Vel Tech
Rangarajan Dr. Sagunthala
R&D Institute of Science and Technology
(Deemed to be University Estd. u/s 3 of UGC Act, 1956)

SHOOL OF ELECTRICAL AND COMMUNICATION

CURRICULUM AND SYLLABI

REGULATION 2015

Department of Biomedical Engineering

VISION & MISSION OF THE DEPARTMENT

VISION:

"To be recognized as an excellent centre in Biomedical Engineering for imparting quality technical education that leads to transformative advancements in healthcare industries"

MISSION:

M1: *To infuse **critical thinking skills** by providing a strong foundation that enables the students for continuing education*

M2: *To create an ambience of academic excellence with **state-of-the-art** laboratories to compete globally*

M3: *To establish a **dynamic research environment** that integrates advanced healthcare technologies for innovation and progress*

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

After 3-4 years of graduation, the undergraduates will be able to

PEO1: *Exhibit **Proficiency in designing and analyzing** healthcare solutions to cater to the needs of the medical industry and societal needs.*

PEO2: *Demonstrate **professional networking** in a diverse team setting and **collaborate** among peers with ethical practices in the workplace, ensuring integrity*

PEO3: *Reinforce **lifelong learning** practices for professional advancement not limited to higher studies and research*

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
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.
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.
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.

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.
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.
7. **Environment and sustainability**: Understand the impact of the professional engineering solution in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **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.
11. **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.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates will be able to

PSO1: *Apply critical reasoning to analyse, identify and solve solutions for problems related to Brain-Computer Interface (BCI)*

PSO2: *Design an effective interface between biological and electronic systems*

Minimum credits required for regular students in various course categories to complete B-tech Biomedical Engineering under VTUR15

Course Category	**Minimum Credits Required**
Foundation Courses (FC)	60
Programme Core (PC)	60
Programme Elective (PE)	18
Allied Elective (AE)	6
University Elective (UE)	10
Value Education Elective	4
Independent Learning (IL)	20
Industry/Higher Institute Learning Interaction (IHL)	2
Total	***180***

Vel Tech Rangarajan & Dr.Sagunthala R&D Institute of Technology
Department of Bio Medical Engineering (VTUR15 Curriculum)

Foundation Courses of VTUR15						
Sl. No.	**Course Code**	**Course Name**	**Class distribution per week**			**C**
			L	**T**	**P**	
1	1150EN102	Technical Communication	3	0	0	3
2	1150PH101	Engineering Physics	3	0	0	3
3	1150CH101	Engineering Chemistry	3	0	0	3
4	1150CH103	Environmental Studies	3	0	0	3
5	1150MA103	Engineering Mathematics-II	3	2	0	4
6	1150MA104	Transform and Partial Differential Equation	2	2	0	3
7	1150EC101	Basic Electronics Engineering	2	0	0	2
8	1150EE101	Basic Electrical Engineering	2	0	0	2
9	1150CE101	Basic Civil Engineering	2	0	0	2
10	1150ME101	Basic Mechanical Engineering	2	0	0	2
11	1150ME103	Engineering Materials	2	0	0	2
12	1150MG101	Project Management and Finance	3	0	0	3
13	1150GE101	Biology for Engineers	2	0	0	2
14	1150GE102	Design Thinking	3	0	0	3
Integrated Courses						
15	1150EN201	Technical English	2	0	2	3
16	1150MA201	Applied Statistics	2	0	2	3
17	1150MA202	Engineering Mathematics-I	2	2	2	4
18	1150CS201	Problem Solving using C	1	2	2	3
19	1150ME202	Engineering Graphics	1	2	4	4
20	1150GE205	Introduction to Engineering	1	0	4	3
Laboratory Courses						
21	1150PH302	Engineering Physics Laboratory	0	0	2	1
22	1150CH302	Engineering Chemistry Laboratory	0	0	2	1
23	1150EE302	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
				Total Credits		**60**

S.No	**Course Code**	**Program Core**	**Class distribution per week**			**C**
			L	**T**	**P**	
1	1151BM101	Anatomy and Human Physiology	3	0	0	3
2	1151BM102	Biochemistry	3	0	0	3
3	1151BM103	Digital Electronics	3	0	0	3

