage, diffusion properties of articular cartilage, mechanical properties of bone, kinetics and kinematics of joints, Lubrication of joints.	9
	MATHEMATICAL MODELS	
IV	Introduction to Finite Element Analysis, Mathematical models - pulse wave velocities in arteries, determination of in-vivo elasticity of blood vessel, dynamics of fluid filled catheters..	9
	ORTHOPAEDIC APPLICATIONS	
V	Dynamics and analysis of human locomotion - Gait analysis (determination of instantaneous joint reaction analysis), occupant response to vehicular vibration. Mechanics of knee joint during standing and walking..	9
	Total	45

Course Outcomes

Upon completion of this course, the students will be able to

- CO1: Understand the use of mechanics in medicine.
- CO2: Understand the mechanics of physiological systems.
- CO3: Distinguish the reason for abnormal patterns.
- CO4: Analyze the biomechanical systems using mathematical models.
- CO5: Design and develop the models specific to orthopedic applications.

TEXT BOOKS:

1. Y.C.Fung,—Bio-Mechanics, "Mechanical Properties of Tissues", Springer-Verilog, 1998.

2. C. Ross Ether and Craig A. Simmons, "Introductory Biomechanics from cells to organisms", Cambridge University Press, New Delhi, 2009

REFERENCES:

1. Susan J Hall, "Basics of Biomechanics", Mc Graw Hill Publishing.co. New York, 5th Edition, 2007.

2. Dhanjoo N.Ghista, "Orthopaedic Mechanics", Academic Press, 1990.

3. Joseph D.Bronzino, "Biomedical Engineering Fundamentals", Taylor & Francis, 2006.

4. John Enderle, Susanblanchard, Joseph Bronzino, "Introduction to Biomedical Engineering", Elsevier, 2005.


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Programme B.E.	Course Code 19BM5203	Name of the Course MICROPROCESSOR AND MICROCONTROLLERS	L 3	T 0	P 0	C 3
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Course Objective

Demonstrate the Architecture of 8086 microprocessor.
 Interpret the system bus structure and Multi processor configuration of 8086 microprocessor.
 Apply the design aspects of I/O and Memory Interfacing circuits.
 Examine the Architecture of 8051 microcontroller
 Practice the design aspect of interfacing circuits with 8051 microcontroller

Unit	Description	Instructional Hours
	8086 MICROPROCESSOR	
I	Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set – Assembly language programming – Modular Programming - Linking and Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines.	9
	8086 SYSTEM BUS STRUCTURE AND MULTIPROCESSOR CONFIGURATIONS	
II	Basic 8086 configurations – System bus timing – Bus Standards – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.	9
	PERIPHERAL DEVICES AND THEIR INTERFACING	
III	Address space partitioning-Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface -D/A and A/D Interface - Timer - Keyboard /display controller – Interrupt controller – DMA controller	9
	8051 MICROCONTROLLER	
IV	Over view of 8051 family-Architecture of 8051 –I/O Pins Ports Circuits and I/O Port Programming - Instruction set - Addressing modes - Assembly language programming.	9
	8051 MICROCONTROLLER INTERFACING WITH PERIPHERAL DEVICE	
V	8051 Timers Programming - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Interfacing with 8255- Stepper Motor Interfacing, Practical applications-Water level indicator and Zigbee interfacing.	9
	Total Instructional Hours	45

Course Outcome	CO1:	Write Assembly Language programs using 8086 microprocessor.
	CO2:	Point out System Bus Structure and Multiprocessor Configuration.
	CO3:	Analyze the various peripheral devices interfacing with 8086 microprocessor.
	CO4:	Model and implement 8051 microcontroller based systems.
	CO5:	Experiment programs on 8051 microcontroller for interfacing various peripheral devices

TEXT BOOKS:


- T1 Yu-Cheng Liu, Glenn A.Gibson, "Microcomputer Systems: The 8086 / 8088 Family -Architecture, Programming and Design", Second Edition, Prentice Hall of India, 2007.
- T2 Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Second Edition, Pearson education, 2011

REFERENCE BOOKS:

- R1 Douglas V.Hall, "Microprocessors and Interfacing, Programming and Hardware, TMH, 2012
- R2 A.K.Ray, K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGrawHill, 2012
- R3 N. Senthil Kumar, M. Saravanan, S. Jeevananthan, "Microprocessors and Microcontrollers", Oxford University Press, 2000.


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Programme B.E.	Course Code 19BM5204	Name of the Course BIOMEDICAL INSTRUMENTATION	L 3	T 0	P 0	C 3
Course Objective	<ol style="list-style-type: none"> To Illustrate about the measurement systems. To design bio amplifier for various physiological recordings Detection of physiological parameters using impedance techniques To learn the different measurement techniques for non-physiological parameters To Summarize different patient safety procedures. 					

Unit	Description	Instructional Hours
I	BIOPOTENTIAL ELECTRODES Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode- skin interface, half-cell potential, impedance, polarization effects of electrode - non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.	9
II	BIOPOTENTIAL MEASUREMENT Bio signal characteristics- frequency and amplitude ranges. ECG - Einthoven's triangle, standard 12 lead system, block diagram. Measurements of heart sounds - PCG. EEG - 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram. EMG - unipolar and bipolar mode, block diagram, EOG and ERG.	9
III	BIOPOTENTIAL AMPLIFIER Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier -right leg driven ECG amplifier. Band pass filtering, isolation amplifiers - transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Artifacts and removal.	9
IV	NON ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT Temperature, respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure: direct methods - Pressure amplifiers - systolic, diastolic, mean detector circuit, indirect methods - auscultatory method, oscillometric method, ultrasonic method. Blood flow - Electromagnetic and ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermodilution method.	9
V	BIOCHEMICAL MEASUREMENT Biochemical sensors - pH, pO ₂ and pCO ₂ , Ion selective Field Effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors - Bloodgas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer.	9
Total Instructional Hours		45
Course Outcome	CO1: To understand the various concepts of measurement systems CO2: To understand the method of designing bioamplifiers. CO3: To understand about the Detection of physiological parameters using impedancetechniques. CO4: To understand about measurement of non electric parameter. CO5: To understand about Patient safety and electromedical equipment.	

TEXT BOOKS:

- T1 - Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education India, Delhi, 2004
 T2 - . Cromwell, "Biomedical Instrumentation and Measurements", Prentice Hall of India, New Delhi, 2007

REFERENCE BOOKS:

- R1-Khandpur. R. S., "Handbook of Biomedical Instrumentation", Prentice Hall of India, New Delhi, 2003.
 R2 - Jacobson B and Webster J G Medical and Clinical Engineering - Prentice Hall of India New
 R3- John. G. Webster. "Medical Instrumentation, Application and Design" Fourth Edition. Wiley & sons, Inc, New York. 2011.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM5251	VIRTUAL INSTRUMENTATION USING LabVIEW	2	0	2	3
Course Objective	1. Understand the fundamentals of Virtual Instrumentation. 2. Idea behind the software used in Virtual Instrumentation 3. To familiarize with the basic programming and working concepts in LabVIEW. 4. Acquire biological data and develop applications using LabVIEW.					
		Description				Instructional Hours
I		INTRODUCTION Virtual Instrumentation Architecture, Conventional Virtual Instruments, Distributed Virtual Instruments, Virtual instruments Vs Traditional Instruments, Advantages of VI, Evolution LabVIEW.				9
II		INTRODUCTION TO LabVIEW AND ITS PROGRAMMING MODES Front Panel and Block Diagram of LabVIEW, LabVIEW environment and its Menus, Palettes of LabVIEW, Creating VI using LabVIEW, Loops, Arrays, Clusters, Strings, Registers, Structures, Nodes, Controls and Indicators for clusters and strings, Waveform chart and Graph types and File I/O. Experiments: <ol style="list-style-type: none"> Basic operations, controls and Indicators Simple programming structures and Timing Issues 				6+(3)P
III		HARDWARE INSTRUMENT CONTROLS Virtual Instruments Software Architecture (VISA), Digital I/O techniques, Data Acquisition in LabVIEW, DAQ Hardware Installation and configuration, DAQ Hardware Sampling and Grounding Techniques, Analog and Digital I/O, Counter/ Timer, Network data acquisition techniques.				6+(3)P
IV		TOOLKITS Biomedical toolkit, Signal Processing Tools-Fourier Transform, Power Spectrum, Correlation, Windowing, Filters, Digital Filter Design Toolkit,				6+(3)P
V		Control System Design Toolkit, Communication Design Toolkit, Vision And Motion Tools, Image processing Toolkit.				
		Experiments: <ol style="list-style-type: none"> Computerized data logging of ECG signal and find the heart beat rate using LabVIEW Acquisition of PCG, EMG Signal 				
		BIOMEDICAL APPLICATION USING LabVIEW Case study: Process Control and Automation Application, Biomedical application, robotics application, IoT application using LabVIEW, Real Time acquisition of ECG, EMG, PCG and EEG signals.				9
Total Instructional Hours						45

- CO1 Analyze Virtual Instruments in Healthcare Domain
- CO2 Explain Virtual Instruments process and software.
- CO3 Illustrate concepts of LabVIEW in Real time application
- CO4 Use DAQ for data acquisition and VI Toolkits for analysis.
- CO5 Outline various research applications using LabVIEW

TEXT BOOKS:

1. John Essick ,” Hands-On Introduction to LabVIEW for Scientists and Engineers “,OxfordUniversity Press, Fourth edition ,2018.
2. Sanjay Gupta, Joesph John,”Virtual Instruments using LabVIEW”, TATA McGraw Hill, NewDelhi, 2017.

REFERENCES:

1. Ronald W. Larsen ,”LabVIEW for Engineers”, Pearson ,First edition, 2010.
2. Robert H. Bishop,” Learning with LabVIEW” , Pearson, First edition, 2014.


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Programme B.E.	Course Code 19BM5001	Name of the Course MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	L T P C 0 0 3 1.5
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Description of the Experiments

1. Simple arithmetic operations: addition / subtraction / multiplication / division.
2. Programming with control instructions:
 - (i) Ascending / Descending order, Maximum / Minimum of numbers
 - (ii) Programs using Rotate instructions
 - (iii) Hex / ASCII / BCD code conversions.
3. Interface Experiments: with 8085
 - (i) A/D Interfacing. & D/A Interfacing.
4. Traffic light controller.
5. I/O Port / Serial communication
6. Programming Practices with Simulators/Emulators/open source
7. Read a key ,interface display
8. Demonstration of basic instructions with 8051 Micro controller execution, including:
 - (i) Conditional jumps, looping (ii) Calling subroutines.
9. Programming I/O Port 8051
 - (i) study on interface with A/D & D/A (ii) study on interface with DC & AC motor.
10. Mini project development with processors.

Practical Hours: 45

**Course
Outcome**

- CO1: understand the basic arithmetic operations in 8085
- CO2: Ability to understand and analyze, about 8085 microprocessor
- CO3: understanding of various interfacing techniques in microcontrollers
- CO4: understand the basic arithmetic operations in 8051
- CO5: Analyze and demonstrate an mini project using microcontroller.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM5002	BIOMEDICAL INSTRUMENTATION LABORATORY	0	0	3	1.5

Description of the Experiments

1. To study the different types of electrodes.
2. To study the Electrocardiogram System.
3. Bed side monitor
4. Evoked Potential Monitoring System (With Auditory, Photic and Electric Stimulus)
5. Measurement of pulse-rate using Photo transducer.
6. Measurement of pH and conductivity.
7. Surgical diathermy
8. SR Measurement setup with Software and Accessories(PC based) - Without PC Workstation
9. Ultrasound Doppler Blood Flow Monitor
10. To study Plethysmograph System.
 11. To study Phonocardiograph System.
 12. To study X-ray produced by X-ray machine.

Practical Hours: 45

Course Outcome

- CO1: Identify various Bio-potential and their specifications in terms of amplitude and frequency.
- CO2: Understand principle and working of various Biomedical Instruments for vital parameter monitoring
- CO3: Decide the applications of therapeutic instruments for treatment purpose.
- CO4: Understand applications of imaging instruments and the modalities involved in each technique.
- CO5: Understand applications of imaging instruments and the modalities involved in each technique.


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	Programme	Course Code	Course Title	L	T	P	C
	B.E.	19HE5071	SOFT SKILLS - I	1	0	0	1
Course Objectives:	1.To employ soft skills to enhance employability and ensure workplace and career success. 2.To enrich students' numerical ability of an individual and is available in technical flavor. 3.To interpret things objectively, to be able to perceive and interpret trends to make generalizations and be able to analyze assumptions behind an argument/statement.						

Unit	Description	Instructional Hours
I	INTRODUCTION TO SOFT SKILLS Introduction- Objective -Hard vs Soft Skills - Measuring Soft Skills- Structure of the Soft Skills -Self Management-Critical Thinking-Reflective thinking and writing- p2p Interaction	3
II	ART OF COMMUNICATION Verbal Communication - Effective Communication - Active listening -Paraphrasing - Feedback - Non-Verbal Communication - Roles-Types- How nonverbal communication can go wrong- How to Improve nonverbal Communication - Importance of feelings in communication - dealing with feelings in communication.	4
III	WORLD OF TEAMS Self Enhancement - importance of developing assertive skills- developing self-confidence - developing emotional intelligence - Importance of Team work - Team vs. Group - Attributes of a successful team - Barriers involved - Working with Groups - Dealing with People- Group Decision Making.	3
IV	QUANTITATIVE APTITUDE Averages - Profit and loss - Partnerships - Time and work - Time, Speed and Distance - Problems based on trains - Problems based on boats and streams	3
V	LOGICAL REASONING Clocks - Calendars - Direction Sense - Data Interpretation: Tables, Pie Chart, Bar Graph - Data Sufficiency	2

Course Outcome:	CO1: Students will have clarity on their career exploration process and to match their skills and interests with a chosen career path.
	CO2: Students will develop knowledge, skills, and judgment around human communication that facilitate their ability to work collaboratively with others
	CO3: Students will understand how teamwork can support leadership skills
	CO4: Students will be able to make sense of problems, develop strategies to find solutions, and persevere in solving them.
	CO5: Students will demonstrate an enhanced ability to draw logical conclusions and implications to solve logical problems.

REFERENCE BOOKS:

- R1: Soft Skills Training: A Workbook to Develop Skills for Employment - Frederick H. Wentz
- R2: How to prepare for data interpretation for CAT by Arun Sharma.
- R3: How to Crack TEST OF REASONING in all competitive examinations by Jaikishan and Premkishan.
- R4: A New Approach To Reasoning Verbal & Non-Verbal By B.S. Sijwali
- R5: Quantitative Aptitude for Competitive Examinations - Dr. R.S. Aggarwal, S. Chand


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19HE5072	DESIGN THINKING	1	0	0	1

- Course Objective**
- To expose students to the design process
 - To develop and test innovative ideas through a rapid iteration cycle.
 - To provide an authentic opportunity for students to develop teamwork and leadership skills

Unit	Description	Instructional Hours
DESIGN ABILITY		
I	Asking Designers about what they Do – Deconstructing what Designers Do – Watching what Designers Do – Thinking about what Designers Do – The Natural Intelligence of Design Sources	4
DESIGNING TO WIN		
II	Formula One Designing – Radical Innovations – City Car Design – Learning From Failures – Design Process and Working Methods	4
DESIGN TO PLEASE AND DESIGNING TOGETHER		
III	Background – Product Innovations – Teamwork versus Individual work – Roles and Responsibilities – Avoiding and Resolving Conflicts.	4
DESIGN EXPERTISE		
IV	Design Process – Creative Design - Design Intelligence – Development of Expertise – Novice to Expert. Critical Thinking – Case studies: Brief history of Albert Einstein, Isaac Newton and Nikola Tesla	3
Total Instructional Hours		15

- Course Outcome**
- Upon completion of the course, students will be able to
- CO1: Develop a strong understanding of the Design Process
CO2: Learn to develop and test innovative ideas through a rapid iteration cycle.
CO3: Develop teamwork and leadership skills

TEXT BOOKS:

T1 - 1. Nigel Cross, "Design Thinking", Kindle Edition.

REFERENCE BOOKS:

R1 - Tom Kelley, "Creative Confidence", 2013.
R2 - 3. Tim Brown, "Change by Design", 2009.


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SEMESTER VI

Programme B.E.	Course Code 19BM6201	Name of the Course BIOSIGNAL PROCESSING	L 3	T 1	P 0	C 4
Course Objective	1. To study about discrete time signals and its applications . 2. To understand the concept of filter designing in signal processing 3. To study about the various biomedical signals and artifact removal techniques. 4. To learn about power spectrum estimation. 5. To understand the basic concepts of wavelet transforms.					
Unit	Description	Instructional Hours				
I	INTRODUCTION TO DIGITAL SIGNAL PROCESSING: Review of sampling and reconstruction, discrete-time signals & systems – correlation of discrete time signals DFT and its properties. FFT algorithms & its application to convolution, Overlap-add & overlap-save methods. Introduction to random process-definition, methods of description, stationarity, time averaging and ergodicity.	9				
II	FILTER DESIGN Digital Processing of Continuous Time Signals, Analog Filter Design-Analog butterworth,Chebyshev LPF Design, Transformations -Analog frequency Transformation, Digital Filter Structures-IIR Realizations ,All Pass Realizations,IIR Filter Design- IIR Design by Bilinear Transformation, Digital to	9				
III	Digital Frequency Transformation, FIR Design-FIR Design by Windowing & Frequency Sampling. BIOMEDICAL SIGNALS & ARTIFACT REMOVAL: Nature of biomedical signals, characteristics of various bio-signals: interference associated with each bio-signal, computer aided diagnosis. Time domain filtering: synchronous averaging,moving average filters, derivative based ,frequency domain filtering-FIR,IIR – notch,comb - optimal filtering - adaptive filtering using LMS algorithm- applications .	9				
IV	POWER SPECTRUM ESTIMATION AND EVENT DETECTION: Introduction – Non parametric methods - The Periodogram – Modified Periodogram - Bartlett, Welch & Blackman - Tukey methods - Performance comparison. Event detection- ECG, correlation analysis of EEG channels,Homomorphic filtering.	9				
V	INTRODUCTION TO WAVELET TRANSFORM: Wavelets Introduction- Continuous wavelet transform, wavelet time-frequency characteristics, Discrete wavelet transform and orthogonal wavelet decomposition, orthonormal wavelets, filter banks-Applications- wavelet de-noising, discontinuity detection, feature detection : wavelet packets ,wavelet compression.	9				
Total Instructional Hours						45
Course Outcome	CO1 Understand the concepts of discrete time signals and its properties CO2 Understand the steps involved in filter designing. CO3 Develop knowledge on biomedical signals and the various processes involved in removing artifacts from the signal. CO4 Understand the concepts of power spectrum estimation. CO5 Understand the concepts of wavelets and its application in signal processing.					

TEXT BOOKS:

1. Rangaraj M Rangayyan: Biomedical Signal Analysis, John Wiley, 2002.
2. John G Proakis & Dimitris G Manolakis: Digital Signal Processing – Principles, Algorithms and Applications, Prentice Hall of India, 2005.

REFERENCE BOOKS:

1. Andreas Antonion: Digital Filters Analysis & Design, Prentice Hall of India, 2002.
2. P. Ramesh Babu: Digital Signal Processing, Scitech Publications, India 2004.
3. R Rabiner & B. Gold: Theory & Application of Digital Signal processing, Prentice Hall of India, 2000.
4. Alan V. Oppenheim & Ronald W Schafer: Digital Signal Processing, Prentice Hall of India, 2004.

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Programme B.E.	Course Code 19BM6202	Name of the Course RADIOLOGICAL EQUIPMENTS AND NUCLEAR MEDICINE	L 3	T 0	P 0	C 3
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Course Objective

- Understand generation of x-rays and its uses in imaging.
- Learn different types of radio diagnostic techniques.
- Know techniques used for visualizing different sections of the body.
- Understanding about different nuclear imaging techniques.
- Learn radiation therapy methodologies and the radiation safety.