4	1151BM104	Electric Circuit Theory	3	2	0	4
5	1151BM105	Analog Electronics and Integrated Circuits	3	0	0	3
6	1151BM106	Engineering Mechanics	2	2	0	3
7	1151BM107	Bio Sensors and Transducers	3	0	0	3
8	1151BM108	Signals and Systems	3	2	0	4
9	1151BM109	Microprocessor and Microcontroller	2	2	0	3
10	1151BM110	Digital Signal Processing	2	2	0	3
11	1151BM111	Bio Medical Instrumentation	3	0	0	3
12	1151BM112	Diagnostic and Therapeutic Equipments-I	3	0	0	3
13	1151BM113	Digital Electronics	3	0	0	3
14	1151BM114	Diagnostic and Therapeutic Equipments -II	3	0	0	3
15	1151BM115	Radiological Equipments	3	0	0	3
16	1151BM116	Diagnostic and Therapeutic Equipments -I	3	0	0	3
17	1151BM117	Diagnostic and Therapeutic Equipments -II	3	0	0	3
Program Core Integrated Courses						
18	1151BM201	Pathology and Microbiology	2	0	2	3
19	1151BM202	Artificial Neural Networks	3	0	2	4
20	1151BM203	Image Processing	3	0	2	4
Laboratory Courses						
21	1151BM301	Biochemistry and Physiology Laboratory	0	0	2	1
22	1151BM302	Analog Electronics and Integrated Circuit Laboratory	0	0	2	1
23	1151BM303	Microprocessor and Microcontroller Laboratory	0	0	2	1
24	1151BM304	Digital Signal Processing Laboratory	0	0	2	1
25	1151BM305	Biomedical Instrumentation Laboratory	0	0	2	1
				Total Credits		**60**

S.No	**Course Code**	**Program Electives**	**Class distribution per week**			**C**
			L	**T**	**P**	
1	1152BM101	Hospital Management	3	0	0	3
2	1152BM102	Telehealth Technology	3	0	0	3
3	1152BM103	Medical Ethics	3	0	0	3
4	1152BM104	Body Area Networks	3	0	0	3
5	1152BM105	Introduction to Nanotechnology	3	0	0	3
6	1152BM106	Rehabilitation Engineering	3	0	0	3
7	1152BM107	Robotics in Medicine	3	0	0	3
8	1152BM108	Biomedical Informatics	3	0	0	3
9	1152BM109	Precision Healthcare Technology	3	0	0	3
Program Elective Integrated Courses						
10	1152BM201	Digital Imaging and Communication in Medicine	1	0	4	3

11	1152BM202	Bio Signal Processing Instrumentation	1	0	4	3
12	1152BM203	Brain Computer Interface	1	0	4	3
13	1152BM204	Biomedical Computational Modelling	1	0	4	3
14	1152BM205	Biomedical Computational Modelling	1	0	4	3
15	1152BM206	Biomechanics	2	0	2	3

S.No	**Course Code**	**Allied Electives**	**Class distribution per week**			**C**
			L	**T**	**P**	
1	1153BM201	Bio Signal Processing Instrumentation	2	0	2	3
2	1153BM202	Brain Computer Interface	2	0	2	3
3	1153BM101	Body Area Networks	3	0	0	3
4	1153BM102	Environmental Conservation	3	0	0	3
5	1153BM103	Telehealth Technology	3	0	0	3
6	1153BM104	Remote Health Technology	3	0	0	3
Institute Electives						
1	1154BM101	Brain Computer Interface	2	0	0	2
2	1154BM102	Plant Biodiversity, Bioprospecting and the Sustainable Development	1	0	0	1
3	1154BM103	Telehealth Technology	3	0	0	3
4	1154BM301	Biomedical Laboratory	0	0	2	1
5	1154BM104	Telehealth Technology	3	0	0	3

S.No	**Course Code**	**Independent learning**	**Class distribution per week**			**C**
			L	**T**	**P**	
	MOOC courses					
1	1156BM401	Medical Biomaterials	2	0	0	2
2	1156BM402	AI for medical diagnosis	1	0	0	1
3	1156BM403	Data Management for clinical research	1	0	0	1
4	1156BM404	Tissue Engineering	2	0	0	2
5	1156BM405	BioMEMS and Microfluidics	1	0	0	1
6	1156BM406	Biophotonics	1	0	0	1
7	1156BM407	Epidemiology: the basic science of public health	1	0	0	1
8	1156BM408	Population health during a pandemic: Contact raising and beyond	1	0	0	1
9	1156BM409	Microfluidics	1	0	0	1
	Total (students should finish 2 credits)					2
	Seminar & Projects					

10	1156BM501	Technical Seminar-I	-	-	-	1
11	1156BM502	Technical Seminar-II	-	-	-	1
	Total					**2**
12	1156BM601	Mini Project	-	-	-	4
	Total					**4**
13	1156BM701	Major Project	-	-	-	12
	Total					**12**

S.No	**Course Code**	**Industry/ Higher Institute Learning and Interactions**	**Class distribution per week**			**C**
			L	**T**	**P**	
1	1157BM901	Fundamentals of BioMEMS and Microfluidics	-	-	-	1
2	1157BM902	Plant Biodiversity Bio prospecting and sustainable development goals	-	-	-	1
3	1157BM904	IOT using Healthcare	-	-	-	1

Group	**Category**
Group-I	Soft Skills
	Aptitude Proficiency
	English Proficiency Certification
Group-II	Sports/Yoga
	National Cadet Corps
	National Service Scheme
	Extra-Curricular Activities
Group-III	Value Added Courses
	Globally accepted Certification Courses
	Co-curricular Activities
	Foreign Languages

Course Code	**Course Title**	**L**	**T**	**P**	**C**

1151BM101	Anatomy and Human Physiology	3	0	0	3

a) Course Category

Program core

b) Preamble

Knowledge of Human anatomy and physiology is essential for a bio medical engineer in order to design any bio medical instruments. This course gives a basic knowledge about human anatomy

c) Prerequisite

None

d) Related Courses

Pathology and microbiology

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe basic structural and functional elements of human body	K2
CO2	Explain organs and structures involving in respiratory system formation and functions	K2
CO3	Explain circulatory system and its components.	K2
CO4	Describe the Kidney function and eye and ear senses	K2
CO5	Explain nervous system and its types	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L												L
CO2	H	L												L
CO3	H	L												L
CO4	H	L												L
CO5	H	L											M	L

f) Course content

UNIT I INTRODUCTION TO TISSUE STRUCTURE 9

Tissue – epithelial – connective – muscle, Membranes, Skeletal system, Joints - Types of Joint, Cavities of the body

UNIT II RESPIRATORY SYSTEM 9

Components of respiratory system, Respiratory Mechanism – Muscles of respiration – Cycle of respiration –Physiological variables – composition of air – Diffusion of gases – External respiration – Control of respiration.

UNIT III CIRCULATORY SYSTEM 9

Blood composition – plasma – cellular content. Blood vessels –Introduction, Structure of heart, Conducting system of heart, Cardiac cycle, Cardiac output, Pulse, Circulation of blood.

UNIT IV URINARY AND SPECIAL SENSORY SYSTEM 9

Urinary system: Structure of Kidney and Nephron. Mechanism of Urine formation and electrolyte balance – Micturition. Special senses: Eye and Ear.

UNIT V NERVOUS SYSTEM 9

Structure of a Neuron – Types of Nerve. Synapse and neurotransmitters. Conduction of action potential in neuron. Brain – Cerebrum – brain stem –cerebellum. Spinal cord – Tracts of spinal cord, Autonomic nervous system.