Unit	Description	Instructional Hours
	MEDICAL X-RAY EQUIPMENT	
I	Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Digital Radiography- discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammography.	9
	COMPUTED TOMOGRAPHY	
II	Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors-Viewing systems- spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques- back projection and iterative method.	9
	MAGNETIC RESONANCE IMAGING	
III	Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system- system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.	9
	NUCLEAR MEDICINE SYSTEM	
IV	Radio Isotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GMcounter and scintillation Detectors, Gamma camera- Principle of operation, collimator, photo multiplier tube, X-Y positioning circuit, pulse height analyzer.Principles of SPECT and PET.	9
	RADIATION THERAPY AND RADIATION SAFETY	
V	Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,-Recent Techniques in radiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instruments-Dosimeter, film badges, Thermo Luminescentdosimeters- electronic dosimeter- Radiation protection in medicine- radiation protection principles	9
	Total Instructional Hours	45

- Course Outcome**
- CO1: Explain theory underlying machine learning.
 - CO2: Construct algorithms to Learn ANN.
 - CO3: Implement single layer feed forward networks.
 - CO4: Construct Algorithms To learn multi- layer feed forward networks.
 - CO5: Apply associative memories learning techniques for real life problems

TEXT BOOKS:


- T1 Steve Webb, The Physics of Medical Imaging, Adam Hilger, Philadelphia, 2008 (Units I, II, III & IV).
- T2 R.Hendee and Russell Ritenour "Medical Imaging Physics", Fourth Edition William, Wiley-Liss, 2002.

REFERENCE BOOKS:

- R1 Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine"- Third edition Springer, 2006.
- R2 B.H.Brown, PV Lawford, RH Small wood, DR Hose, DC Barber, "Medical physics and biomedical Engineering", - CRC Press, 1999.
- R3 Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
- R4 P.Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19HE6203	ENTREPRENEURSHIP DEVELOPMENT	3	0	0	3
Course Objective	To become familiar entrepreneurship development To learn concepts of creativity and innovation. To learn steps in developing business model. To study about appraisal of projects. To become familiar different forms of business organisations					
Unit	Description	Instructional Hours				
I	INTRODUCTION TO ENTREPRENEURSHIP Definition – Characteristics and Functions of an Entrepreneur – Common myths about entrepreneurs – Importance of Entrepreneurship. Seminar in R5 & R6.	6				
II	CREATIVITY AND INNOVATION: The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process.	6				
III	DEVELOPING AN EFFECTIVE BUSINESS MODEL: The Importance of a Business Model – Starting a small scale industry -Components of an Effective Business Model.	6				
IV	APPRAISAL OF PROJECTS: Importance of Evaluating Various options and future investments- Entrepreneurship incentives and subsidies – Appraisal Techniques.	6				
V	FORMS OF BUSINESS ORGANIZATION:: Sole Proprietorship – Partnership – Limited liability partnership - Joint Stock Companies and Cooperatives..	6				
Total Instructional Hours						45
Course Outcome	CO1: Know and understand the basics of entrepreneurship development. CO2: Understand the role of creativity in entrepreneurship development. CO3: Understand the concepts of developing an effective business model. CO4: Learn the basics of appraisal of projects. CO5: Understand the different forms of business organisations					

TEXT BOOKS:

1. Donald F. Kuratko and Richard M. Hodgetts, —Entrepreneurship, South-Western.
2. Vasant Desai, —The Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 2010.

REFERENCES:

1. Gupta S.L., Arun Mittal, —Entrepreneurship Development, International Book House, 2012.
2. Sudha G. S., —Management and Entrepreneurship Development, Indus Valley Publication, 2009.
3. Badi V., Badi N. V., —Business Ethics, R. Vrinda Publication (P) Ltd., 2012.
4. Prasanna Chandra, —Projects- Planning, Analysis, Financing, Implementation and review, TATA McGraw Hill, 2012.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM6251	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – I	3	0	1	3.5

Course Objective	
	1. Gather basic knowledge about measurements of parameters related to patient monitoring.
	2. Learn techniques of blood gas analyzers and oximeters.
	3. Understand blood rheology parameters.
	4. Know ultrasound imaging technique and its use in diagnosis .
	5. Know the importance of patient safety against electrical hazard .

Unit	Description	Instructional Hours
I	<p>PATIENT MONITORING SYSTEMS System concepts- Cardiac monitor- selection of system parameters-Bedside monitors- Central monitors- Heart rate meter- Pulse rate meter- Holter monitor and Cardiac stress test- Cardiac cauterization instrumentation- Organization and equipments used in ICCU & ITU.</p> <p>Experiments: <i>Measurement of various biological signals using bedside monitors.</i> <i>Analysis of ECG, EEG and EMG signals.</i></p>	9
II	<p>BLOOD GAS ANALYZERS AND OXIMETERS Blood pH measurement, Blood pCO₂ measurement, Blood pO₂ measurement, a complete blood gas analyzer-Fiber optic based blood gas sensors, Oximetry- Principles of oximetric measurements-Ear oximeter- Pulse oximeter- Intravascular oximeter.</p> <p>Experiments: <i>Recording of Audiogram. Measurement of pH and conductivity.</i></p>	9
III	<p>EXTRA CORPOREAL DEVICES AND SPECIAL DIAGNOSTIC TECHNIQUES Need for heart lung machine, Functioning of bubble, Disc type and membrane type oxygenators, finger pump, roller pump. Hemodialyser unit, Peritoneal dialyser unit, Thermography – Recording Principle and clinical application.</p> <p>Experiments: <i>To study the working of heart lung machine. To study the working of Hemodialysis unit.</i></p>	9


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CORONARY CARE EQUIPMENTS

- Cardiac pacemakers: different modes of operation- external and implantable pacemakers-
pacemaker standard codes -Defibrillator: AC and DC defibrillator - Implantable
defibrillator and automated external defibrillator(AED) - Pacer- cardioverter defibrillator-
defibrillator analysers - Heart lung machine (HLM) and types of oxygenators. 9

Experiments:

Study the working of Defibrillator and pacemakers.

Study of heart lung machine model.

- V **SURGICAL AND THERAPEUTIC EQUIPMENTS** 9

Surgical diathermy unit - Endoscopy basic components and types – Laparoscope-
gastro scope- bronchoscope - Cryogenic techniques and application - Operating
microscope- arthroscopy - Modern lithotripter system- laser lithotripsy.

Experiments:

Analyze the working of ESU – cutting and coagulation modes. Study of hemodialysis

model

Total Instructional Hours 45

Course Outcome

- CO1:** Explain about measurements of parameters related to Patient Monitoring Systems.
CO2: Describe the measurement techniques of Blood gas analyzers and Oximeters.
CO3: Analyze different types and uses of Blood cell counters and Blood Flow meters
CO4: Discuss about the various coronary care equipments used in hospitals.
CO5: Outline the different surgical and therapeutic equipments used in hospitals .

TEXT BOOKS:

- T1 Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.
T2 Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, NewDelhi, 2007

REFERENCE BOOKS:

- R1 Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
R2 L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.
R3 John G. Webster, "Bioinstrumentation", John Willey and sons, New York, 2004.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM6001	BIO SIGNAL PROCESSING LABORATORY	0	0	3	1.5

Description of Experiments

1. MATLAB familiarization
2. Acquisition of biosignals to the system
3. Implementation of filters.
4. Processing of ECG signals for acquiring parameters like heart rate, QRS complex, P wave etc
5. Arrhythmia analysis.
6. Analysis of plethysmographic signal.
7. Automated detection of systolic and diastolic pressure from cuff pressure and peripheral pulse.
8. Signal Classification using neural networks.
9. 50 Hz interference rejection in ECG signals.
10. Event detection in EEG signals
11. Spectral analysis of EEG, EMG signals.


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Programme	Course Code	Course Title	L	T	P	C
B.E.	19HE6071	Soft Skills-II	1	0	0	1
Course Objectives:	1. To make the students aware of the importance, the role and the content of soft skills through instruction, knowledge acquisition, demonstration and practice. 2. To learn everything from equations to probability with a completely different approach. 3. To make the students learn on an increased ability to explain the problem comprehensively.					
Unit	Description	Instructional Hours				
	GROUP DISCUSSION & PRESENTATION SKILLS					
I	GD skills – Understanding the objective and skills tested in a GD – General types of GDs – Roles in a GD – Do's & Don'ts – Mock GD & Feedback. - Presentation Skills – Stages involved in an effective presentation – selection of topic, content, aids – Engaging the audience – Time management – Mock Presentations & Feedback	4				
	INTERVIEW SKILLS AND PERSONALITY SKILLS					
II	Interview handling Skills – Self preparation checklist – Grooming tips: do's & don'ts – mock interview & feedback - Interpersonal skills-creative thinking-problem solving-analytical skills	3				
	BUSINESS ETIQUETTE & ETHICS					
III	Etiquette – Telephone & E-mail etiquette – Dining etiquette – do's & Don'ts in a formal setting – how to impress. Ethics – Importance of Ethics and Values – Choices and Dilemmas faced – Discussions from news headlines.	3				
	QUANTITATIVE APTITUDE					
IV	Permutation, Combination - Probability - Logarithm - Quadratic Equations - Algebra - Progression - Geometry - Mensuration.	3				
	LOGICAL REASONING					
V	Logical Connectives - Syllogisms - Venn Diagrams – Cubes - Coded inequalities - Conditions and Grouping	2				
Course Outcome:	CO1: Students will have learnt to keep going according to plan, coping with the unfamiliar, managing disappointment and dealing with conflict. CO2: Students will Actively participate meetings, Group Discussions / interviews and prepare & deliver presentations CO3: Students will define professional behavior and suggest standards for appearance, actions and attitude in a Business environment CO4: Students will be able to apply quantitative reasoning and mathematical analysis methodologies to understand and solve problems. CO5: Students will excel in complex reasoning.					

REFERENCE BOOKS:

- R1: Bridging the Soft Skills Gap: How to Teach the Missing Basics to Today's Young Talent- Bruce Tulgan
 R2: Quantitative Aptitude for Competitive Examinations (5th Edition) - Abhjit Guha
 R3: How to crack test of Reasoning - Jaikishan and Premkishan
 R4: The hand on guide to Analytical Reasoning and Logical Reasoning - Peeyush Bhardwaj


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Programme	Course Code	Course Title	L	T	P	C
B.E.	19HE6072	INTELLECTUAL PROPERTY RIGHTS (IPR)	1	0	0	1
Course Objectives:	1. To introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries. 2. To disseminate knowledge on patents, patent regime in India and abroad and registration aspects. 3. To disseminate knowledge on copyrights and its related rights and registration aspects. 4. To disseminate knowledge on trademarks and registration aspects. 5. To disseminate knowledge on Design, Geographical Indication (GI) and their registration aspects.					

Unit	Description	Instructional Hours
I	INTRODUCTION TO INTELLECTUAL PROPERTY Introduction, Types of Intellectual Property, International Organizations, Agencies and Treaties, Importance of Intellectual Property Rights.	3
II	PATENTS Patents -Elements of Patentability: Novelty, Non-Obviousness (Inventive Steps), Industrial Application -Non -Patentable Subject Matter -Registration Procedure, Rights and Duties of Patentee, Assignment and license.	3
III	COPYRIGHTS Purpose And Function Of Trade Marks, Acquisition Of Trade Mark Rights, Protectable Matter, Selecting And Evaluating Trade Mark, Trade Mark Registration Processes.	3
IV	TRADEMARKS Concept of Trademarks -Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) -Non-Registrable Trademarks - Registration of Trademarks.	3
V	DESIGN AND GEOGRAPHICAL INDICATION Design: meaning and concept of novel and original -Procedure for registration. Geographical indication: meaning, and difference between GI and trademarks -Procedure for registration.	3

Course Outcome:	CO1:	Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
	CO2:	Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development.
	CO3:	Identify, apply and assess ownership rights and marketing protection under intellectual property law as applicable to information, ideas, new products and product marketing.
	CO4:	Identify different types of trademarks and procedure for registration
	CO5:	Recognize the concept of design, geographical indication and procedure for registration

TEXT BOOKS:

- T1- Neeraj, P., & Khushdeep, D. (2014). Intellectual Property Rights. India, IN: PHI learning Private Limited.
 T2- V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt. Ltd, 2012.

REFERENCE BOOKS:

- R1- Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
 R2- Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.


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PROFESSIONAL ELECTIVE I

Programme	COURSECODE	NAME OF THE COURSE	L	T	P	C
B.E.	19BM5301	MEDICAL PHYSICS	3	0	0	3

Course Objective

- 1.To apply the basic concept of radiation physics
2. To Know about the genetic effect and Optical radiation principle
3. Students should know about the fundamentals of Radiation safety.

UNIT	DESCRIPTION	TOTAL INSTRUCTIONAL HOURS
	BASICS OF RADIATION PHYSICS	
I	Atomic Structure - Nuclear Transformation - Radioactivity and Interaction; electromagnetic radiation, charged particles and neutrons - Radiation attenuation coefficients – Principle of Radiation dosimetric device - cavity theories Bremsstrahlung effect, Annihilation Interaction of X and Gamma radiation with matter- Compton Scattering , Pair production -Non Ionization medical Radiation physics - Penetration and propagation of signal effects in various vital organs.	9
	MOLECULAR PHYSICS AND GENETIC EFFECTS	
II	Introduction- Molecular biophysics - Phases of matter – GIBBS law – TheHagen-poiseuille law – Strokes Law – Raoult law – Osmotic pressure –Diffusion – Phase border phenomena . Genetic Effects- Effects on DNA damage, embryo, Chromosomal damage - factors affecting frequency of radiation induced mutation - Gene controlled hereditary diseases.	9
	ACOUSTICS AND OPTICAL RADIATION	
III	Introduction of Acoustics and properties – Doppler effect - Piezo electric effect - weber-Fechners law – Effects ofultrasound in tissues - Shock waves – Propagation of light – Light scattering - Photo Medicine –Various types of optical radiations - Optical properties of tissues, applications of optical radiations.	9
	INTERACTION OF NUCLEAR PHYSICS	
IV	Principles of Nuclear Physics – Natural radioactivity, Decay series, type of radiation and their properties. Production of artificial isotopes – accelerator principles: Betatron, Cyclotron . fission and electron Capture reaction, radionuclide Generator-Technetium generator – Applications of artificial isotopes and Radio nuclides in Nuclear Medicine and biology.	9
V	RADIATION ONCOLOGY & SAFETY Introduction -exposure- Inverse square law-KERMA- Bremsstrahlung radi Bragg's curve- Principles of MPD, ADEL and ALARA - concept of LD Gamma knife – LINAC – Chemotherapy – Brachytherapy – Dosimeter – Raddetector and Types – Radiation safety and Its Principle	9
TOTAL INSTRUCTIONAL HOURS		45

- CO1:** Analyze the physics of Radiation.
CO2: Understand the use of molecular and Genetic Engineering
CO3: Understand principles of Acoustics and Optical radiation
CO4: Analyze the interaction methods of Nuclear Physics
CO5: understand the basics of radiation Oncology and safety principles.

TEXT BOOKS

1. Daniel Jirak, Frantisek Vitek Basics of Medical Physics.
2. Moumita Mukherjee, J.K. Mandal , Advance in medical Physics and healthcareEngineering, Springers Singapore , 2021

REFERENCES

- 1.P.Uma Devi, A.Nagarathnam , B S SatishRao , "Introduction to Radiation Biology" B.I Chur Chill Livingstone pvt Ltd, 2000.
- 2.S.Webb" The Physics of Medical Imaging", Taylor and Francis, 2018.
- 3.J.P.Woodcock, Ultrasonic,Medical Physics Handbook series 1, Adam Hilger


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM5302	ROBOTICS IN MEDICINE	3	0	0	3

Course Objectives:

1. To study the characteristics of robotics
2. To understand the response of actuators and gripper.
3. To learn about the pneumatic manipulators
4. To know the compatibility and functioning power source and sensors

UNIT I	INTRODUCTION OF ROBOTICS	9
Introduction to Robotics and his history, Overview of robot subsystems, Degrees of freedom, Configurations - Automation, Mechanisms and movements, Dynamic stabilization- Application of robotics in medici		
UNIT II	ACTUATORS AND GRIPPERS	9
Pneumatic and hydraulic actuators, stepper motor control circuits, End effectors, Various types of Gripper and methods, Design consideration in vacuum and, PD and PID feedback actuator models.		
UNIT III	MANIPULATORS AND BASIC KINEMATICS	9
Construction of Manipulators, Electronic and pneumatic manipulator, Forward Kinematic, Inverse Kinematics.		
UNIT IV	POWER SOURCE AND SENSORS	9
Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder, LASER – Acoustic , Magnetic fibre optic and Tactile sensor.		
UNIT V	ROBOTICS APPLICATION IN MEDICAL FIELD	9
Da Vinci Surgical system, Image guided robotic system in USG, Robotic Tele-surgical system .Urologic applications, Cardiac (CABG) surgery, Neurosurgery, Paediatric, and general –Surgery, Gynaecologic Surgery, Laparoscopy, General Surgery and Nano robotics.		

TOTAL : 45 PERIOD

COURSE OUTCOMES:

At the end of the course, the student will able to

- CO1: Analyze different types of materials and its application in Robotics
- CO2: Choose materials for design of Robotics.
- CO3: Evaluate response of robotic in medical field.
- CO4: Assess compatibility and functioning of robots
- CO5: Design and develop robots for biomedical application.

TEXT BOOKS

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill , First edition, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wileyand Sons, First edition , 2008.
3. Fu.K.S. Gonzalaz.R.C., Lee C.S.G, "Robotics Control", sensing , Vision and Intelligence, Tata McGrawHill International, First edition, 2008.

REFERENCES

1. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thrun, "Principles of robot motion: Theory, Algorithms, and Implementations", Prentice hall of India, First edition, 2005
2. Jacob Rosen, Blake Hannaford & Richard M Satava, " Surgical Robotics: System Applications & Visions", Springer 2011

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Programme	Course Code	Name of the Course	L	T	P	C	
B.E.	19BM5303	TOTAL QUALITY MANAGEMENT	3	0	0	3	
Course Objectives	Upon completion of this course, the students will be familiar with 1. To facilitate the understanding of Quality Management frame work. 2. Understand TQM principles. 3. Learn TQM Tools and Techniques. 4. Know Quality Function Deployment (QFD), Taguchi quality loss function. 5. Understand Quality Management System.						
Unit	Description						Instructional Hours
	INTRODUCTION						
I	Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.						9
	TQM PRINCIPLES						
II	Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.						9
	TQM TOOLS AND TECHNIQUES I						
III	The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.						9
	TQM TOOLS AND TECHNIQUES II						
IV	Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.						9
	QUALITY MANAGEMENT SYSTEM						
V	Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards— Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements— Implementation— Documentation—Internal Audits— Registration- ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction— ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.						9
Total Instructional Hours						45	

	CO1: The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.
Course	CO2: Discuss TQM principles.
Outcomes	CO3: Able to use TQM Tools and Techniques.
	CO4: Apply Quality Function Deployment (QFD), Taguchi quality lossfunction.
	CO5: The student would be able to apply the Quality Management System.

TEXT BOOKS:

T1 B.Michna, Glen H. Besterfield, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, — Total Quality Management, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCES:

- R1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
R2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", PrenticeHall (India) Pvt. Ltd., 2006.
R3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
R4. ISO9001-2015 standards.


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Programme	COURSE CODE	NAME OF THE COURSE	L	T	P	C
B.E.	19BM5304	MEDICAL ETHICS AND STANDARDS	3	0	0	3

Course Objective	
	1. Achieve familiarity with some basic ethical framework& understand how theseethical frameworks can help us to think through contemporary questions in medical ethics.
	2. Students will be able to know about the legal and ethical principles
	3. To apply these principles in health care settings & gain knowledge about the medical standards that to be followed in hospitals.