Total: 45 Hrs.

g) Learning Resources

Text Books

1. Anne Waugh and Allison Grant, Ross and Wilson "Anatomy and Human Physiology in Health and Illness" Ninth edition.

Reference Books

1. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2009
2. William F.Ganong, "Review of Medical Physiology", 22nd Edition, Mc Graw Hill, New Delhi, 2000

Course Code	Course Title	L	T	P	C
1151BM102	Biochemistry	3	0	0	3

a) Course Category

Program core

b) Preamble

The Purpose of the course is to understand the various biochemicals and their activities in the body.

c) Prerequisite

Biology for Engineers.

d) Related Courses

Pathology and Microbiology

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the fundamentals of biochemistry	K2
CO2	Explain about carbohydrates and its importance.	K2
CO3	Explain about lipids and its importance.	K2
CO4	Describe the nucleic acids and proteins and various separation techniques.	K2
CO5	Describe the biochemistry of body fluids	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L		L
CO2	H	L	L				L					L		L
CO3	H	L	L				L					L		L
CO4	H	L	L				L					L		L
CO5	H	L	L				L					L		L

f) Course Content

UNIT I INTRODUCTION TO BIOCHEMISTRY 9

Introduction to Biochemistry, water as a biological solvent, weak acid and bases, pH, buffers, Handerson-Hasselbalch equation, physiological buffers, fitness of the aqueous environment for living organism . Principle of viscosity, surface tension, adsorption, diffusion, osmosis and their applications in biological systems.

UNIT II CARBOHYDRATES 9

Classification of carbohydrates - mono, di, oligo and polysaccharides. Isomerism, racemisation and mutarotation .Structure, physical and chemical properties of carbohydrates. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain.Oxidative phosphorylation

UNIT III LIPIDS 9

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat. Saponification number, Reichert- Meissl number and iodine number. Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, structural architecture and significance of biological membrane.

UNIT IV NUCLEIC ACID & PROTEIN 9

Structure of purines and pyrimidines, nucleoside , nucleotide , DNA act as a genetic material, chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Classification, structure and properties of proteins, structural organization of proteins, classification and properties of aminoacids.Separation of protein: gel filtration, electrophoresis and ultracentrifugation.

UNIT V BIOCHEMISTRY OF BLOOD AND BODY FLUIDS 9

Liver function test. Renal function test. Acid base balance and imbalance measurements of electrolytes, their abnormal and normal values and conditions. Biochemistry of urine testing, uses of isotopes in Biochemistry

Total: 45 Hrs

g) Learning Resources

Text Books

1. David.W.Martin, Pete1151r.A.Mayes , Victor. W.Rodwell, “Harper’s Review of Biochemistry”, LANGE Medical Publications, 1981
2. Keith Wilson & John Walker, “Practical Biochemistry - Principles & Techniques”, University Press, 2009.
3. Text book of medical biochemistry – Rana shine, MN Chatterje 3rd edition (for unit 5).

Reference Books

1. Trevor palmer, “Understanding Enzymes”, Ellis Horwood Ltd. 1991.
2. Pamela.C.Champe & Richard.A.Harvey, “Lippincott Biochemistry Lippincott’s Illustrated Reviews”, Raven publishers,1994.
3. Sathyanarayana, Textbook of Biochemistry, 2003

Course Code	Course Title	L	T	P	C
1151BM103	**Digital Electronics**	**3**	**0**	**0**	**3**

a) Course Category

Program core

b) Preamble

To understand the basics of the Digital systems

c) Prerequisite

None

d) Related Courses

Microprocessor and Microcontroller.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the basic digital logic circuits and number system.	K2
CO2	Explain the concept of circuit simplification using gates	K2
CO3	Explain the concept of filp flops.	K2
CO4	Explain the concept of counters	K2
CO5	Describe about the memory organization and memory devices.	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L											L
CO2	H	L	L											L
CO3	H	L	L											L
CO4	H	M	L											L
CO5	H	L	L											L

f) Course content

UNIT I NUMBER SYSTEM & BOOLEAN ALGEBRA 9

Number system; Base conversion methods; compliments- 1's and 2's compliment; Codes- BCD-2421- Excess 3- Gray and ASCII; [Error detection and correction - hamming and parity check.] Boolean Algebra: Basic theorems and properties- Boolean laws and De-morgans theorem; Canonical & Standard form; Introduction to logic gates; Boolean algebraic simplification and realising using logic gates.

UNIT II GATE LEVEL MINIMISATION & COMBINATIONAL LOGIC 9

Gate-level minimisation: Introduction; Map Method- Three, four and five variable maps; Dont care conditions; Other minimisation techniques; Universal gate implementation; Exclusive OR function (parity check). Combinational Logic: Introduction; Arithmatic circuits; Comparators; Decoders and encoders; Multiplexers and De-multiplexers.