UNIT	DESCRIPTION	TOTAL INSTRUCTIONAL HOURS
	INTRODUCTION TO MEDICAL ETHICS	
I	Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor and Society	9
	ETHICAL THEORIES & MORAL PRINCIPLES	
II	Theories-Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles Non- Maleficence, Beneficence, Autonomy, Veracity, Justice. Autonomy & Confidentiality issues in medical practice. Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine	9
	HOSPITAL ACCREDITATION AND SAFETY STANDARDS	
III	Accreditation- JCI Accreditation & its Policies. Patient centeredstandards, Healthcare Organization management standards.	9
	HOSPITAL SAFETY STANDARDS	
IV	Life Safety Standards- Protecting Occupants, Protecting the Hospital from Fire, Smoke, and Heat, Protecting Individuals from Fire and Smoke, Providing and Maintaining Fire Alarm Systems, Systems for Extinguishing Fires Environment of Care Standards-Minimizing EC Risks, Smoking Prohibitions, Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.	9

MEDICAL EQUIPMENT SAFETY STANDARDS

V Fi General requirements for basic safety & essential performance of medical equipment. IEC 60601 standards, Indian and International standards, ISO standards - Base Standard-general requirement of electrical medical devices, Collateral Standards- EMC radiation protection & programmable medical device system, Particular Standards-type of medical device. 9

TOTAL INSTRUCTIONAL HOURS 45

Upon completion of the course, students will be able to

Course Outcome

CO1: Describe the Social responsibility in healthcare systems

CO2: Discuss the Bioethics and engineers role

CO3 : Apply Legal and professional guidelines for the hospital accreditation

CO4: Understand hospital safety aspects

CO5 : Comprehend the medical equipment safety standards and medical device maintenance.

TEXT BOOKS:

T1: Domiel A Vallero, Biomedical Ethics for Engineers, Elsevier Pub. 1st edition, 2017

T2: Johnna Fisher, Biomedical Ethics: A Canadian Focus., Oxford University Press Canada, 2019.

REFERENCE BOOKS:

R1: Robert M Veatch, The Basics of Bio Ethics, 3rd Edition. Routledge, 2019.

R2: Physical Environment Online: A Guide to The Joint Commission's Safety Standards is published by HCPro, Inc. 2020


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Programme B.E.	Course Code 19BM5305	Name of the Course INTELLECTUAL PROPERTY RIGHTS	L 3	T 0	P 0	C 3
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Upon completion of this course, the students will be familiar with

- Course Objectives**
1. To give an idea about IPR, Patents and Copyrights.
 2. Understand registration of IPRs.
 3. Understand Agreements and Legislations.
 4. To know Digital products and Law.
 5. Discuss IPR and its enforcement.

Unit	Description	Instructional Hours
I	INTRODUCTION Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO – TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.	9
II	REGISTRATION OF IPRs Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad.	10
III	AGREEMENTS AND LEGISLATIONS International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.	10
IV	DIGITAL PRODUCTS AND LAW Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.	9
V	ENFORCEMENT OF IPRs Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.	7
Instructional Hours Total		45

Course Outcomes

Upon completion of this course, the students will be able to
 CO1: Ability to manage Intellectual Property portfolio to enhance the value of the firm.
 CO2: Discuss registration of IPRs.
 CO3: Able to use Agreements and Legislations of IPR. CO4: Use Digital products and Law.
 CO5: Acquire knowledge of IPR and its enforcement.

TEXT BOOKS:

- T1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012
 T2. S. V. Satakar, —Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.

REFERENCES:

- R1. Deborah E. Bouchoux, —Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets, Cengage Learning, Third Edition, 2012.
 R2. Prabuddha Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, McGraw Hill Education, 2011.
 R3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.


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PROFESSIONAL ELECTIVE II

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM6301	BIOMATERIALS AND ARTIFICIAL ORGANS	3	0	0	3

Course Objectives:

- To study the characteristics and classification of biomaterials.
- To understand the response of biomaterials in living system.
- To learn about the polymeric materials and composites in tissue replacements.
- To know the compatibility and functioning of artificial organs inside the living system.

UNIT I STRUCTURE OF BIO-MATERIALS AND BIO- COMPATIBILITY

Definition and classification of bio-materials, mechanical properties, viscoelasticity, wound Healing process, body response to implants, blood compatibility, HLA compatibility.

UNIT II IMPLANTMATERIALS

Metallic implant materials, stainless steels, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite, glass ceramics, carbons, medical applications case study on bone replacement

UNIT III POLYMERIC IMPLANTMATERIALS

Polymerization, polyamides, Acrylic polymers, Hydrogels, rubbers, high strength, thermoplastics, medical applications. Bio polymers: collagen and elastin. Medical Textiles:silica,chitosan, PLA, composites ,Sutures, wound dressings .Materials for ophthalmology: contactlens, Intra ocularlens. Membranes for plasma separation and blood oxygenation.

UNIT IV TISSUE REPLACEMENTIMPLANTS

Small intestinal submucosa and other decellularized matrix biomaterials for tissue repair. Soft- tissue replacements, types of transplant by stem cell,sutures, surgicaltapes ,Tissue adhesive/ glue. Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts,har dtissue replacement Implants, joint replacements, Pancreas replacement case study ontissue replacement.

UNIT V ARTIFICIAL ORGANS

Artificial Blood, Artificial Skin, Artificial Heart,Prosthetic Cardiac valves, Artificial Lung(Oxy genator), Artificial Kidney(Dialyzer Membrane), Dental Implants, Retinal Implantscase study on dental and heart valve

TOTAL:45 PERIODS

COURSE OUTCOMES:

At the end of the course, the student will able to

- CO1: Analyze different types of materials and its applicationin biomedical field.
- CO2: Choose materials for design of implants in tissue replacement.
- CO3:Evaluate response of biomaterials in living system.
- CO4: Assess compatibility and functioning of artificial organs inside the living system.
- CO5: Design and develop biomaterial based scaffold for biomedical application.

TEXTBOOKS

1. Sujata V.Bhatt, "Biomaterials", Narosa Publishing House, 7th Edition, 2005.
2. Joon B. Park, Joseph D. Bronzino, "Biomaterials- Principles and Applications", CRC Press, 2003.

REFERENCES:

1. H.H. Willard, D.L. Merrit, "Instrumental Methods of Analysis", CBS Publishers, 1992.
2. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.


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Programme B.E.	Course Code 19BM6302	Name of the Course EMBEDDED SYSTEMS IN MEDICALDEVICES	L 3	T 0	P 0	C 3
Course Objective	1. Understand overview of Processors and hardware units.					
	2. Understand Intel MCS51 Architecture.					
	3. Learn PIC Microcontroller.					
	4. Understand Embedded system evolution trends.					
	5. Discuss applications of embedded system.					
Unit	Description					Instructional Hours
	Introduction to embedded systems Definition and Classification – Overview of Processors and hardware units in an embedded system – Software Embedded into the System – Complex System Design and the various Processors - Concept of Design Process in Embedded Systems - Design Examples – Classifications in Embedded Systems and Skills required for an Embedded Systems Designer					9
	Interfacing with 8051 and Introduction to Arduino UNO R3 Introduction to 16 bit Microcontroller. Interfacing of 8051 with ADC, sensors, stepper motor, key board, & DAC - Introduction to Arduino UNO R3 Hardware setup – I/O functions – Real time Application					9
	Introduction to PIC Microcontroller PIC Microcontroller - Introduction, CPU architecture, registers, instruction sets addressing modes Loop timing, timers, Interrupts, Interrupt timing, I/o Expansion, I 2C Bus Operation Serial EEPROM, Analog to digital converter, UART-Baud Rate- Data Handling, Special Features					9
	Real time Operating system Concepts Recursion, Debugging strategies, Simulators, Task and Task States, tasks and data, semaphores and shared Data Operating system Services-Message queues- Timer Function- Events-Memory Management, Interrupt Routines in an RTOSenvironment, basic design Using RTOS					9
	Embedded systems application in Medical devices Embedded medical applications: Ophthalmology - Glaucoma screening device, Medical Imaging Acquisition User Interface, Drug delivery systems, Patient monitoring Systems.					9
Total Instructional Hours						45
Course Outcome	CO1: Explain overview of Processors and hardware units. CO2: Apply Intel MCS51 Architecture. CO3: Describe PIC Microcontroller. CO4: Explain Embedded system evolution trends. CO5: Apply applications of embedded system.					

TEXT BOOKS:


1. Rajkamal, Embedded Systems Architecture, Programming and Design, TATA McGraw-Hill, First reprint Oct. 2003
2. M A Mazidi & Mazidi, The 8051 micro controllers, Pearson Education, 2005

REFERENCES:

1. Tim Wilmshurst, Designing Embedded Systems with PIC, Newnes publishing, 2007
2. Steve Heath, Embedded Systems Design, Second Edition-2003, Newnes,
David E. Simon, An Embedded Software Primer, Pearson Education Asia, First Indian Reprint 2000.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM6303	BIOMEDICAL WASTE MANAGEMENT	3	0	0	3
Course Objective	1. Understand hazard control 2. Understand the hazardous materials used in hospital and its impact on health 3. Understand various waste disposal procedures and management. 4. Learn safety of hospital 5. Understand infection control, prevention and patient safety					
Unit	Description					Instructional Hours
	HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS					
I	Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education, and Training.					9
	HOSPITAL WASTE MANAGEMENT					
II	Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal					9
	HAZARDOUS MATERIALS					
III	Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.					9
	FACILITY SAFETY					
IV	Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.					9
	INFECTION CONTROL, PREVENTION AND PATIENT SAFETY					
V	Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.					9
	Total Instructional Hours					45
Course Outcome	CO1: Analyse various hazards, accidents and its control CO2: Design waste disposal procedures for different biowastes CO3: Categorise different biowastes based on its properties CO4: Design different safety facility in hospitals CO5: Propose various regulations and safety norms					

TEXT BOOKS:

1. James T., Healthcare hazard control and safety management-CRC Press, Taylor and Francis (2014).
2. Sukhjot Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012).

REFERENCES:

1. C. Goyal —Hospital Administration and Human Resource Management, PHI —Fourth Edition, 2006
2. J. Landrum, —Medical Waste Management and Disposal, Elsevier, 1991


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Programme B.E.	Course Code 19BM6304	Name of the Course PHYSIOLOGICAL MODELLING	L 3	T 0	P 0	C 3
Course Objective	1. To understand the concepts of physiological modelling 2. To learn the different approaches used in modeling of physiological systems. 3. To learn the concepts of modeling human thermal regulatory system. 4. To learn the concepts of modeling human respiratory system. 5. To study about the electrical properties of neuron and to model them.					

Unit	Description	Instructional Hours
	Introduction to physiological modelling	
I	Physiological complexity and the need for models: Complexity , Feedback and Control in Physiological Systems Models and the modeling process: Model Formulation , Identification Validation and Simulation.	9
	Different approaches of modeling physiological systems	
II	Linear Modeling Distributed Modeling Nonlinear Modeling Time-varying Modeling Mathematical approach, electrical analogues, etc. Introduction to various process controls like cardiac rate, blood pressure, respiratory rate. Blood - Glucose regulation. Pharmacokinetic modeling-compartmental models, blood-tissue models.	9
	Modeling of human thermal regulatory system	
III	Parameters involved, control system model etc. Biochemistry of digestion, Loss of heat to the environment, Heat transfer within the body, Models describing heat transfer between core and skin, heat distribution in extremities.	9
IV	Modeling of Respiratory system Human Lungs: Anatomy and physiology of the respiratory system, mass balance in lungs, oxygen and carbon dioxide transport in blood Modeling oxygen uptake by RBC and pulmonary capillaries .	
	Neuron Models	
V	Electrical properties of Neurons, Single compartment models, voltage dependent conductances, Hodgkin Huxley model, Integrate fire neuron model, conductance based models, Cable equation, multi compartment models. Fitzhugh Nagumo models.	9
	Total Instructional Hours	45
Course Outcome	CO1 Gain adequate knowledge about the modeling of physiological systems CO2 Have an in depth idea about different approaches in modeling physiological systems CO3 Design and develop the physiological model of human thermal regulatory system. CO4 Design and develop the physiological model of human respiratory system CO5 Gain in-depth knowledge about different types of neuron models and its electrical properties	

TEXT BOOKS:


1. Arthur C Guyton, Text Book of Medical physiology, PRISM Books India, 2000
2. David Cooney, Biomedical Engineering Principles, Marcel Decker Publications, 2001.

REFERENCE BOOKS:

1. Peter Dayan, Theoretical Neuroscience: Computational and Mathematical modeling of Neural systems MIT Press
2. Vasilis Z Marmarelis, Nonlinear Dynamic Modeling of Physiological systems IEEE Press series in Biomedical Engineering.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM6305	ARTIFICIAL NEURAL NETWORKS	3	0	0	3

Course Objective

- To understand the need for machine learning for various problem solving
- To study the various supervised, semi-supervised and unsupervised learning algorithms in machine learning
- To learn the new approaches in machine learning
- To design appropriate machine learning algorithms for problem solving
- To understand about the basic concepts of associative memories.

Unit	Description	Instructional Hours
I	INTRODUCTION TO NEURAL NETWORKS Introduction-Humans and Computers- Organization of the Brain- Biological Neuron-Biological and Artificial Neuron Models-Characteristics of ANN- McCulloch Pitts Model- Historical Developments- Potential Applications of ANN.	9
II	ESSENTIALS OF ARTIFICIAL NEURAL NETWORKS Artificial Neuron Model- Operations of Artificial Neuron- Types of Neuron Activation Function- ANN Architectures- Classification Taxonomy of ANN – Connectivity- Learning Strategy- Supervised, Unsupervised, Reinforcement- Learning Rules.	9
III	SINGLE LAYER FEED FORWARD NETWORKS Introduction-Perceptron Models: Discrete, Continuous and Multi-Category- Training Algorithms: Discrete and Continuous Perceptron Networks- Limitations of the Perceptron Model.	9
IV	MULTI- LAYER FEED FORWARD NETWORKS Credit Assignment Problem- Generalized Delta Rule- Derivation of Backpropagation (BP) Training,-Summary of Backpropagation Algorithm- Kolmogorov Theorem- Learning Difficulties and Improvements.	9
V	ASSOCIATIVE MEMORIES Paradigms of Associative Memory-Pattern Mathematics-Hebbian Learning- General Concepts of Associative Memory- Bidirectional Associative Memory (BAM) Architecture- BAM Training Algorithms-Storage and Recall Algorithm- BAM Energy Function-Architecture of Hopfield Network: Discrete and Continuous versions-Storage and Recall Algorithm,-Stability Analysis- Neural network applications: Process identification, control, fault diagnosis.	9
Total Instructional Hours		45

Course Outcome

- CO1: Explain theory underlying machine learning.
- CO2: Construct algorithms to Learn ANN.
- CO3: Implement single layer feed forward networks.
- CO4: Construct Algorithms To learn multi- layer feed forward networks.
- CO5: Apply associative memories learning techniques for real life problems

TEXT BOOKS:

- T1 LaureneFausett, "Fundamentals of Neural Networks", Pearson Education,2014.
- T2 Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2013.

REFERENCE BOOKS:

- R1 S.N.Sivanandam, S.Sumathi,S. N. Deepa "Introduction to Neural Networks using MATLAB 6.0", TATA McGraw Hill, 2016.
- R2 S. Rajasekharan and G. A. Vijayalakshmi, "Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications", PHI Publication, 2014.
- R3 Timothy J. Ross, " Fuzzy Logic With Engineering Applications", Tata McGraw-Hill Inc. 2010.


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SEMESTER VII

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	19BM7201	MEDICAL IMAGE PROCESSING	3	0	0	3

Course Objective	
	1. To become familiar with digital image fundamentals
	2. To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
	3. To learn concepts of degradation function and restoration techniques.
	4. To study the image segmentation and representation techniques.
	5. To become familiar with image compression and recognition methods

Unit	Description	
	DIGITAL IMAGE FUNDAMENTALS	
I	Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.	9
	IMAGE ENHANCEMENT	
II	Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.	9
	IMAGE RESTORATION	
III	Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering	9
	IMAGE SEGMENTATION	
IV	Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds –basic concepts – Dam construction – Watershed segmentation algorithm.	9
	IMAGE COMPRESSION AND RECOGNITION IN MEDICAL IMAGES:	
V	Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.	9
	Total Instructional Hours	45

	CO1: Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.
	CO2: Operate on images using the techniques of smoothing, sharpening and enhancement.
Course Outcome	CO3: Understand the restoration concepts and filtering techniques.
	CO4: Learn the basics of segmentation, features extraction, compression and recognition methods for color models.
	CO5: Able to analyze image compression and recognition methods

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, 'Digital Image Processing', Pearson, Third Edition, 2010.
2. Anil K. Jain, 'Fundamentals of Digital Image Processing', Pearson, 2002.

REFERENCES:

1. Kenneth R. Castleman, 'Digital Image Processing', Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education, Inc., 2011.
3. D.E. Dudgeon and R.M. Mersereau, 'Multidimensional Digital Signal Processing', Prentice Hall Professional Technical Reference, 1990.
4. William K. Pratt, 'Digital Image Processing', John Wiley, New York, 2002
5. Milan Sonka et al 'Image processing, analysis and machine vision', Brookes/Cole, Vikas Publishing House, 2nd edition, 1999


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Programme/	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7202	DIAGNOSTIC AND THERAPEUTIC EQUIPMENT – II	3	0	0	3

Course Objective
<ol style="list-style-type: none"> 1. Gather basic knowledge about measurements of parameters related to respiratory system. 2. Learn measurement techniques of sensory responses and Hearing Aid Equipment's. 3. Understand different types and uses of diathermy units. 4. Know ultrasound imaging technique and its use in diagnosis . 5. Know the importance of patient safety against electrical hazard .

Unit	Description	Instructional Hours
I	INSTRUMENTS DEALING WITH BONES AND RESPIRATORY CARE Respiratory care equipments: humidifier, nebulizer, aspirators - Ventilators and types- Capnography -Anesthesia machine - Baby incubator-BMD measurements- Single X-ray Absorptiometry (SXA) -Dual X-ray Absorptiometry (DXA) - Quantitative ultrasound- bone densitometer.	9
II	SENSORY DIAGNOSIS AND HEARING AID EQUIPMENTS Mechanism of hearing, sound conduction system - basic audiometer, pure tone audiometer - Speech audiometer, Bekesy audiometer system - Evoked response audiometry system - Hearing aids-cochlear implants - Tonometry - Measurement of basal skin response and galvanic skin response.	9
III	DIATHERMY Short wave diathermy -Microwave diathermy -Ultrasonic therapy unit -Electro diagnostic and therapeutic apparatus -Interferential current therapy- Transcutaneous electrical nerve stimulation(TENS)-Spinal cord stimulator- bladder stimulator-deep brain stimulation - Photo therapy unit	9
IV	ULTRASONIC TECHNIQUE Characteristics of sound- interactions of ultrasound with matter -Ultrasound transducers- ultrasound beam properties-image data acquisition -Modes of image display and storage - Doppler ultrasound-Ultrasound doppler blood flow meter - Ultrasonography in emergency cardiovascular care - Echocardiogram- Echoencephalogram	9
V	PATIENT SAFETY Physiological effects of electricity – important susceptibility parameters – Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces- Electrical safety codes and standards – IEC 6060112005 standard, Basic Approaches to Protection against shock, Protection equipment design, Electrical safety analyzer – Testing the Electric system.	9
Total Instructional Hours		45

**Course
Outcome**

- CO1:** Explain about measurements of parameters related to respiratory system.
CO2: Describe the measurement techniques of sensory responses.
CO3: Analyze different types and uses of diathermy units.
CO4: Discuss ultrasound imaging techniques and its usefulness in diagnosis.
CO5: Outline the importance of patient safety .

TEXT BOOKS:

- T1 Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2003.
T2 Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, NewDelhi, 2007

REFERENCE BOOKS:

- R1 Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
R2 L.A Geddas and L.E.Baker "Principles of Applied Biomedical Instrumentation" 2004.R3
John G. Webster, "Bioinstrumentation", John Willey and sons, New York, 2004.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16HE7104	ENTREPRENEURSHIP DEVELOPMENT	2	0	0	2
Course Objective	1. To become familiar entrepreneurship development					
	2. To learn concepts of creativity and innovation.					
	3. To learn steps in developing business model.					
	4. To study about appraisal of projects.					
	5. To become familiar different forms of business organisations					
Instructional Hours						
Unit	Description					Instructional Hours
						6
	INTRODUCTION TO ENTREPRENEURSHIP					
I	Definition – Characteristics and Functions of an Entrepreneur – Common myths about entrepreneurs – Importance of Entrepreneurship. Seminar in R5 & R6.					
	CREATIVITY AND INNOVATION:					
II	The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process.					6
	DEVELOPING AN EFFECTIVE BUSINESS MODEL:					
III	The Importance of a Business Model – Starting a small scale industry - Components of an Effective Business Model.					6
	APPRAISAL OF PROJECTS:					
IV	Importance of Evaluating Various options and future investments- Entrepreneurship incentives and subsidies – Appraisal Techniques.					6
	FORMS OF BUSINESS ORGANIZATION::					
V	Sole Proprietorship – Partnership – Limited liability partnership - Joint Stock Companies and Cooperatives..					6
Total Instructional Hours					45	
Course Outcome	CO1: Know and understand the basics of entrepreneurship development.					
	CO2: Understand the role of creativity in entrepreneurship development.					
	CO3: Understand the concepts of developing an effective business model.					
	CO4: Learn the basics of appraisal of projects.					
	CO5: Understand the different forms of business organisations					

TEXT BOOKS:

1. Donald F.Kuratko and Richard M. Hodgetts, —Entrepreneurship, South-Western.
2. Vasant Desai, —The Dynamics of Entrepreneurial Development and Management, Himalaya Publishing House, 2010.

REFERENCES:

1. Gupta S.L., Arun Mittal, —Entrepreneurship Development, International Book House, 2012.
2. Sudha G. S., —Management and Entrepreneurship Development, Indus Valley Publication, 2009.
3. Badi V., Badi N. V., —Business Ethics, R. Vrinda Publication (P) Ltd., 2012.
4. Prasanna Chandra, —Projects- Planning, Analysis, Financing, Implementation and review, TATA McGraw Hill, 2012.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7001	MEDICAL IMAGE PROCESSING LABORATORY	0	0	4	2

Description of the Experiments

1. To perform basic operations on images.
2. To perform histogram equalization.
3. To perform image filtering in spatial domain.
4. To perform image filtering in frequency domain.
5. To perform image restoration.
6. To perform image compression using DCT / Wavelet transform.
7. To perform edge detection using various masks.
8. To perform global and adaptive thresholding. To
9. apply morphological operators on an image.
10. To obtain boundary / regional descriptors of an image. To
11. perform image classification / recognition
12. To perform basic operations on images.
13. To perform histogram equalization.
14. To perform image filtering in spatial domain.
15. To perform image filtering in frequency domain.

Note: It is suggested to carry out the above experiments by Matlab / C programming on diagnostic images such as x-ray / CT / MRI / Ultrasound.

Total Practical Hours: 45


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PROFESSIONAL ELECTIVE III

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7301	ARTIFICIAL ORGANS AND IMPLANTS	3	0	0	3

Course Objective

1. To introduce existing artificial organs, prostheses, and rehabilitation systems, focusing on their goals, working principles, and limitations.
2. To make the students familiarize about various artificial organs particularly artificial kidney
3. To make the students familiarize about various artificial organs particularly artificial heart lung machine.
4. To stimulate the student's innovation skills through the deep understanding of the global problem of interfacing a rehabilitation device.
5. To introduce students about Implant Design Parameters and its Solution.

Instructional Hours

Unit	Description	Instructional Hours
I	INTRODUCTION TO ARTIFICIAL ORGANS Need of artificial organs- design consideration and evaluation process- artificial heart and engineering design-circulatory assist devices-IABP and SSI-cardiac catheterization, stents- CVP and SWAN catheters- blood substitutes and haemo Dilution-oxygen carrying and hemoglobin based artificial blood-liver support system- artificial pancreas- artificial skin.	9
II	ARTIFICIAL KIDNEY Brief of kidney filtration, basic methods of artificial waste removal, hemodialysis, equation for artificial kidney and middle molecule hypothesis, artificial kidney machine, hemodialysers: flat plate type, coil type and hollow fiber. Mass transfer in dialysers, regeneration of dialysate, membrane configuration, portable and implantable artificial kidney machine, electrical safety and maintenance.	9
III	ARTIFICIAL HEART-LUNG MACHINE Brief of lungs gaseous exchange / transport, artificial heart-lung devices, oxygenators: bubble, film oxygenators and membrane oxygenators. Gas flow rate and area for membrane oxygenators.	9

	REHABILITATION ENGINEERING	
IV	Impairments- disabilities and handicaps- measurement and assessment- Engineering concepts in sensory and motor rehabilitation-Rehabs for locomotion- visual and speech- Spinal rehabilitation- ultrasonic binaural sensing aid for theblind- rehabilitation in sports.	9
V	IMPLANT DESIGN PARAMETERS AND ITS SOLUTION Biocompatibility- local and systemic effects of implants- Design specifications for tissue bonding and modulus matching-Degradation of devices- natural and synthetic polymers- corrosion- wear and tear- Implants for Bone- Devices for nerve regeneration.	9
	Total Instructional Hours	45

- Course Outcome**
- CO1: Gain adequate knowledge about artificial organs and transplants.
 - CO2: Have in-depth knowledge about Artificial kidney
 - CO3: Have in-depth knowledge about Artificial heart-lung machine
 - CO4: Explain different types of Rehabilitation Engineering techniques.
 - CO5: Get clear idea about implant design and its parameters and solution.

TEXT BOOKS:

- T1 Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 2001.T2
Park J.B., Biomaterials Science and Engineering, Plenum Press, 2004.

REFERENCE BOOKS:

- R1 Bronzino Joseph, Hand book of biomedical Engineering, Springer, 2000.R2
Gerald E Miller, Artificial Organs, Morgan & Claypool, 2006.
R3 Kondraske, G. V, Rehabilitation Engineering. CRC press1995.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM702	VLSI DESIGN	3	0	0	3

Course Objective	Description
	<ol style="list-style-type: none"> 1. In this course, the MOS circuit realization of the various building blocks that is common to any microprocessor or digital VLSI circuit is studied. 2. Architectural choices and performance tradeoffs involved in designing and realizing the circuits in CMOS technology are discussed. 3. The main focus in this course is on the transistor circuit level design and realization for digital operation and the issues involved as well as the topics covered are quite distinct from those encountered in courses on CMOS Analog IC design. 4. The main focus is to design arithmetic building blocks for vlsi design 5. This unit covers about the various implementation strategies in FPGA.

Unit	Description	Instructional Hours
	MOS TRANSISTOR PRINCIPLE	
I	NMOS and PMOS transistors- Process parameters for MOS and CMOS- Electrical properties of CMOS circuits and device modeling- Scaling principles and fundamental limits- CMOS inverter scaling-propagation delays-Stick diagram-Layout diagrams.	9
	COMBINATIONAL LOGIC CIRCUITS	
II	Examples of Combinational Logic Design-Elmore's constant- Pass transistor Logic- Transmission gates- static and dynamic CMOS design- Power dissipation – Low power design principles.	9
	SEQUENTIAL LOGIC CIRCUITS	
III	Static and Dynamic Latches and Registers- Timing issues- pipelines-clock strategies-Memory architecture and memory control circuits- Low power memory circuits-Synchronous and Asynchronous design.	9
	DESIGNING ARITHMETIC BUILDING BLOCKS	
IV	Data path circuits- Architectures for ripple carry adders-carry look ahead adders- High speed adders-accumulators- Multipliers-dividers-Barrel shifters-speed and area tradeoff	9

IMPLEMENTATION STRATEGIES

V	Full custom and Semi custom design- Standard cell design and cell libraries-FPGA building block architectures- FPGA interconnect routing procedures.	9
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Total Instructional Hours 45

Course Outcome	CO1: Explain the basic CMOS circuits and the CMOS process technology.
	CO2: Discuss the techniques of chip design using programmable devices.
	CO3: Model the digital system using Hardware Description Language.
	CO4: To understand about FPGA and its implementation strategies.
	CO5: To explain in detail about designing of arithmetic building blocks.

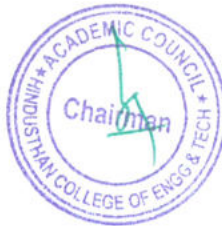
TEXT BOOKS:

- T1 Jan Rabaey, Anantha Chandrakasan, B.Nikolic, "Digital Integrated Circuits: A Design Perspective". Second Edition, Prentice Hall of India, 2003.
- T2 M.J. Smith, "Application specific integrated Circuits", Addison Wesley, 2007.

REFERENCE BOOKS:

- R1 N.Weste, K.Eshraghian, "Principles of CMOS VLSI Design", Second Edition, Addison Wesley 1993
- R2 R.Jacob Baker, Harry W.LI., David E.Boyee, "CMOS Circuit Design, Layout and Simulation", PrenticeHall of India, 2005
- R3 A.Pucknell, Kamran Eshraghian, "BASIC VLSI Design", Third Edition, Prentice Hall of India, 2007.


**Chairman BoS
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**Dean (Academics)
HiCET**

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7303	ADVANCED BIO ANALYTICAL AND THERAPEUTIC TECHNIQUES	3	0	0	3

Course Objective
<ol style="list-style-type: none"> 1. Understand the basics of Analytical Techniques . 2. Understand the basics of enzymes as a diagnostic tool. 3. Explore various Radioisotopic Techniques . 4. Explore various applications of Gene Therapy. 5. Understanding on basic principles of Nanotherapeutics.

Unit	Description	Instructional Hours
	ANALYTICAL TECHNIQUES	
I	Principle- instrumentation and application of electrophoresis- SDS, native gel- UV and IR spectroscopy and its application –Spectrophotometry- fluorimetry- NMR – principle- instrumentation and application in medical sciences.	9
	ENZYMES AS A DIAGNOSTIC TOOL	
II	Isoenzymes and their significance in diagnosis-enzyme pattern in health and diseased condition- lipase- amylase- ALP, ACP, SGOT, SGPT, LDH & CPK. - Techniques in screening isoenzymes -Biosensors- enzyme based- antibody based, DNA based -optical biosensor- Blotting techniques-Automation in clinical laboratory.	9
	RADIOISOTOPIC TECHNIQUES	
III	Types of radioisotopes- Units of measurements-methods in measuring radioactivity -G.M liquid scintillation counter application in diagnosis (RIA & ELISA) –autoradiography- biological hazards- safety measures in handling isotopes- disposal of labeled compounds and radio dosimetry.	9
	GENE THERAPY	
IV	Central concept of gene therapy-basic molecular mechanism of gene transfer- human genome project- prerequisite of human gene therapy- biological basis of gene therapy strategies- vehicles for gene transfer- gene transfer methods- clinical gene therapy studies-gene therapy for hereditary disease- gene therapy for cancer-gene therapy for HIV-Ethical issues in human gene therapy.	9

NANOTHERAPEUTICS

V	Nanoparticles as carriers in drug delivery- design- manufacture and Physiochemical properties- transport across biological barriers- nanotechnology in Cancer therapy-bone treatment- nano particles for oral vaccination and skin disease-Types of nanoparticles-half life-Fate of nano particles.	9
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Total Instructional Hours 45

Course Outcome	CO1 : Comprehend and appreciate the significance of analytical techniques
	CO2 : Demonstrate the knowledge of enzymes as a diagnostic tool
	CO3 : Understand the concept and methods of Radio-isotopic techniques
	CO4 : Describe the details and ethical issues in human gene therapy
	CO5 : Gain knowledge about the concepts of nano-therapeutics in drug delivery

TEXT BOOKS:

- T1 Douglas A. —Principles of Instrumental Analysis, SkoogBrooks Cole publisher 6th edition 2006.T2
Keith Wilson & John Walker,— Practical Biochemistry , Principles and Techniques. Oxford University Press 7th edition 2010.

REFERENCE BOOKS:

- R1 G. Louis Hornyak, John J. Moore, Harry F. Tibbals and Joydeep Dutta, —Fundamentals of Nanotechnology, CRC press, 1st edition 2008.
R2 Harvey Lodish W. H. —Molecular Cell Biology, Freeman publisher 7th Edition 2012
R3 Gabor L. Hornyak, Joydeep Dutta, H.F. Tibbals, Anil Rao, —Introduction to NanoScience, CRC press2008.


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**Dean (Academics)
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Programme	Course Code	Name of the Course	L	T	P	C
		INTERNET OF THINGS AND ITS MEDICAL APPLICATIONS	3	0	0	3

B.E. 16BM7304

- Course Objective**
- To understand the basic theory of IoT
 - To study the various IoT Protocols
 - To study the various Physical Devices
 - To study the various IoT Security

Unit	Description	Instructional Hours
I	Basics of IoT Definition and characteristics of IoT, Internet of Things: Vision, Emerging Trends, Economic Significance, Technical Building Blocks, Physical design of IoT, Things of IoT, IoT Protocols, Logical design of IoT, IoT functional blocks, IoT communication models.	9
II	Embedded IoT M2M: The internet of devices, RFID: The internet of objects, WSN: The internet of transducer, SCADA: The internet of controllers, DCM: Device, Connect and Manage, Device: Things that talk, Connect: Pervasive Network.	9
III	IoT Protocols Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Issues with IoT Standardization, Unified Data Standards, Protocols –IEEE 802.15.4, BACNet Protocol, Modbus, KNX, Zigbee Architecture, Network layer, APS layer.	9
IV	IoT Physical Devices IoT Physical Devices and Endpoints: Basic building blocks of an IoT device, Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python, Beagle board and Other IoT Devices	9
V	IOT in Medical Field IoMT-Working, Internet of Things in Hospitals: Collection and Integration of Clinical Data: Benefits of IoT in Healthcare-Future of IoT in Healthcare-IoT-Based Patient Health Monitoring System-Examples of Healthcare IoT-IoT in Healthcare/Medical Projects.	9

Upon completion of this course, the students will be able to:

CO1 : Outline the basic concepts of IoT

CO2 : Discuss about Embedded IoT

CO3 : Summarize the IoT protocols

**Course
Outcome**

CO4 : Choose a suitable devices and implement program for stated IoT challenge

CO5 : Explain the fundamentals of security in IoT

TEXT BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press,2017
2. Arshdeep Bahga, Vijay Madiseti, —Internet of Things – A hands-on approach, Universities Press,2015.

REFERENCES:

1. Jan Ho" ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. DavidBoyle, "From Machine-to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.
2. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Key applications andProtocols, Wiley, 2012. 5. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7305	NEURAL ENGINEERING	3	0	0	3

Course Objective
1. To discuss the physiological concepts of sensory neural prosthesis.
2. To discuss about various applications in neural prosthesis.
3. To Explore neural rehabilitation engineering and its importance in medicine
4. To introduce various techniques to study neuro robotics.
5. To discuss the electrophysiological evaluation in special situations.

Unit	Description	Instructional Hours
	SENSORY NEURAL PROSTHESIS	
I	Introduction -Fundamentals of Sensory Neural Prosthesis- Electrodes for Neural Stimulation- Fabrication Of Neural Stimulating Electrodes- Techniques For Driving Electrodes- Cochlear Implants- Retinal Prostheses- BCI, BMI, Neuro Prosthetics.	9
	NEURAL PROSTHESIS	
II	Communication and control in paralysis- brain stem stroke- vegetative state and minimally conscious states- BCIs and neuro feedback systems: sensation and perception- action (motor)- learning and memory- reward and reinforcement- and conscious and non-conscious processing- Restoration of movement by implantable neural motor prostheses- Reconfigurable retina-like preprocessing platform for cortical visual neuroprostheses- Brain-implantable biomimetic electronics as neural prostheses to restore lost cognitive function- advances in retinal neuroprosthetics- and Practical considerations in retinal neuroprostheses design.	9
	NEURAL REHABILITATION ENGINEERING	
III	Neuro rehabilitation- neural restoration and repair in psychiatric and neurological brain disorders- such as stroke- Parkinson's, spinal cord injury, pain, depression, schizophrenia- psychopathy- memory disorders- addiction and substance abuse.	9
	NEUROBOTICS	
IV	Introduction -Directly Interfacing with the brain- Representation of Information in the brain -Coding Strategies of Ensembles of Single Neurons- decoding the neural signal- neuro robotic control.	9

ELECTROPHYSIOLOGICAL EVALUATION IN SPECIAL SITUATIONS

V	Electrophysiological evaluation of sacral function: Bladder, bowel function- Vestibular laboratory testing- Polysomnographic evaluation of sleep disorders- Electrophysiologic evaluation of brain death- patients in the intensive care unit-patients with suspected neurotoxic disorders.	9
Total Instructional Hours		45

Course Outcome	CO1: Understand the physiology behind generation of neural prosthesis. CO2 : Describe various techniques that are used to evaluate the functioning of neural prosthesis CO3: Differentiate between a normal and abnormal signal coming from a healthy and a diseased nervous system respectively. CO4: Analyze the applications of neuro robotics CO5: Discuss about the electrophysiological evaluation in special situations.
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TEXT BOOKS:

- T1 Michael J. Aminoff, et. al., —Aminoff's electrodiagnosis in Clinical Neurology, Sixth Edition, Elsevier Saunders, 2012.
- T2 Kim E. Barrett et. al., —Ganong's review of Medical Physiology, 23rd Edition, McGraw Hill Medical, 2010.

REFERENCE BOOKS:

- R1 Eric R. Kandel et. al., —Principles of Neural Science, McGraw-Hill, New York, 2012.
- R2 R. Cooper, et. al., —Techniques in Clinical Neurophysiology: A Practical Manual, Elsevier, Amsterdam, The Netherlands, 2005.
- R3 Holodny, Andrei I., et al., —Functional neuroimaging: a clinical approach. Informa Health Care, 2008.


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PROFESSIONAL ELECTIVE IV

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7306	BIOFLUIDS AND DYNAMICS	3	0	0	3

Course Objective

1. An understanding on the physiology and anatomy of studied systems,
2. A capability to analyze the flow properties of blood.
3. To analyze cellular, ocular, cardiovascular and respiratory fluid mechanics
4. To understand the basics of soft tissue mechanics,
5. To learn mathematical modeling of fluid biological systems.

Unit	Description	Instructional Hours
I BIO-FLUID MECHANICS	Newtons laws, Stress, Strain, Elasticity- Hooks-law-viscosity- Newtonian fluid- Non-Newtonian fluid- Viscoelastic fluids- vascular tree- Relationship between diameter- velocity and pressure of blood flow- Resistance against flow-Bio viscoelastic fluid: Viscoelasticity - Viscoelastic models, Maxwell, Voigt and Kelvin Models, Response to Harmonic variation- Use of viscoelastic models- Bio- Viscoelastic fluids; Protoplasm- Mucus- Saliva- Synovial fluids.	9
II FLOW PROPERTIES OF BLOOD	Physical- Chemical and Rheological properties of blood-Apparent and relative viscosity- Blood viscosity variation- Effect of shear rate- hematocrit- temperature- protein contents of blood- Casson's equation-Problems associated with extracorporeal blood flow- Rheology of Blood In Microvessels- Fahraeus - Lindquist effect and inverse effect- distribution of suspended particles in a narrow rigid tube- Nature of red blood cells in tightly fitting tubes-hematocrit in very narrow tube.	9
III CARDIAC MECHANICS	Cardiovascular system- Mechanical properties of blood vessels: arteries, arterioles, capillaries and veins- Blood flow: Laminar and Turbulent- Physics of cardiovascular diseases- Prosthetic heart valves and replacements- Respiratory Mechanics-Alveoli mechanics- Interaction of Blood and Lung P-V curve of Lung- Breathing mechanism- Airway resistance- Physics of Lung diseases.	9
IV SOFT TISSUE MECHANICS	Pseudo elasticity- non-linear stress-strain relationship- Visco elasticity- Structure- function and mechanical properties of skin- ligaments and tendons.	9
V ORTHOPEDIC MECHANICS	Mechanical properties of cartilage- diffusion properties of Articular cartilage- mechanical properties of bone- kinetics and kinematics of joints- lubrication of joints.	9
Total Instructional Hours		45

Course Outcome

- CO1: Understand the principles of biofluid mechanics
 CO2: Outline the flow properties of blood.
 CO3: Discuss on Cardiovascular and pulmanory system in human body
 CO4: Explain blood properties ,especially the anatomy and physiology of soft tissues.
 CO5: Understanding the concepts of orthopedic mechanics.

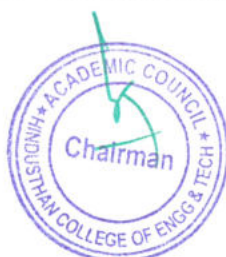
TEXT BOOKS:

- T1 Y.C Fung, "Biomechanics- Mechanical properties of living tissues", 2nd Edition, Springer-Verlag,2003.
 T2 David A. Rubenstein, Weiyin, Mary D. Frame, "Biofluid Mechanics- An Introduction to fluidmechanics, Macrocirculation and Microcirculation", Springer, 2013.

REFERENCE BOOKS:

- R1 Dhanjoo N. Ghista. (2008). Applied Biomedical Engineering Mechanics. CRC Press.
 R2 Silver Frederick H. Biomaterials, Medical Devices & Tissue Engineering: Chapman & Hall, London, 1994
 R3 Nihanth ozkai, D.A Mc Donald , "Biomechanics, Blood flow in arteries", Edward Arnold Ltd, 1998.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7307	ARTIFICIAL NEURAL NETWORKS	3	0	0	3

Course Objective

To understand the need for machine learning for various problem solving

1. To study the various supervised, semi-supervised and unsupervised learning Algorithms in machine learning
2. To learn the new approaches in machine learning
3. To design appropriate machine learning algorithms for problem solving
4. To understand about the basic concepts of associative memories.

Unit	Description	Instructional Hours
I	INTRODUCTION TO NEURAL NETWORKS Introduction-Humans and Computers- Organization of the Brain- Biological Neuron- Biological and Artificial Neuron Models-Characteristics of ANN- McCulloch Pitts Model- Historical Developments- Potential Applications of ANN.	9
II	ESSENTIALS OF ARTIFICIAL NEURAL NETWORKS Artificial Neuron Model- Operations of Artificial Neuron- Types of Neuron Activation Function- ANN Architectures- Classification Taxonomy of ANN – Connectivity- Learning Strategy- Supervised, Unsupervised, Reinforcement- Learning Rules.	
III	SINGLE LAYER FEED FORWARD NETWORKS Introduction-Perceptron Models: Discrete, Continuous and Multi-Category- Training Algorithms: Discrete and Continuous Perceptron Networks- Limitations of the Perceptron Model.	
IV	MULTI- LAYER FEED FORWARD NETWORKS Credit Assignment Problem- Generalized Delta Rule- Derivation of Backpropagation (BP) Training,-Summary of Backpropagation Algorithm- Kolmogorov Theorem- Learning Difficulties and Improvements.	
V	ASSOCIATIVE MEMORIES Paradigms of Associative Memory-Pattern Mathematics-Hebbian Learning- General Concepts of Associative Memory- Bidirectional Associative Memory (BAM) Architecture- BAM Training Algorithms-Storage and Recall Algorithm- BAM Energy Function-Architecture of Hopfield Network: Discrete and Continuous versions-Storage and Recall Algorithm,-Stability Analysis- Neural network applications: Process identification, control, fault diagnosis.	9
Outcome		Total Instructional Hours
		45

Course

learning.
CO1: Explain theory underlying machine
CO2: Construct algorithms to Learn ANN.
CO3: Implement single layer feed forward networks.
CO4: Construct Algorithms to learn multi-layer feed forward networks.
CO5: Apply associative memories learning techniques for real life problems

TEXT BOOKS:

- T1 Laurene Fausett, "Fundamentals of Neural Networks" , Pearson Education,2004.
T2 Simon Haykin, "Neural Networks- A comprehensive foundation", Pearson Education, 2003.

REFERENCE BOOKS:

- R1 Mc Graw Hill, 2006. TATA
R2 S. Rajasekharan and G. A. Vijayalakshmi pai, "Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications", PHI Publication, 2004.
R3 Timothy J. Ross, " Fuzzy Logic With Engineering Applications", Tata McGraw-Hill Inc. 2000.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7308	MEDICAL DATA ANALYTICS	3	0	0	3

- Objective**
1. The student should be made to learn about data analytics and different statistical tools related to medical data application
 2. The student should be made to learn about statistical learning.
 3. To understand about how to development algorithms for regression
 4. To understand about how to development algorithms for classification
 5. Discuss about the various computational tools available for medical data analytics.

Unit	Description	Instructional Hours
I	INTRODUCTION TO HEALTHCARE DATA Typical problems of data analysis, descriptive statistics, predictive modeling, health surveys - measure of disease risk and association, standardization of data - Introduction to spreadsheet - importing, coding and manipulating data, writing formulas and linking tables, pivot tables, what-if analysis and data displays.	9
II	INTRODUCTION TO STATISTICAL LEARNING Probability - Bayes Rule - types of distributions - estimation of unknown function, prediction accuracy and model interpretability, supervised versus unsupervised learning, regression versus classification, modeling data, principles of guesstimation.	9
III	ALGORITHMS FOR REGRESSION Linear regression, ridge regression, the lasso, logistic regression, linear discriminant analysis- case studies.	9
IV	ALGORITHMS FOR CLASSIFICATION K-nearest neighbors - splines - generalized additive models, tree-based methods - support vector machines, Random forests, case studies.	9
V	COMPUTATIONAL TOOLS Introduction to R Package: Basic commands, Graphics, Indexing data, loading data, time series analysis, graphical multivariate analysis - analytics in clinical trials- predicting the medical devices life cycle- predicting deterioration of patient's condition using EMR.	9
Total Instructional Hours		45

- Course Outcome**
- CO1 : Demonstrate the knowledge on basics of health care data
 - CO2 : Identify the various statistical learning methods
 - CO3 : Identify and utilize the algorithms for regression and classification
 - CO4 : Identify and utilize the algorithms for regression and classification
 - CO5: Utilize various data computational tools

TEXT BOOKS:

- T1 Trevor Strome, Healthcare Analytics for Quality and Performance Improvement, Hoboken: John Wiley & Sons Inc., 2013.
- T2 Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, —An Introduction to Statistical Learning —, Springer, 2013.

REFERENCE BOOKS:

- R1 Victor A. Bloomfield, —Using R for Numerical Analysis in Science and Engineering, Chapman & Hall, CRC, 2014.
- R2 Sarah Stowell, —Instant R: An Introduction to R for Statistical Analysis, Jotunheim Publishing, 2012. 93
- R3 Philipp K. Janet, —Data Analysis with Open Source Tools A hands-on guide for programmers and data scientists, O'Reilly Media, 2010.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7309	ROBOTICS IN MEDICINE	3	0	0	3
Course Objective	<ol style="list-style-type: none"> 1. Understand the basics of Robotics, Kinematics. 2. Understand the basics of Inverse Kinematics. 3. Explore various kinematic motion planning solutions for various Robotic configurations. 4. Explore various applications of Robots in Medicine. 5. Understanding on basic principles of how to design a robot 					
Unit	Description					Instructional Hours
	INTRODUCTION					
I	Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare.					
	LOCALIZATION AND TRACKING					
II	Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking - Video Matching - Fiber optic tracking systems - Hybrid systems.					9
III	SURGICAL ROBOTICS					9
	Minimally invasive surgery and robotic integration – surgical robotic sub systems - Synergistic control. Control Modes – Radio surgery - Orthopedic Surgery -Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.					
	REHABILITATION& ROBOTS IN MEDICAL CARE					
IV	Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles – case Studies. Assistive robots –types of assistive robots – case studies.					9
	DESIGN OF MEDICAL ROBOTS					
V	Characterization of gestures to the design of robots- Design methodologies- Technological choices- Security.					9
	Total Instructional Hours					45
Course Outcome	<p>CO1: Understand the basics of robotic systems.</p> <p>CO2: Design basic Robotics system and formulate Kinematics.</p> <p>CO3: Construct Inverse Kinematic motion planning solutions for various Robotic configurations.</p> <p>CO4: Understanding the importance of robots in rehabilitation.</p> <p>CO5: Design Robotic systems for Medical application.</p>					

TEXT BOOKS:

- T1 Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, —Robot Modeling and Control, WileyPublishers, 2006.
T2 Paula Gomes, "Medical robotics Minimally invasive surgery", Woodhead, 2012.

REFERENCE BOOKS:

- R1 Achim Schweikard, Floris Ernst, —Medical RoboticsI, Springer, 2015.R2 Jocelyne Troccaz, —Medical RoboticsI, Wiley-ISTE, 2012.
R3 Vanja Bonzovic, I Medical RoboticsI, I-tech Education publishing, Austria,2008.



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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7310	CANCER BIOLOGY	3	0	0	3

- Course Objective**
1. To understand about the Basics of biology of cancer
 2. Impact of antibodies against cancer in the human body leading to more effective treatments
 3. Enhanced immunology based detection methods and imaging techniques
 4. Development of cell based and cytokine based immunotherapy against cancer.
 5. Discuss about the various screening methods for cancer

Unit	Description	Instructional Hours
I	OVERVIEW AND ELEMENTS OF THE CANCER IMMUNOLOGY Role of Immune system in cancer – role of individual immune cell types against cancer – role of cytokines in immune cell programming against cancer.	9
II	CANCER ANTIGENS Source of cancer antigens – clonal (viral)/mutational origin – detection and processing by immune cell types through MHC – T-cell receptor – B-cell receptor and cytokines involved – cancer cell death strategies induced by immune cells.	9
III	ANTIBODY DEVELOPMENT AGAINST CANCER ANTIGENS Role of VDJ recombination – Causes for the failure to recognize cancer antigen – roles and mechanism of immune self-tolerance machinery and Immune surveillance – Correlating pathway specific deregulations in self-tolerance machinery and Immune surveillance as a risk factor/potential target towards autoimmune disorders and cancer.	9
IV	ESSENTIALS OF RADIATION THERAPY Introduction, Biologic Aspects of Radiation Oncology- Factors that Affect Radiation Response- Drugs that Affect Radiation Sensitivity- Principles of Combining Anticancer Agents with Radiation Therapy.	9
V	CANCER INCIDENCE AND SCREENING Data Source and Measurements -Overall Cancer Risk -Incidence and Mortality Patterns for Common Cancer- Issues in Interpreting Temporal Trends -Analytical Methods for Epidemiological Studies of cancer-Cancer Screening – Definition – Principles- Evaluating Screening Tests- Developing and evaluating A Cancer Screening Programme - Different Kind of Screening Tests-Screening for Specific Types of Cance- Genetic Counseling.	9
Total Instructional Hours		45

**Course
Outcome**

- CO1: To appreciate the role of immune system in cancer.
CO2: To describe self – tolerance machinery and immune surveillance.
CO3: To understand the cancer microenvironment and its influence on immune cells.
CO4: To have awareness on medical radiation therapy against cancer.
CO5: To understand about various screening methods available for cancer.

TEXT BOOKS:

- T1 Robert A. Weinberg, "The Biology of Cancer", 2nd edition, Garland Science, 2014.
T2 Lewis J. Kleinsmith, "Principles of Cancer biology", 1st Edition Pearson Education India, 2016

REFERENCE BOOKS:

- R1 Roger J.B. King and Mike W. Robins, "Cancer Biology", 3rd edition, Benjamin Cummings, 2006
R2 Robert G. McKinnell, Ralph E. Parchment, Alan O. Perantoni, G. Barry Pierce, "The Biological Basis of Cancer", 2nd Edition, Cambridge University Press, 1998
R3 Journal of Cancer Science & Therapy


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**Dean (Academics)
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PROFESSIONAL ELECTIVE V

Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech./VIII	16BM8301	ARTIFICIAL INTELLIGENCE	3	0	0	3

COURSE OBJECTIVES:

1. To understand the various characteristics of Intelligent agents
2. To learn about the different search strategies in AI
3. To learn to represent knowledge in solving AI problems
4. To understand the different ways of designing software agents
5. To know about the various medical applications of AI.

UNIT I INTRODUCTION

Introduction–Definition - Future of Artificial Intelligence – Characteristics of Intelligent Agents– Typical Intelligent Agents – Problem Solving Approach to Typical AI problems.

UNIT II PROBLEM SOLVING METHODS

9

Problem solving Methods - Search Strategies- Uninformed - Informed - Heuristics - Local Search Algorithms and Optimization Problems - Searching with Partial Observations - Constraint Satisfaction Problems – Constraint Propagation - Backtracking Search - Game Playing - Optimal Decisions in Games – Alpha - Beta Pruning - Stochastic Games

UNIT III KNOWLEDGE REPRESENTATION

First Order Predicate Logic – Prolog Programming – Unification – Forward Chaining-Backward Chaining – Resolution – Knowledge Representation - Ontological Engineering-Categories and Objects – Events - Mental Events and Mental Objects - Reasoning Systems for Categories - Reasoning with Default Information

UNIT IV SOFTWARE AGENTS

9

Architecture for Intelligent Agents – Agent communication – Negotiation and Bargaining – Argumentation among Agents – Trust and Reputation in Multi-agent systems.

UNIT V MEDICAL APPLICATIONS

9

AI applications – drug discovery- patient data collection management- disease diagnostic and treatment guidance- predictive analytics: omics data for precision/personalized medicine- AI- based platforms/projects in healthcare, e.g. IBM Watson, Microsoft’s Inner Eye- Case studies of AI-based startups in healthcare, e.g. Sentient.ai

TOTAL : 45 HOURS

COURSE OUTCOMES:

1. Use appropriate search algorithms for any AI problem
2. Represent a problem using first order and predicate logic
3. Provide the apt agent strategy to solve a given problem
4. Design software agents to solve a problem
5. Design medical applications in Artificial Intelligence.

TEXT BOOKS:

S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2009

I. Bratko, —Prolog: Programming for Artificial Intelligence, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.

REFERENCES:

M. Tim Jones, —Artificial Intelligence: A Systems Approach (Computer Science), Jones and Bartlett Publishers, Inc.; First Edition, 2008

David L. Poole and Alan K. Mackworth, —Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010

Gerhard Weiss, —Multi Agent Systems, Second Edition, MIT Press, 2013


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Programme	Course Code	Name of the Course	L	T	P	C
B.E./B.Tech./VIII	16BM8302	MACHINE LEARNING TECHNIQUES IN MEDICINE	3	0	0	3

Course Objective
1. To learn the fundamental concepts of Machine learning.
2. To study the steps involved in supervised learning.
3. To understand the concepts of various neural networks and kernel methods
4. To study the feature selection methods.
5. To understand various dimensionality reduction techniques involved in unsupervised learning.

Unit	Description	Instructional Hours
I	INTRODUCTION TO MACHINE LEARNING Introduction to Probability Theory and Probability Distribution - Formulation of Learning Problem, Learning model, Probabilistic model, Types of learning – supervised, unsupervised, reinforcement – challenges in Machine Learning - error and noise	9
II	SUPERVISED LEARNING Basic Regression - Linear Regression, Nonlinear regression, Basic Classification - Decision Trees, Nearest neighbor, Probabilistic Approach - Logistic Regression, Bayesian Network, Case Studies – Tumor Type Prediction, Vital Signs Monitoring	9
III	NEURAL NETWORKS AND KERNEL METHODS Introduction to ANN, Perceptron, Multilayer Perceptron, Backpropagation, Support Vector Machines - The Kernel trick, SVM, Support Vector Regression, Case Study – Cognitive State Detection	9
IV	FEATURE SELECTION Filter, Wrapper and Embedded Methods, Linear Discriminant Analysis (LDA), mRMR Feature Selection.	9

V	UNSUPERVISED LEARNING Dimensionality Reduction - KL-Transform, SVD, Eigenspace and Eigen-Analysis, Clustering – k means, Gaussian Mixture Models, PRINCIPAL /DEAN ACADEMICS Component Analysis (PCA), Case Study – Medical Imaging.	9
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Total Instructional Hours **45**

Course Outcome	CO1	Understand the concepts of machine learning..
	CO2	Explain the processes involved in supervised learningCO3
		Learn the concept of neural networks.
	CO4	Understand the steps involved in feature selection.
	CO5	Understand the procedures involved in unsupervised learning.

TEXT BOOKS:

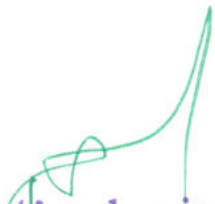
1. Abu-Mostafa Y.S., Magdon-Ismaali M., Lin H.T., —Learning from Data, AMLBookPublishers, 2012.
2. Bishop C. M., —Pattern Recognition and Machine Learning, Springer InformationScience and Statistics, 2007.

REFERENCE BOOKS:

1. Shalev S., Shai S., David B., —Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2015.
2. Solomon J., —Numerical Algorithms: Methods for Computer Vision, Machine Learning, and Graphics, CRC Press, 2015.
3. Rogers S., Girolami M., —First Course In Machine Learning, CRC Press, 2015.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM8303	MEDICAL DEVICE DESIGN	3	0	0	3

- Course Objective**
1. To learn the basic steps involved in design of biomedical devices and systems.
 2. To study about product development, specification and requirements.
 3. To understand hardware development methods and tools.
 4. To understand software development methods and tools.
 5. To study about biological engineering designs.

Unit	Description	Instructional Hours
	DESIGN OF BIOMEDICAL DEVICES AND SYSTEMS	
I	The essentials of design, Biomedical engineering design in industrial context, industrial design process, Fundamentals design tools, Brain storming and idea generation techniques, Function analysis, Elementary decision-making Techniques, objectives trees, quality function deployment diagrams, Design team Management, reporting and documentation.	9
	PRODUCT DEFINITION	
II	The product definition process, The QFD process, Requirements, design, Verification and validation, The product specification, Product developments, Product requirements, Design and development planning, System requirements Specification, Design input, Design output, Formal design review, Design Verification, Design validation, Design transfer.	9
	HARDWARE DEVELOPMENT METHODS AND TOOLS	
III	Design for six sigma, Methodologies, Structure, Design for six sigma tools,	9

	Component Dating, Safety margin, Load protection, Environmental protection, Product misuse, Reliability prediction, Design for variation, Design of experiments, Design changes, Design for manufacturability, Design for assembly, Design reviews.	
	SOFTWARE DEVELOPMENT METHODS AND TOOLS	
IV	Software design levels, Design alternatives and trade-offs, Software architecture, Choosing a methodology, Structure analysis, Object oriented design, Choosing a language, Software risk analysis.	9
	BIOLOGICAL ENGINEERING DESIGNS	
V	Biomedical System, Special issues when dealing with non-human subjects, Unintended consequences, Environmental interactions, Biological principles, Design objectives, Resistance development, regulations and standards, Ethics, Biological engineering design examples	9
	Total Instructional Hours	45
Course Outcome	CO1 Understand the basic steps involved in design of biomedical devices and systems. CO2 Understand about product development, specification and requirements	
	CO3 Understand hardware development methods and tools. CO4 Understand software development methods and tools CO5 Understand about biological engineering designs.	

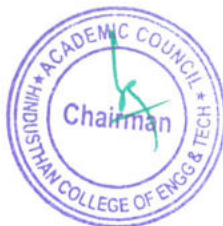
TEXT BOOKS:


1. Paul H. King, Richard C. Fries, Arthur T. Johnson, "Design of Biomedical devices and systems", 3rd Edition, CRC Press, 2016
2. Mathew Bret Weinger, Michael E Wiklund, Daryle Jean Gardner- Bonneau. "HandBook of Human factors in Medical Device Design", CRC Press 2010

REFERENCE BOOKS:

1. Peter J. Ogradnik, "Medical Device Design: Innovation from Concept to Market", Academic Press, 2012.
2. "Biodesign: The Process of Innovating Medical Technologies", Paul Yock, Stefanos A. Zenios, and Todd J.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM8304	TELEMEDICINE	3	0	0	3

- Course**
- To study about telemedicine and telehealth and telecare techniques.
 - To understand the different type of information and standards used in telemedicine.
- Objective**
- To understand the applications in the field of telemedicine.
 - To understand the use of internet in telemedicine.
 - To understand the ethical and legal aspects in telemedicine.

Unit	Description	Instructional Hours
	INTRODUCTION	
I	Definitions of telemedicine telehealth and telecare. History of telemedicine: Main phases of telemedicine Pre electronic telemedicine Electronic telemedicine Technical Requirements.	9
	TYPE OF INFORMATION AND STANDARDS	
II	Type of information and standards, audio, data, Fax, Video Types of communications and networking- networking architecture, POTS, ISDN, ATM Other Fixed networks, Air/aireless communications.- RF,Microwaves, Satellite, GSM, CDPD (Cellular Digital Packet Data) Acquisition/ displays: Acquisition systems Cameras, Scanners, Other medical specialized acquisition system	9
	APPLICATIONS	
III	Telemedicine applications- Basic parts of a teleradiography system- Telepathology- Telecytology- Telecardiology- Teleoncology- Teledermatology- Telesurgery, telepsychiatry	9
	INTERNET IN TELEMEDICINE	
IV	Internet in telemedicine 1) The internet 2) Basic concepts 3) Security – secure socket layer – Firewalls – proxies. Personal Communication , Medical data	9

sharing needs for telemedicine- -Internet problems Distant training, teleworkingand telecasting.

ETHICAL AND LEGAL ASPECTS

V Ethical and legal aspects of telemedicine-confidentiality, patient rights and consent-ethical and legal aspects of internet-telemedical malpractice. Constraints for the wide spread use of telemedicine-constraints linked to economy, socialacceptance Strategic planning for telemedicine implementation 9

Total Instructional Hours 45

Course Outcome

- CO1 Understand the concepts of telemedicine, telehealth and telecare.
- CO2 Acquire knowledge in different types of information and standards used intelemedicine.
- CO3 Understand the applications of telemedicine.
- CO4 Explain the use of internet in telemedicine
- CO5 Learn the ethical and legal aspects in telemedicine.

TEXT BOOKS:

1. Olga (EDT), Ferrer – Roca, M. Sosa (EDT), Marcelo C, *Handbook of telemedicine*, IOSPress 2003.
2. A. C. Norris *Essentials of Telemedicine and Telecare*, John Wiley & Sons 2002.

REFERENCE BOOKS:

1. Ling Guan, *Multimedia image and video processing*, CRC Press 2000
2. Thorsten M Buzug, Heinz Handels, Dietrich Holz, *Telemedicine: Medicine and Communication*”,Springer Verlag 2001
3. Douglas V.Goldstein, “ E Healthcare: Harness the power of Internet, e-commerce and e-care”,Jones and Barlett Publishers


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM8305	WEARABLE MEDICAL DEVICES	3	0	0	3

Course Objective

1. To understand wearable health monitoring systems and the electrodes used for the acquisition of biological signals.
2. To determine the multifunctional sensor systems for health monitoring and their energy harvesting methodology under the self-powered category.
3. To apply the various wireless communication modalities for healthcare devices and understand the designing of wireless health platforms.
4. To understand the sensor skins used for healthcare monitoring and nanomaterial-based skin Electronics.
5. To apply the concept of wearable electronics to medical diagnostics and monitoring.

Unit	Description	Instructional Hours
	INTRODUCTION	
I	Sensors for wearable systems, optical electrodes, Multifunctional Epidermal Sensor Systems with Ultrathin Encapsulation -Packaging for Health Monitoring, sensing of biological signals-Device requirements, data acquisition, system integration.	9
	ENERGY HARVESTING	
II	Energy Harvesting for Self-powered wearable devices, wireless communication technologies, Design of wireless health platforms.	9
	LOW POWER HEALTH MONITORING SYSTEMS	
III	Semiconductors in flexible electronics, Low power analog and digital circuit design for bio potential acquisition – architecture and practical considerations. Intelligent patches.	9
	SENSOR SKINS	
IV	Sensor Skins: An Overview, Nanomaterials-Based Skin-Like Electronics for the Unconscious and Continuous Monitoring of Body Status - detection mechanisms, fabrication.	9

MEDICAL TEXTILES

	Textile engineering for wearable sensing devices, Sensory application of textiles-EMG and ECG monitoring, Respiratory monitoring. Active Textiles for therapeutic applications- Textile electrodes for electrical muscle stimulation, textile interactive medical agent (depots and disposing systems), Heatable textiles. Passive textile for therapeutic applications- Reusable 3- D knitted elastic short traction bandages.	9
	Total Instructional Hours	45

Course Outcome	CO1	Develop applications in C using pointers and structures.
	CO2	Acquire knowledge the most common abstractions for data collections (e.g., stacks, queues, lists).
	CO3	Use non linear data structures such as trees to solve problems. .
	CO4	Apply Graph algorithms to find the shortest path cost
	CO5	Apply Algorithms for solving problems like sorting and searching.

TEXT BOOKS:

1. Bonfiglio A, De Rossi.D, "Wearable monitoring Systems", Springer, 2011.
2. Rogers J.A, Ghaffari.R, Kim.D, "Stretchable Bioelectronics for Medical Devices andSystems", Springer, 2016.

REFERENCE BOOKS:

1. Roger Narayan, "Medical Biosensors for Point of Care, (POC) Applications", 1st Edition, Wood head publishing, 2016.
2. Wen Zhong, "An Introduction to Healthcare and Medical Textiles", DEStech publication, Inc, 2013.
3. Bartels V. T, "Handbook of Medical Textiles", Wood Head publishing, 2011.
4. Subhas Chandra Mukhopadhyay, "Intelligent Sensing, Instruments and Measurement- Wireless Sensors and Sensor Networks", 1st edition, Springer Berlin Heidelberg, 2013.


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PROFESSIONAL ELECTIVE VI

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM8306	REHABILITATION ENGINEERING	3	0	0	3

- Course Objective**
1. To understand the rehabilitation concepts and Rehabilitation team members for future development and applications
 2. To understand the Principles of Rehabilitation Engineering.
 3. To understand the different types of Therapeutic Exercise Technique.
 4. To understand the tests to assess the hearing loss, development of electronic devices to compensate for the loss and various assist devices for visually and auditory impaired
 5. To understand the concepts of orthotic devices and prosthetic devices to overcome orthopedic problems.

Unit	Description	Instructional Hours
I	INTRODUCTION TO REHABILITATION What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Psychiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Rehabilitation team Classification of members, The Role of Psychiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist.	9
II	PRINCIPLES OF REHABILITATION Introduction, The Human Component, Principles of Assistive Technology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles, Key Ergonomic Principles - Practice of Rehabilitation and Assistive Technology	9
III	THERAPEUTIC EXERCISE TECHNIQUE Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation,	9

	Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises	
	MANAGEMENT OF COMMUNICATION & VIRTUAL REALITY	
IV	Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids. Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation	9
	ORTHOTIC, PROSTHETIC DEVICES & RESTORATION TECHNIQUES	
V	General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Calipers- FO, AFO, KAFO, HKAFO. Prosthetic devices: Hand and arm replacement, Body powered prosthetics, Myoelectric controlled prosthetics and Externally powered limb prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS)..	9
	Total Instructional Hours	45
Course Outcome	CO1 Gain adequate knowledge about the needs of rehabilitations and its future development	
	CO2 Have an in depth idea about Engineering Concepts in Sensory & Motor rehabilitation. Apply the different types of Therapeutic Exercise Technique to benefit the society.	
	CO3	
	CO4 Design and apply different types Hearing aids, visual aids and their application in biomedical field and hence the benefit of the society.	
	CO5 Gain in-depth knowledge about different types of models of Hand and arm replacement.	

TEXT BOOKS:

- 1 Sunder 'Textbook of Rehabilitation', Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007
2. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third edition-3 volume set, Taylor & Francis, 2006

REFERENCE BOOKS:

1. Horia- Nocholai Teodorecu, L.C.Jain ,Intelligent systems and technologies in rehabilitation Engineering; CRC; December 2000.
2. Keswick. J., What is Rehabilitation Engineering, Annual Reviews of Rehabilitation- Springer- Verlag, New York, 1982.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM8307	PHYSIOLOGICAL MODELLING	3	0	0	3

- Course Objective**
1. To understand the concepts of physiological modelling
 2. To learn the different approaches used in modeling of physiological systems.
 3. To learn the concepts of modeling human thermal regulatory system.
 4. To learn the concepts of modeling human respiratory system.
 5. To study about the electrical properties of neuron and to model them.

Unit	Description	Instructional Hours
I	Introduction to physiological modelling Physiological complexity and the need for models: Complexity , Feedback and Control in Physiological Systems Models and the modeling process: Model Formulation , Identification Validation and Simulation.	9
II	Different approaches of modeling physiological systems Linear Modeling Distributed Modeling Nonlinear Modeling Time-varying Modeling Mathematical approach, electrical analogues, etc. Introduction to various process controls like cardiac rate, blood pressure, respiratory rate. Blood - Glucose regulation. Pharmacokinetic modeling-compartmental models, blood-tissue models.	9
III	Modeling of human thermal regulatory system Parameters involved, control system model etc. Biochemistry of digestion, Loss of heat to the environment, Heat transfer within the body, Models describing heat transfer between core and skin, heat distribution in extremities.	9
IV	Modeling of Respiratory system Human Lungs: Anatomy and physiology of the respiratory system, mass balance in lungs, oxygen and carbon dioxide transport in blood Modeling	9

oxygen uptake by RBC and pulmonary capillaries .

Neuron Models

V	Electrical properties of Neurons, Single compartment models, voltage dependent conductances, Hodgkin Huxley model, Integrate fire neuron model, conductance based models, Cable equation, multi compartment models.Fitzhugh Nagumo models.	9
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Total Instructional Hours 45

Course Outcome	CO1 Gain adequate knowledge about the modeling of physiological systems
	CO2 Have an in depth idea about different approaches in modeling physiological systems
	CO3 Design and develop the physiological model of human thermal regulatory system.CO4 Design and develop the physiological model of human respiratory system
	CO5 Gain in-depth knowledge about different types of neuron models and its electrical properties

TEXT BOOKS:

1. Arthur C Guyton, *Text Book of Medical physiology*, PRISM Books India, 2000
2. David Cooney, *Biomedical Engineering Principles*, Marcel Decker Publications, 2001

REFERENCE BOOKS:

1. Peter Dayan, *Theoretical Neuroscience: Computational and Mathematical modeling of Neural systems* MIT Press
2. Vasilis Z Marmarelis, *Nonlinear Dynamic Modeling of Physiological systems* IEEE Press series in Biomedical Engineering,


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM8308	BIOMETRICS	3	0	0	3

- Course Objective**
1. To understand the technologies of fingerprint, iris, face and speech recognition
 2. To understand the general principles of design of biometric systems and the underlying trade-offs.
 3. To recognize personal privacy and security implications of biometrics based identification technology.
 4. To identify issues in the realistic evaluation of biometrics based systems.

Unit	Description	Instructional Hours
	INTRODUCTION TO BIOMETRICS Introduction and back ground – biometric technologies – passive biometrics – active biometrics - Biometrics Vs traditional techniques – Benefits of biometrics -	
I	Operation of a biometric system– Key biometric processes: verification, identification and biometric matching – Performance measures in biometric systems: FAR, FRR, FTE rate, FTA rate and rate- Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications	9
	FINGERPRINT IDENTIFICATION TECHNOLOGY Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges - Fingerprint Image Processing - Minutiae Determination - Fingerprint Matching: Fingerprint Classification, Matching policies.	
II		9
	FACE RECOGNITION Introduction, components, Facial Scan Technologies, Face Detection, Face Recognition, Representation and Classification, Kernel- based Methods and 3D Models, Learning the Face Spare, Facial Scan Strengths and Weaknesses, Methods for assessing progress in Face Recognition.	
III		9

	VOICE SCAN	
IV	Introduction, Components, Features and Models, Addition Method for managing Variability, Measuring Performance, Alternative Approaches, Voice Scan Strengths and Weaknesses, NIST Speaker Recognition Evaluation Program, Biometric System Integration.	9
	FUSION IN BIOMETRICS	
V	Introduction to Multibiometric - Information Fusion in Biometrics - Issues in Designing a Multibiometric System - Sources of Multiple Evidence - Levels of Fusion in Biometrics - Sensor level, Feature level, Rank level, Decision level fusion - Score level Fusion. Examples – biopotential and gait based biometric systems.	9
	Total Instructional Hours	45

Course Outcome	CO1	Understand the basic technologies used in biometric systems
	CO2	Acquire knowledge the most common abstractions for data collections (e.g., stacks, queues, lists).
	CO3	Use non linear data structures such as trees to solve problems. .CO4
		Apply Graph algorithms to find the shortest path cost
	CO5	Apply Algorithms for solving problems like sorting and searching.

TEXT BOOKS:

1. James Wayman, Anil Jain, Davide Maltoni, Dario Maio, —Biometric Systems, Technology Design and Performance Evaluation, Springer, 2005.
2. David D. Zhang, —Automated Biometrics: Technologies and Systems, Kluwer Academic Publishers, New Delhi, 2000.

REFERENCE BOOKS:

1. Paul Reid, —Biometrics for Network Security, Pearson Education, 2004.
2. Nalini K Ratha, Ruud Bolle, —Automatic fingerprint Recognition System, Springer, 2003
3. L C Jain, I Hayashi, S B Lee, U Halici, —Intelligent Biometric Techniques in Fingerprint and Face Recognition, CRC Press, 1999.
4. John Chirillo, Scott Blaul, —Implementing Biometric Security, John Wiley, 2003.


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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM8309	INTERNET OF THINGS	3	0	0	3

Course Objective
1. To understand Smart Objects and IoT Architectures
2. To learn about various IOT-related protocols
3. To build simple IoT Systems using Arduino and Raspberry Pi.
4. To understand data analytics and cloud in the context of IoT
5. To develop IoT infrastructure for popular applications

Unit	Description	Instructional Hours
	FUNDAMENTALS OF IoT	
I	Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects	9
	IoT PROTOCOLS	
II	IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT	9
	DESIGN AND DEVELOPMENT	
III	Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.	9
	DATA ANALYTICS AND SUPPORTING SERVICES	
IV	Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively	9



Cloud for IoT, Python Web Application Framework – Django – AWS for IoT –System Management with NETCONF-YANG.

CASE STUDIES/INDUSTRIAL APPLICATIONS

V	Cisco IoT system - IBM Watson IoT platform – Manufacturing - Converged Plantwide Ethernet Model (CPwE) – Power Utility Industry – GridBlocks Reference Model - Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture and Smart Traffic Control	9
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Total Instructional Hours 45

Course Outcome	CO1 Explain the concept of IoT
	CO2 Analyze various protocols for IoT
	CO3 Design a PoC of an IoT system using Rasperry Pi/Arduino.
	CO4 Apply data analytics and use cloud offerings related to IoT
	CO5 Analyze applications of IoT in real time scenario

TEXT BOOKS:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, —IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, CiscoPress, 2017
2. Arshdeep Bahga, Vijay Madiseti, —Internet of Things – A hands-on approach, Universities Press,2015.

REFERENCE BOOKS:

1. Olivier Hersent, David Boswarthick, Omar Elloumi , —The Internet of Things – Keyapplications and Protocols, Wiley, 2012 (for Unit 2).
2. Jan Ho" ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Kamouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Ageof Intelligence", Elsevier, 2014.
3. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011.
4. 5. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance YourProjects, 2nd Edition, O'Reilly Media, 2011.



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**Dean (Academics)
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Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM8310	BRAIN COMPUTER INTERFACE	3	0	0	3

Course Objective
1. Understand the basic concepts of brain computer interface
2. Study the various signal acquisition methods
3. Learn about the signal processing methods used in BCI
4. Understand the various machine learning methods of BCI.
5. Learn the various applications of BCI

Unit	Description	Instructional Hours
I	INTRODUCTION TO BCI Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.	9
II	BRAIN ACTIVATION Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.	9
III	FEATURE EXTRACTION METHODS Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -PRINCIPAL /DEAN ACADEMICS Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization and coherence.	9
IV	MACHINE LEARNING METHODS FOR BCI Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression	9

- Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis

APPLICATIONS OF BCI

V	Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.	9
Total Instructional Hours		45

Course Outcome	<p>Comprehend and appreciate the significance and role of this course in the present contemporary world</p> <p>CO1</p> <p>Evaluate concept of BCI</p> <p>CO2</p> <p>Assign functions appropriately to the human and to the machine.</p> <p>CO3</p> <p>Select appropriate feature extraction methods</p> <p>CO4</p> <p>Use machine learning algorithms for translation.</p> <p>CO5</p>
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TEXT BOOKS:

1. Rajesh.P.N.Rao, —Brain-Computer Interfacing: An Introduction, Cambridge University Press, First edition, 2013. Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015.
2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, —Brain Computer Interfaces: Principles and practice, Oxford University Press, USA, Edition 1, January 2012.

REFERENCE BOOKS:

1. Ella Hassianien, A & Azar.A.T (Editors), —Brain-Computer Interfaces Current Trends and Applications, Springer, 2015.
2. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010
3. Ali Bashashati, Mehrdad Fatourehchi, Rabab K Ward, Gary E Birch, "A survey of signal Processing algorithms in brain-computer interfaces based on electrical brain signals" Journal of Neural Engineering, Vol.4, 2007, PP.32-57
4. Arnon Kohen, —Biomedical Signal Processing, Vol I and II, CRC Press Inc, Boca Rato, Florida.



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OPEN ELECTIVE

Programme	Course Code	Name of the Course	L	T	P	C
B.E.	16BM7401	FIRST AID IN EMERGENCY CARE	3	0	0	3
Course Objective	1. To study about introduction of first aid. 2. To understand about emergency first aid. 3. To gain a knowledge in First Aid Techniques. 4. To learn about emergency equipment 5. To study about healthcare technologies.					

Unit	Description	Instructional Hours
I	INTRODUCTION TO FIRSTAID First aider - First aid priorities- Managing incident - Traffic accident – Fires – Clothing on Fire - Electrical Incidents-low and high Voltage current– Lighting- Water Incidents-Water recue	9
II	EMERGENCY FIRST AID Action in an Emergency-ChestcompressiononlyCPR-CPRforadult-CPRforchild-CPRforinfant- Heart Attack-Stroke–Asthma–Head Injuries.	9
III	FIRST AID TECHNIQUES Removing head gear-First aid Material –Dressing – Types of Dressing –Principles of Bandaging– Roller bandages– Hand Bandages– Hand and Foot cover–Arm Sling	9
IV	EMERGENCY EQUIPMENT Patient Monitor – Sphygmomanometer – Pulse oximeter- Heart rate monitor- Defibrillators–Ventilator –ECG.	9
V	HEALTH CARE TECHNOLOGIES Introduction to m health–heathcare3.0–IoTin healthcare– Medical IoT devices –Remote Patient Monitoring–Depression Monitoring.	9
Total Instructional Hours		45

- CO1: Explain the Introduction to First aid.
- CO2: Familiar with emergency First aid.
- CO3: Discuss about First technologies.
- CO4: Explain the emergency equipment.
- CO5: Discuss about the various healthcare technologies

TEXTBOOKS:

T1 The authorized manual of St. John Ambulance, St. Andrew's Ambulance association and the British red cross society, First Aid manual, 9th edition, Dorling Kindersley, London

T2 American college of emergency physicians, First Aid manual, 5th edition, Dorling Kindersley, London

REFERENCEBOOKS:

R1 Clement Textbook on First Aid & Emergency Nursing, First edition, JP brothers, 2012

R2 Philip Jevon, Emergency care and First Aid for Nurses, A practical guide, Churchill Living Stone, 2007

R3 Mahadevan, Swaminatha V., and Gus M. Garmel. An introduction to clinical emergency medicine: guide for practitioners in the emergency department. Cambridge University Press, 2005.


**Chairman BoS
BME - HiCET**




**Dean (Academics)
HiCET**



DEPARTMENT OF BIOMEDICAL ENGINEERING
ACADEMIC YEAR 2021-2022
REGULATION 2019
CO'S, PO'S & PSO'S MAPPING
Semester – I

Course Code & Name:19HE1101& Technical English

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	2	-	1	2	1	2	3	1	3	3	2	1
CO2	1	2	1	1	1	2	1	1	1	3	1	2	2	3	2
CO3	1	2	1	1	1	2	1	1	2	3	1	2	2	2	1
CO4	1	1	-	1	1	1	1	1	2	3	1	2	3	3	1
CO5	-	1	1	1	1	1	1	2	2	3	1	2	2	2	1
Avg	1	1	1	1	1	1	1	1	2	3	1	2	2	2	1

Course Code & Name:19MA1103 & Calculus and Differential Equations

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2	1
CO2	3	3	3	3	3	-	-	-	-	-	-	2	2	3	1
CO3	3	3	3	3	3	-	-	-	-	-	-	2	1	2	1
CO4	3	3	3	3	3	-	-	-	-	-	-	2	2	1	1
CO5	3	3	3	2	3	-	-	-	-	-	-	2	2	2	1
Avg	3	3	3	3	3	-	-	-	-	-	-	2	2	2	1

Course Code & Name:19PH1151&Applied Physics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	1	1	-	-	-	-	-	1	2	1	1
CO2	3	3	1	1	2	-	-	-	-	-	-	1	3	3	1
CO3	3	2	1	2	2	-	-	-	-	-	-	1	3	3	1
CO4	3	2	3	2	3	1	-	-	-	-	-	1	2	2	2
CO5	3	2	3	2	2	2	-	-	-	-	-	1	2	3	1
Avg	3	2	2	2	2	1	-	-	-	-	-	1	2	2	1

Course Code & Name:19CY1151&Chemistry for Engineers

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	2	1	1	-	-	-	-	1	1	1	2
CO2	3	2	2	-	2	1	-	-	-	-	-	1	1	-	1
CO3	3	2	2	-	2	1	1	-	-	-	-	1	1	-	2
CO4	3	2	2	2	2	1	-	-	-	-	-	1	1	1	2
CO5	3	2	2	-	2	1	-	-	-	-	-	1	1	1	1
Avg	3	2	2	2	2	1	1	-	-	-	-	1	1	1	2

Course Code & Name:19CS1151&Python Programming and Practices

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	3	-	2	-	-	-	-	-	-	2	2	2	1
CO2	2	3	3	-	2	-	-	-	2	-	-	2	2	2	1
CO3	2	3	3	-	2	-	-	-	2	-	-	2	2	2	1
CO4	2	3	3	-	2	-	-	-	2	-	-	2	2	2	2
CO5	2	3	3	-	2	-	-	-	2	-	-	2	2	2	1
Avg	2	3	3	-	2	-	-	-	2	-	-	2	2	2	1

Course Code & Name:19EE1155&Basics of Electrical Engineering

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO3	-	3	-	-	1	-	-	-	-	-	-	-	-	-	1
CO4	-	-	3	-	2	-	-	-	-	-	-	-	2	-	1
CO5	-	-	3	-	2	-	-	-	-	-	-	-	2	-	1
Avg	-	2	1	-	1	-	-	-	-	-	-	-	1	-	1

SEMESTER II

Course Code & Name: 19HE2101 & Business English for Engineers

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	1	1	1	2	1	2	2	3	-	3	1	-	2
CO2	2	1	1	1	1	2	2	2	2	3	-	2	-	1	1
CO3	2	2	1	1	1	2	2	2	2	3	1	3	1	-	1
CO4	2	2	1	1	2	2	2	2	3	3	1	3	1	1	2
CO5	1	1	1	1	1	2	2	1	2	3	1	3	1	1	1
Avg	2	2	1	1	2	2	2	2	2	3	1	3	1	1	1

Course Code & Name:19MA2102 &ComplexVariables And TransformCalculus

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2	1
CO2	3	3	3	2	3	-	-	-	-	-	-	2	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	2	2	2	1
CO4	3	3	3	3	3	-	-	-	-	-	-	2	1	2	1
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	1	2
Avg	3	3	3	3	3	-	-	-	-	-	-	2	2	2	1

Course Code & Name:19PH2151&MaterialScience

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	1	1	-	-	-	-	-	1	2	1	1
CO2	3	3	1	1	2	-	-	-	-	-	-	1	2	2	1
CO3	3	2	1	2	2	-	-	-	-	-	-	1	2	3	2

CO4	3	3	1	2	2	1	-	-	-	-	-	1	2	2	1
CO5	3	2	2	3	2	1	2	-	-	-	-	1	2	3	2
Avg	3	2	1	2	2	1	2	-	-	-	-	1	2	2	1

Course Code & Name:19CY2151 Environmental Studies

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	2	3	3	2	-	-	2	-	-	1
CO2	2	-	-	-	-	2	3	3	2	-	-	2	-	-	2
CO3	2	1	1	-	-	2	3	3	2	-	-	2	-	-	1
CO4	2	1	2	-	-	2	3	3	2	-	-	2	-	-	1
CO5	2	1	2	-	-	2	3	3	2	-	-	2	-	-	2
Avg	2	1	2	-	-	1	2	3	2	-	-	2	-	-	1

Course Code & Name:19CS2152 Essentials of C&C++Programming

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	-		3	-	-	1	1	-	2	2	3	3	1
CO2	3	3	2	2	3	-	-	1	1	-	2	2	2	3	1
CO3	3	3	2	2	3	-	-	1	1	-	2	2	2	3	2
CO4	3	3	-	2	3	-	-	1	1	-	2	2	2	3	1
CO5	3	-	2	2	3	-	-	1	1	-	2	2	2	3	2
Avg	3	3	2	2	3	-	-	1	1		2	2	2	3	1

Course Code & Name:19ME2154 Engineering Graphics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	2	2	-	-	-	-	-	-	2	1	1	1
CO2	3	3	3	2	2	-	-	-	-	-	-	3	2	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	3	3	3	1
CO4	3	3	3	2	2	-	-	-	-	-	-	3	1	1	1
CO5	3	3	3	2	2	-	-	-	-	-	-	3	2	2	2
Avg	3	3	3	2	2	-	-	-	-	-	-	3	2	2	1

Course Code & Name:19ME2001 Engineering Practices

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	3	-	3	-	1	-	1	-	-	-	1	2	1
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Avg	3	-	3	-	3	-	-	-	1	-	-	-	1	2	1

Semester – III**Course Code & Name: 19MA3102 Fourier Analysis and Transforms**

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	2	-	-	-	-	-	-	2	2	2	1
CO2	3	3	3	3	3	-	-	-	-	-	-	2	2	1	2
CO3	3	3	3	3	2	-	-	-	-	-	-	2	2	1	1
CO4	3	3	3	3	3	-	-	-	-	-	-	2	2	1	1
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	1	2
Avg	3	3	3	3	3	-	-	-	-	-	-	2	2	1	1

Course Code & Name: 19BM3201 Electron Devices and Circuits

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	3	2	-	-	-	-	-	-	-	-	1	2	1
CO2	2	2	2	-	-	-	-	-	-	-	-	-	1	2	1
CO3	3	2	3	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	-	2	3	-	-	-	-	-	-	-	-	-	3	1
CO5	2	-			-	-	-	-	-	-	-	-	-	3	1
Avg	2	1	2	1	-	-	-	-	-	-	-	-	0	2	1

Course Code & Name: 19BM3202 Medical Biochemistry

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	2
CO2	3	-	2		-	2	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3	-	2		-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	2	-	3	2
Avg	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1

Course Code & Name: 19BM3203 Human Anatomy and physiology

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	2
CO2	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO3	1	1	-	1	1	-	-	-	-	-	-	2	2	1	1
CO4	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO5	1	1	-	1	-	-	-	-	-	-	-	2	2	1	2
Avg	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1

Course Code & Name:19BM3251 Digital Electronics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	-	1	-	2	-	2	2	-	2	1
CO2	2	2	2	2	2	-	-	-	-	2	2	2	-	2	2
CO3	2	2	3	2	2	-	2	2	2	-	2	2	-	2	1
CO4	2	2	2	2	2	-	2	2	-	2	2	-	-	2	1
CO5	2	-	2	1	2	-	-	-	-	-	2	1	-	1	2
Avg	2	2	2	2	2	0	1	1	1	1	2	1	0	2	1

Course Code & Name:19BM3001 Electron Devices and Circuits Laboratory

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	2	-	-	-	-	-	3	-	-	-	-	2	2
CO2	2	2	3	-	-	-	-	-	3	-	-	-	-	2	1
CO3	3	-	-	-	-	-	-	-	3	-	-	-	-	2	1
CO4	3	-	-	-	-	-	-	-	3	-	-	-	-	3	1
CO5	3	-	-	-	-	-	-	-	3	-	-	-	1		1
Avg	3	0	1	-	-	-	-	-	3	-	-	-	1	2	1

Course Code & Name:19BM3002 Biochemistry Laboratory

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO2	3	-	2	-	-	2	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	-	-	-	-	-	-	-	-	3	2
CO4	3	-	2	-	-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	2	-	3	1
Avg	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1

Semester – IV

Course Code & Name:19BM4201 Linear Integrated Circuits

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1
CO2	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO3	1	1	2	1	1	-	-	-	-	-	-	2	2	1	1
CO4	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO5	1	1	2	1	-	-	-	-	-	-	-	2	2	1	2
Avg	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1

Course Code & Name:19BM4202 Bio MEMS and Nanotechnology

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	-	-	-	-	-	-	-	-	-	2	2	1
CO2	2	2	3	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	2	2

CO4	2	2	3	-	-	-	-	-	-	-	-	-	2	3	1
CO5	2	2	2	-	-	-	-	-	-	-	-	-	3	3	1
Avg	2	2	2	-	-	-	-	-	-	-	-	-	2	2	1

Course Code & Name:19BM4203 Pathology and Microbiology

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2	-	-	-	-	-	-	-	1	1	1	2	2
CO2	1	1	2	3		1	-	-	-	-		1	1	1	1
CO3	1	3	3	-	-	-	-	-	3	1	2	2	3	2	1
CO4	1	1	2	-	-	-	-	-	-	-	-	1	1	1	1
CO5	1	3	3	3		2	-	-	3	1	2	2	3	3	1
Avg	1	2	2	1		1	-	-	1	0	1	1	2	2	1

Course Code & Name:19MA4152 Statistics and Numerical Methods

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	1	2	-	-	-	-	-	-	2	3	2	1
CO2	3	3	3	2	1	-	-	-	-	-	-	3	2	2	1
CO3	3	3	3	1	1	-	-	-	-	-	-	2	2	2	2
CO4	3	3	3	3	3	-	-	-	-	-	-	2	2	2	1
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	2	1
Avg	3	3	3	2	2	-	-	-	-	-	-	2	2	2	1

Course Code & Name:19BM4251 Sensors and Measurement

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	-	-	-	-	-	1	1	1		1	1	1	1
CO2	3	-	-	-	-	-	-	1	1	1		1	1	1	1
CO3	3	-	-	-	-	-	-	1	1	1		1	1	1	1
CO4	3	-	-	-	-	-	-	1	1	1		1	1	1	1
CO5	3	-	-	-	-	-	-	1	1	1		1			1
Avg	3	0	-	-	-	-	-	1	1	1		1	1	1	1

Course Code & Name: 19BM4001 Integrated Circuits lab

PO& PSO	PO1	PO2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	3	-	-	2		3	1
CO2	2	-	2	-	-	-	-	-	3	-	-	2		3	1
CO3	3	-	3	2	-	-	-	-	3	-	-	-	-	3	1
CO4	3	-	-	-	2	-	-	-	3	-	-	-	-	2	1
CO5	3	-	-	2	-	-	-	-	3	-	-	2	1	3	1
Avg	3	0	1	1	0	-	-	-	3	-	-	1	0	3	1

Course Code & Name: 19BM4002 Human Physiology Laboratory

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	3	-	-	2	-	3	1
CO2	2	-	2	-	-	-	-	-	3	-	-	2	-	3	1
CO3	3	-	3	2	-	-	-	-	3	-	-	-	-	3	1
CO4	3	-	-	-	2	-	-	-	3	-	-	-	-	2	1
CO5	3			2		-	-	-	3	-	-	2	3	3	1
Avg	3	0	1	1	0	-	-	-	3	-	-	1	1	3	1

Semester – V

Course Code & Name: 19BM5201 Biocontrol systems

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	2	-	-	-	-	-	-	-	-	-	-	2		1
CO2	3	2	-	2	-	-	-	-	-	-	-	-	2	3	1
CO3	2	3	-	3	-	-	-	-	-	-	-	-	2	3	1
CO4	3	2	-	-	-	-	-	-	-	-	-	-	1	-	1
CO5	3	-	-		-	-	-	-	-	-	-	-	-	-	1
Avg	2	2	-	1	-	-	-	-	-	-	-	-	1	1	1

Course Code & Name: 19BM5202 Biomechanics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO2	3	-	2	-	-	-	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	2	-	-	-	-	-	-	-	3	1
CO4	3	-	2	-	-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	2	-	3	1
Avg	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1

Course Code & Name: 19BM5203 Microprocessors and Microcontrollers

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	-	-	-	-	-	-	-	-	-	-	3	-	1
CO2	1	3	-	-	-	-	-	-	-	-	-	-	2	3	1
CO3	3	-	3	-	2	-	-	-	-	-	-	-	-	3	1
CO4	2	-	3	-	3	-	-	-	-	-	-	-	-	2	1
CO5	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Avg	2	1	1		1	-	-	-	-	-	-	-	2	2	1

Course Code & Name:19BM5204 Biomedical Instrumentation

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PS O2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	-	2	1	1
CO2	1	1	-	-	-	-	-	-	-	-	-	-	2	1	2
CO3	1	1	1	1	-	1	-	-	-	-	-	-	2	2	1
CO4	0	0	1	1	-	1	-	-	-	-	-	-	2	2	1
CO5	0	0	-	-	-	-	-	-	-	-	-	-	2	1	1
Avg	1	1	0	0	-	0	-	-	-	-	-	-	2	1	1

Course Code & Name: 19BM5251 Virtual Instrumentation using Lab VIEW

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	2	2	1	2
CO2	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1
CO3	1	1	1	1		1	-	-	-	-	-	2	2	2	1
CO4	0	0	1	1		1	-	-	-	-	-	1	2	2	1
CO5	0	0	-	-	-	-	-	-	-	-	-	2	2	1	2
Avg	1	1	0	0		0	-	-	-	-	-	2	2	1	1

Course Code & Name:19BM5001 Microprocessors and Microcontrollers Lab

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	3	-	-	2	-	3	1
CO2	2	-	2	-	-	-	-	-	3	-	-	2	-	3	2
CO3	3	-	3	2	-	-	-	-	3	-	-	-	-	3	1
CO4	3	-	-		2	-	-	-	3	-	-	-	-	2	2
CO5	3	-	-	2	-	-	-	-	3	-	-	2	3	3	1
Avg	3	0	1	1	0	-	-		3	-	-	1	1	3	1

Course Code & Name:19BM5002 Biomedical Instrumentation Lab

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	3	-	-	2	-	3	1
CO2	2	-	2	-	-	-		-	3	-	-	2	-	3	1
CO3	3	-	3	2	-	-	-	-	3	-	-	-	-	3	1
CO4	3	-	-	-	2	-	-	-	3	-	-	-	-	2	1
CO5	3			2	-	-	-	-	3	-	-	2	3	3	1
Avg	3	0	1	1	0	-	-	-	3	-	-	1	1	3	1

SEMESTER VI

Course Code & Name:19BM6201 Biosignal Processing

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	1	2	-	-	-	-	-	-	-	1	1	1	2
CO2	-	1	1	2	3	-	1	-	-	-	-	-	1	1	1

CO3	-	1	3	3	-	-	-	-	-	3	1	2	2	3	2
CO4	-	1	1	2	-	-	-	-	-	-	-	-	1	1	1
CO5	-	1	3	3	3	-	2	-	-	3	1	2	2	3	3
Avg	-	1	2	2	1	-	1	-	-	1	0	1	1	2	2

Course Code & Name: 19BM6202 Radiological Equipment's and nuclear Medicine

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO2	3	-	2	-	-	2	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3		2	-	-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	2	-	3	1
Avg	2	1	2	1	-	0	-	-	-	-	-	-	1	3	1

Course Code & Name: 19BM6203 Entrepreneurship Development

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1
CO2	-	-	-	-	2	2	-	-	2	2	3	-	-	-	1
CO3	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1
CO4	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1
CO5	-	-	-	-	-	-	-	-	2	2	3	-	-	-	1
Avg	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1

Course Code & Name:19BM6251 Diagnostic and Therapeutic Equipment-I

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO2	3	-	2	-	-	2	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3		2	-	-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	-	-	3	1
Avg	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1

Course Code & Name:19BM6001 Biosignal Processing Laboratory

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	-	-	-	-	3	-	-	2	-	3	1
CO2	2	-	2	-	-	-	-	-	3	-	-	2	-	3	1
CO3	3	-	3	2	-	-	-	-	3	-	-	-	-	3	1
CO4	3	-	-		2	-	-	-	3	-	-	-	-	2	1
CO5	3	-	-	2	-	-	-	-	-	-	-	2	3	3	1
Avg	3	0	1	1	0	-	-	-	3	-	-	1	1	3	1

PROFESSIONAL ELECTIVE I**Course Code & Name:19BM5301 Medical Physics**

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	1	-	-	3	2	2	1	-	2	2	1	1
CO2	2	2	2	1	-	-	3	2	-	1	-	2	2	1	1
CO3	2	2	3	1	-	-	3	2	2	1	-	2	2	1	1
CO4	2	2	2	1	-	-	3	2	-	1	-	2	2	1	1
CO5	2	2	2	1	-	-	3	2	-	1	-	2	2	1	1
Avg	2	2	2	1	-	-	3	2	1	1	-	2	2	1	1

Course Code & Name:19BM5302 Robotics in Medicine

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-	-	1
CO2	3	2	2	-	-	-	-	-	-	-	-	3	-	-	1
CO3	-	1	2	2	-	2	-	-	-	-	-	-	-	-	1
CO4	3	-	2	-	-	-	-	-	-	-	-	-	-	-	1
CO5	1	3	2	3	-	-	-	-	-	-	-	-	-	-	1
Avg	2	1	3	1	-	0	-	-	-	-	-	1	-	-	1

Course Code & Name:19BM5303 Total Quality Management

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	-	1
CO3	-	3	-	-	-	-	-	-	-	-	-	-	2	-	1
CO4	-	-	3	-	2	-	-	-	-	-	-	-	2	-	1
CO5	-	-	3	-	2	-	-	-	-	-	-	-	2	-	1
Avg	-	2	1	-	1	-	-	-	-	-	-	-	1	-	1

Course Code & Name:19BM5304 Medical Ethics and Standards

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	3	-	2	-	-	-	-	-	-	-	1	-	1
CO2	1	-	3	-	-	-	-	-	-	2	-	-	2	-	1
CO3	1	-	3	-	-	-	-	-	-	2	-	-	3	-	1
CO4	1	-	2	-	3	-	-	-	-	2	-	-	-	-	1
CO5	1	-	2	-	-	-	-	-	-	2	-	-	-	-	1
Avg	1	-	3	-	1	-	-	-	-	2	-	-	1	-	1

CO2	2	1	-	-	2	-	-	-	-	-	-	2	-	-	2
CO3	2	1	-	-	0	-	-	1	-	-	-	1	-	-	-
CO4	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-
CO5	-	-	-	-	-	-	-	1	-	-	-	1	-	-	2
Avg	2	1	-	-	0	-	-	1	-	-	-	1	-	-	1

Course Code & Name:19BM6305 Artificial Neural Networks

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1
CO2	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1
CO3	1	1	1	1	-	1	-	-	-	-	-	2	2	2	1
CO4	0	0	1	1	-	1	-	-	-	-	-	1	2	2	1
CO5	0	0	-	-	-	-	-	-	-	-	-	2	2	1	1
Avg	1	1	0	0	-	0	-	-	-	-	-	2	2	1	1

SEMESTER VII

Course Code & Name: 16BM7201 Medical Image Processing

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	-	1	-	2		2	2	2	1	1
CO2	2	2	2	2	2	-	-	-	-	2	2	2	2	1	1
CO3	2	2	3	2	2	-	2	2	2	-	2	2	2	1	1
CO4	2	2	2	2	2	-	2	2	-	2	2	-	2	1	1
CO5	2	-	2	1	2	-	-	-	-	-	2	1	2	1	1
Avg	2	1	2	2	2	-	1	1	1	1	2	2	2	1	1

Course Code & Name: 16BM7202 Diagnostic and Therapeutic Equipment-II

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO2	3	-	2	-	-	2	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3		2	-	-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	2	-	3	1
Avg	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1

Course Code & Name: 16HE7104 Entrepreneurship Development

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1
CO2	-	-	-	-	2	2	-	-	2	2	3	-	-	-	1
CO3	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1
CO4	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1
CO5	-	-	-	-	-	-	-	-	2	2	3	-	-	-	1
Avg	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1

Course Code & Name: 16BM7001 Medical Image Processing Laboratory

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2	-	2	-	-	-	2	-	-	-	-	-	1
CO2	1	1	2	-	2	-	-	-	2	-	-	-	-	-	1
CO3	1	1	2	-	2	-	-	-	2	-	-	-	-	-	1
CO4	1	1	2	-	2	-	-	-	2	-	-	-	-	-	1
CO5	1	1	2	-	2	-	-	-	2	-	-	-	-	-	1
Avg	1	1	2	-	2	-	-	-	2	-	-	-	-	-	1

Semester – VIII

Course Code & Name: 16BM8012 Project Work

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	3	-	3	-	-	-	1
CO2	-	-	-	-	-	-	-	-	3	-	3	-	-	-	1
CO3	-	-	-	-	-	-	-	-	3	-	3	-	-	-	1
CO4	-	-	-	-	-	-	-	-	3	-	3	-	-	-	1
CO5	-	-	-	-	-	-	-	-	3	-	3	-	-	-	1
Avg	-	-	-	-	-	-	-	-	3	-	3	-	-	-	1

PROFESSIONAL ELECTIVE III

Course Code & Name: 16BM7301 Artificial Organs and Implants

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO2	3	-	2	-	-	2	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3	-	2	-	-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	2	-	3	1
Avg	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1

Course Code & Name: 16BM7302 VLSI Design

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	1	-	-	-	3	-	3	-	-	-	-	1
CO2	2	-	3	-	-	-	-	3	-	1	-	1	-	-	1
CO3	2	-	3	-	-	-	-	3	-	1	-	1	-	-	1
CO4	2	-	3	-	-	-	-	3	-	1	-	-	-	-	1
CO5	-	-	3	-	-	-	-	1	-	1	-	-	-	-	1
Avg	2	-	3	0	-	-	-	3	-	1	-	1	-	-	1

Course Code & Name: 16BM7303 Advanced Bio Analytical And Therapeutic Techniques

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	1	2	-	-	-	-	-	-	-	1	1	1	1
CO2	-	1	1	2	3	-	1	-	-	-	-	-	1	1	1
CO3	-	1	3	3	-	-	-	-	-	3	1	2	2	3	3
CO4	-	1	1	2	-	-	-	-	-	-	-	-	1	1	1
CO5	-	1	3	3	3	-	2	-	-	3	1	2	2	3	3
Avg	-	1	2	2	1	-	1	-	-	1	0	1	1	2	2

Course Code & Name: 16BM7304 Advanced Biosignal Processing

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	1	2	-	-	-	-	-	-	-	1	1	1	2
CO2	-	1	1	2	3	-	1	-	-	-	-	-	1	1	1
CO3	-	1	3	3	-	-	-	-	-	3	1	2	2	3	2
CO4	-	1	1	2	-	-	-	-	-	-	-	-	1	1	1
CO5	-	1	3	3	3	-	2	-	-	3	1	2	2	3	3
Avg	-	1	2	2	1	-	1	-	-	1	0	1	1	2	2

Course Code & Name: 16BM7305 Neural Engineering

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1
CO2	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1
CO3	1	1	1	1	-	1	-	-	-	-	-	2	2	2	1
CO4	0	0	1	1	-	1	-	-	-	-	-	1	2	2	1
CO5	0	0	-	-	-	-	-	-	-	-	-	2	2	1	1
Avg	1	1	0	0	-	0	-	-	-	-	-	2	2	1	1

PROFESSIONAL ELECTIVE IV

Course Code & Name: 16BM7306 Biofluids and Dynamics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	3	2	-	-	-	-	-	-	-	3	-	-	1
CO2	1	-	-	2	-	-	-	-	2	-	-	-	-	-	1
CO3	1	-	3	2	-	-	1	-	2	-	-	3	-	3	1
CO4	1	-	3	2	-	-	1	-	3	-	-	-	-	-	1
CO5	1	-	-	2	-	-	-	-	-	-	-	3	-	1	1
Avg	1	-	2	2	-	-	1	-	2	-	-	2	-	1	1

Course Code & Name: 16BM7307 Artificial Neural Networks

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1
CO2	1	1	-	-	-	-	-	-	-	-	-	2	2	1	1

CO3	1	1	1	1	-	1	-	-	-	-	-	2	2	2	1
CO4	0	0	1	1	-	1	-	-	-	-	-	1	2	2	1
CO5	0	0	-	-	-	-	-	-	-	-	-	2	2	1	1
Avg	1	1	0	0	-	0	-	-	-	-	-	2	2	1	1

Course Code & Name: 16BM7308 Medical Data Analytics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1
CO2	-	-	1	3	-	-	1	-	3	-	-	-	1	-	1
CO3	-	-	2	-	-	-	1	-	3	-	-	-	2	-	1
CO4	-	-	2	2	-	-	1	-	3	-	-	-	1	1	1
CO5	-	-	2	-	-	-	1	-	-	-	-	-	-	-	1
Avg	-	-	2	1	-	-	1	-	2	-	-	-	1	0	1

Course Code & Name: 16BM7309 Robotics in Medicine

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	-	-	-	-	-	-	-	-	-	-	3	-	-	1
CO2	3	2	2	-	-	-	-	-	-	-	-	3	-	-	1
CO3	-	1	2	2	-	2	-	-	-	-	-	-	-	-	1
CO4	3	-	2	-	-	-	-	-	-	-	-	-	-	-	1
CO5	1	3	2	3	-	-	-	-	-	-	-	-	-	-	1
Avg	2	1	3	1	-	0	-	-	-	-	-	1	-	-	1

Course Code & Name: 16BM7310 Cancer Biology

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	2	-	-	-	-	-	-	-	1	1	1	2	2
CO2	1	1	2	3		1	-	-	-	-		1	1	1	1
CO3	1	3	3	-	-	-	-	-	3	1	2	2	3	2	1
CO4	1	1	2	-	-	-	-	-	-	-	-	1	1	1	1
CO5	1	3	3	3		2	-	-	3	1	2	2	3	3	1
Avg	1	2	2	1		1	-	-	1	0	1	1	2	2	1

PROFESSIONAL ELECTIVE V

Course Code & Name: 16BM8301 Mechatronics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	-	-	-	-	-	2	2	1	1	-
CO2	1	1	1	1	1	-	-	-	-	-	1	2	1	1	-
CO3	1	1	-	1	1	-	-	-	-	-	2	2	1	1	-
CO4	1	1	1	1	1	-	-	-	-	-	1	2	1	1	-
CO5	1	1	-	1	-	-	-	-	-	-	2	2	1	1	-
Avg	1	1	1	1	1	-	-	-	-	-	2	2	1	1	-

Course Code & Name: 16BM8302 Machine learning Techniques in Medicine

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	-	-	-	-	-	-	-	-	1	-	-	-	1
CO2	3	2	3	-	-	-	1	-	-	-	1	-	3	-	1
CO3	3	2	3	-	-	-	3	-	-	-	1	-	3	-	1
CO4	3	-	2	-	-	-	2	-	-	-	3	-	2	-	1
CO5	3	-	-	-	-	-	-	-	-	-	3	-	-	-	1
Avg	3	1	2	-	-	-	1	-	-	-	2	-	2	-	1

Course Code & Name: 16BM8303 Medical Device Design

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	3	-	-	-	2	-	-	-	-	3
CO3	1	-	-	-	-	3	2	-	-	-	-	-	-	-	3
CO4	1	-	2	-	-	3	1	-	-	3	-	-	-	-	3
CO5	1	-	2	-	-	1	3	-	-	1	-	-	-	-	-
Avg	1	-	1	-	-	2	1	-	-	1	-	-	-	-	2

Course Code & Name: 16BM8304 Telemedicine

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1
CO2	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO3	1	-	1	1	1	-	-	-	-	-	-	2	2	1	1
CO4	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO5	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-
Avg	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1

Course Code & Name: 16BM8305 Wearable Medical Devices

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO2	1	-	-	-	-	3	-	-	-	2	-	-	-	-	3
CO3	1	-	-	-	-	3	2	-	-	-	-	-	-	-	3
CO4	1	-	2	-	-	3	1	-	-	3	-	-	-	-	3
CO5	1	-	2	-	-	1	3	-	-	1	-	-	-	-	-
Avg	1	-	1	-	-	2	1	-	-	1	-	-	-	-	2

PROFESSIONAL ELECTIVE VI

Course Code & Name: 16BM8306 Rehabilitation Engineering

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	-	-	-	-	-	2	2	1	1	1
CO2	1	1	1	1	1	-	-	-	-	-	1	2	1	1	1
CO3	1	1	-	1	1	-	-	-	-	-	2	2	1	1	1
CO4	1	1	1	1	1	-	-	-	-	-	1	2	1	1	1
CO5	1	1	-	1	-	-	-	-	-	-	2	2	1	1	1
Avg	1	1	1	1	1	-	-	-	-	-	1	2	1	1	1

Course Code & Name: 16BM8307 Physiological Modelling

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	2	-	-	-	-	-	-	2	-	-	2
CO3	2	1	-	-	0	-	-	1	-	-	-	1	-	-	-
CO4	-	-	-	-	-	-	-	1	-	-	-	2	-	-	-
CO5	-	-	-	-	-	-	-	1	-	-	-	1	-	-	2
Avg	2	1	-	-	0	-	-	1	-	-	-	1	-	-	1

Course Code & Name: 16BM8308 Biometrics

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	-	-	-	-	-	-	-	-	2	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	-	2	2	1	1
CO3	2	1	2	-	-	-	-	-	-	-	-	1	3	1	1
CO4	2	1	1	-	-	-	-	-	-	-	-	1	2	1	1
CO5	2	1	2	-	-	-	-	-	-	-	-	2	2	1	1
Avg	2	1	2	-	-	-	-	-	-	-	-	1	2	1	1

Course Code & Name: 16BM8309 Internet of Things

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	1	-	2	-	2	-	-	2	-	-	-	-	-	1
CO2	-	1	-	3	-	2	-	-	2	-	-	-	1	-	1
CO3	-	1	-	3	-	3	-	-	2	-	-	-	-	-	1
CO4	-	1	-	3	-	3	-	-	-	-	-	-	-	-	1
CO5	-	1	-	3	-	3	-	-	-	-	-	-	1	-	1
Avg	-	1	-	3	-	3	-	-	1	-	-	-	0	-	1

Course Code & Name: 16BM8310 Brain Computer Interface

PO& PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1
CO2	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO3	1	-	1	1	1	-	-	-	-	-	-	2	2	1	1
CO4	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
CO5	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-
Avg	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1

OPEN ELECTIVES

Course Code & Name: 19BM6401 Applications of Biomedical Engineering

PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	2	1
CO2	3	-	2	-	-	2	-	-	-	-	-	-	3	2	1
CO3	-	1	2	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3	-	2	-	-	-	-	-	-	-	-	2	-	3	1
CO5	1	3	3	3	-	-	-	-	-	-	-	2	-	3	1
Avg	2	1	2	1	-	0	-	-	-	-	-	1	1	2	1

**Mapping of Course Outcome and Programme Outcome:
Regulation 2019**

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO	PSO2	PSO 3				
I	I	19HE1101 & Technical English	1	1	1	1	1	1	1	1	1	2	3	1	2	2	2	1			
		19MA1103 Calculus and Differential Equations	3	3	3	3	3	-	-	-	-	-	-	-	2	2	2	2	1		
		19PH1151 Applied Physics	3	2	2	2	2	1	-	-	-	-	-	-	1	2	2	2	1		
		19CY1151 Chemistry for Engineers	3	2	2	2	2	2	1	1	-	-	-	-	1	1	1	1	2		
		19CS1151 Python Programming and Practices	2	3	3	-	2	-	-	-	-	2	-	-	2	2	2	2	2	1	
		19EE1155 Basics of Electrical Engineering	-	2	1	-	1	-	-	-	-	-	-	-	-	1	-	-	1		
	II	II	19HE2101 Business English for Engineers	2	2	1	1	2	2	2	2	2	2	3	1	3	1	1	1	1	
			19MA2102 Complex Variables And Transform Calculus	3	3	3	3	3	3	-	-	-	-	-	-	2	2	2	2	2	1
			19PH2151 Material Science	3	2	1	2	2	2	1	2	-	-	-	-	1	2	2	2	2	1
			19CY2151 Environmental Studies	2	1	2	-	-	-	1	2	3	2	-	-	2	-	-	-	1	
19CS2152 Essentials			3	3	2	2	2	3	-	-	1	1	-	-	2	2	2	3	3	1	

		of C&C++ Programming																
		19ME2154Engineering Graphics	3	3	3	2	2	-	-	-	-	-	-	3	2	2	1	
II	III	19MA3102 Fourier Analysis and Transforms	3	3	3	3	3	-	-	-	-	-	-	2	2	1	1	
		19BM3201Electron Devices and Circuits	2	1	2	1	-	-	-	-	-	-	-	-	0	2	1	
		19BM3202Medical Biochemistry	2	1	2	1	-	0	-	-	-	-	-	-	1	1	3	1
		19BM3203Human Anatomy and physiology	1	1	1	1	1	-	-	-	-	-	-	-	2	2	1	1
		19BM3251Digital Electronics	2	2	2	2	2	0	1	1	1	1	2	1	0	2	1	
		19BM3001Electron Devices and Circuits Laboratory	3	0	1	-	-	-	-	-	3	-	-	-	-	1	2	1
		19BM3002Biochemistry Laboratory	2	1	2	1	-	0	-	-	-	-	-	-	1	1	3	1
	IV	19BM4201Linear Integrated Circuits	1	1	1	1	1	-	-	-	-	-	-	-	2	2	1	1
		19BM4202Bio MEMS and Nanotechnology	2	2	2	-	-	-	-	-	-	-	-	-	-	2	2	1
		19BM4203Pathology and Microbiology	1	2	2	1		1	-	-	1	0	1	1	2	2	2	1
		19MA4152Statistics and Numerical Methods	3	3	3	2	2								2	2	2	1
		19BM4251Sensors and Measurement	3	3	3	2	2	-	-	-	-	-	-	-	2	2	2	1
		19BM4001Integrated Circuits lab	3	0	1	1	0	-	-	-	3	-	-	-	1	0	3	1
		19BM4002Human Physiology Laboratory	3	0	1	1	0	-	-	-	3	-	-	-	1	1	3	1
II I	V	19BM5201Biocontrol systems	2	2	-	1	-	-	-	-	-	-	-	-	1	1	1	
		19BM5202Biomecha	2	1	2	1	-	0	-	-	-	-	-	-	1	1	3	1

		tics															
		19BM5203Microprocessors and Microcontrollers	2	1	1		1	-	-	-	-	-	-	2	2	1	
		19BM5204Biomedical Instrumentation	1	1	0	0	-	0	-	-	-	-	-	2	1	1	
		19BM5251Virtual Instrumentation using LabVIEW	1	1	0	0		0	-	-	-	-	2	2	1	1	
		19BM5001Microprocessors and Microcontrollers Lab	3	0	1	1	0	-	-		3	-	-	1	1	3	1
		19BM5002Biomedical Instrumentation Lab	3	0	1	1	0	-	-	-	3	-	-	1	1	3	1
	VI	19BM6201Biosignal Processing	-	1	2	2	1	-	1	-	-	1	0	1	1	2	2
		19BM6202Radiological Equipments and nuclear Medicine	2	1	2	1	-	0	-	-	-	-	-	-	1	3	1
		19BM6203Entrepreneurship Development	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1
		19BM6251Diagnostic and Therapeutic Equipment-I	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1
		19BM6001Biosignal Processing Laboratory	3	0	1	1	0	-	-	-	3	-	-	1	1	3	1
	PEI	19BM5301Medical Physics	2	2	2	1	-	-	3	2	1	1	-	2	2	1	1
		19BM5302Robotics in Medicine	2	1	3	1	-	0	-	-	-	-	-	1	-	-	1
		19BM5303Total Quality Managements	-	2	1	-	1	-	-	-	-	-	-	-	1	-	1
		19BM5304 Medical Ethics and Standards	1	-	3	-	1	-	-	-	-	2	-	-	1	-	1
		19BM5305 Intellectual Property Right	-	2	1	2	-	-	-	-	1	0	-	2	-	-	1
	PE2	19BM6301 Biomaterial and	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1

		Artificial Organs															
		19BM6302 Embedded Systems in Medical Devices	2	-	3	0	-	-	-	3	-	1	-	1	-	-	1
		19BM6303 Biomedical Waste Management	1	2	2	-	-	-	-	-	-	1	-	1	-	-	1
		19BM6304 Physiological Modelling	2	1	-	-	0	-	-	1	-	-	-	1	-	-	1
		19BM6305 Artificial Neural Networks	1	1	0	0	-	0	-	-	-	-	-	2	2	1	1
	PE3	19BM7301 Drug Delivery	2	-	2	0	-	-	1	-	-	3	-	-	-	2	1
		19BM7302 IOT Applications in Healthcare	-	1	-	3	-	3	-	-	1	-	-	-	0	-	1
		19BM7303 Advanced Bio Analytical And Therapeutic Techniques	-	1	2	2	1	-	1	-	-	1	0	1	1	2	
		19BM7304 Advanced Biosignal Processing	-	-	2	1	-	-	1	-	2	-	-	-	1	0	
		19BM7305 Ultrasound in Medicine	-	-	2	1	-	-	1	-	2	-	-	-	1	0	
	OEI	19BM6401 Applications of Biomedical Engineering	2	1	2	1	-	0	-	-	-	-	-	1	1	2	1

Regulation 2016

Year	Sem	Course code & Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO2
IV	VII	16BM7201 Medical Image Processing	1	1	2	-	2	-	-	-	2	-	-	-	-	-	1
		16BM7202 Diagnostic and Therapeutic	2	1	2	1	-	0	-	-	-	-	-	-	1	1	3

		Equipment-II															
		16HE7104 Entrepreneurship Development	-	-	-	-	1	1	-	-	2	2	3	-	-	-	1
		16BM7001 Medical Image Processing Laboratory	1	1	2	-	2	-	-	-	2	-	-	-	-	-	1
	PE 3	16BM7301 Artificial Organs and Implants	2	1	2	1	-	0	-	-	-	-	-	1	1	3	1
		16BM7302 VLSI Design	2	-	3	0	-	-	-	3	-	1	-	1	-	-	1
		16BM7303 Advanced Bio Analytical And Therapeutic Techniques	-	1	2	2	1	-	1	-	-	1	0	1	1	2	2
		16BM7304 Advanced Biosignal Processing	-	1	2	2	1	-	1	-	-	1	0	1	1	2	2
		16BM7305 Neural Engineering	1	1	0	0	-	0	-	-	-	-	-	2	2	1	1
	PE 4	16BM7306 Biofluids and Dynamics	1	-	2	2	-	-	1	-	2	-	-	2	-	1	1
		16BM7307 Artificial Neural Networks	1	1	0	0	-	0	-	-	-	-	-	2	2	1	1
		16BM7308 Medical Data Analytics	-	-	2	1	-	-	1	-	2	-	-	-	1	0	1
		16BM7309 Robotics in Medicine	2	1	3	1	-	0	-	-	-	-	-	1	-	-	1
		16BM7310 Cancer Biology	1	2	2	1		1	-	-	1	0	1	1	2	2	1
	PE 5	16BM8301 Mechantronics	1	1	1	1	1	-	-	-	-	-	2	2	1	1	-
		16BM8302 Machine learning Techniques in Medicine	3	1	2	-	-	-	1	-	-	-	2	-	2	-	1
		16BM8303 Medical Device Design	1	-	1	-	-	2	1	-	-	1	-	-	-	-	2
		16BM8304	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1

		Telemedicine															
		16BM8305 Wearable Medical Devices	1	-	1	-	-	2	1	-	-	1	-	-	-	-	2
	PE 6	16BM8306 Rehabilitation Engineering	1	1	1	1	1	-	-	-	-	-	1	2	1	1	1
		16BM8307 Physiological Modelling	2	1	-	-	0	-	-	1	-	-	-	1	-	-	1
		16BM8308 Biometrics	2	1	2	-	-	-	-	-	-	-	-	1	2	1	1
		16BM8309 Advanced Biosignal Processing	-	1	2	2	1	-	1	-	-	1	0	1	1	2	2
		16BM8310 Brain Computer Interface	1	1	1	1	1	-	-	-	-	-	-	1	2	1	1
	OE 2	16BM7401 Digital Healthcare Technology	1	1	1	1	1	-	-	-	-	-	-	2	2	1	1

Handwritten signature in blue ink.

Handwritten signature in black ink.

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CHAIRMAN-BOS

DEAN ACADEMICS