UNIT III SEQUENTIAL MACHIENE FUNDAMENTALS 9

Fundamentals of sequential machiene operation; Storage elements- Latches & Flipflops (D-Flipflop, T-Flipflop, J-K flipflop and Clocked flipflops); Timing and triggering consideration; ROM; RAM; Programmable logic array and programmable array logic

UNIT IV SEQUENTIAL CIRCUTI DESIGN & ANALYSIS 9

Counters-Design of single mod counter- ripple counter- ring counter; Registers- Shift register sequences. State Diagram; Approaches to the design of synchronous sequential finite state machines (ASM); State reduction steps.

UNIT V ASYNCHRONOUS SEQUENTIAL LOGIC 9

Introduction; Analysis Procedure; Circuits with latches; Design procedure; Reduction of State and flow tables; Race-free state assignment; Hazards.

Total 45 Hrs.

g) Learning Resources

Text Books

1. M. Morris Mano- Digital Design- pearson- fourth edition

Reference Books

1. Donald P Leach- Digital principles and applications-pearson- seventh edition

Course Code	Course Title	L	T	P	C
1151BM104	Electric Circuit Theory	3	2	0	4

a) Course Category

Program core

b) Preamble

Any analog circuit design/debugging needs thorough analysis of current and voltage at each point. This course introduces knowledge background needed for designing any electronic circuit or solving any problems encountered in the electronic circuit

c) Prerequisite

None

d) Links to other courses

Analog Electronics and Integrated Circuits

e) Course Outcomes

Upon successful completion of the course the students will be able to

CO Nos.	Course outcome	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Solve circuits for current and voltage using simple mesh and node analysis and theorems	K3
CO2	Reduce the complicated circuit to an equivalent simple circuit	K3
CO3	Compute the resonance frequency of series and parallel resonance circuits	K3
CO4	Solve problems on how RL, RC an RLC circuits behave with respect to time domain for both dc/ac input	K3
CO5	Design simple RC filter circuits for the given specification	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M										L	
CO2	H	H	M										L	
CO3	H	H	M										L	
CO4	H	H	M										M	
CO5	H	H	M										M	

f) Course Content

UNIT-I Basic Circuit Analysis **15**

Ohm's Law – Kirchhoff's laws – DC and AC Circuits – Resistors in series and parallel circuits –Mesh current and node voltage method of analysis for D.C and A.C. circuits

UNIT-II Network Theorems for DC **15**

Network reduction: voltage and current division, source transformation – star delta conversion. Thevenin's and Norton & Theorem – Superposition Theorem – Maximum power transfer theorem– Reciprocity Theorem, (Qualitative) Treatment only

UNIT-III Resonance and Coupled Circuits **15**

Series and parallel resonance – frequency response, Quality factor and Bandwidth. Self and mutual inductance – Coefficient of coupling, Tuned circuits, Single tuned circuits.

UNIT-IV Transient Response **15**

Transient response of RL, RC and RLC Circuits using Laplace transform for DC input and A.C. with sinusoidal input

UNIT-V RC Filters **15**

Two port networks, Hybrid parameters. Passive filters-RC Low pass, High pass, Band Pass and Band Reject filters

Total: 75 Hrs

g) Learning Resources

Text Books

1. Arumugam and Prem Kumar " Electric Circuit Theory", Khanna Publishers, 2000
2. Joseph Edminister, "Electric Cicuits" Schaum's outline series, Tata McGraw Hill Book Company, Third Edition, 2013

Reference Books

1. A.Chakrabarti," Circuit Theory – Analysis and Synthesis", Dhanpat Rai & Co. New Delhi, Fifth Edition 2006
2. Hayt W.H and Kemmerley J.E," Engineering Circuit Analysys", Tata McGraw Hill Book Co., Fifth Edition 2002

Course Code	Course Title	L	T	P	C
1151BM105	Analog Electronics and Integrated Circuits	3	0	0	3

a) Course Category

Program core

b) Preamble

To be exposed to the operation and applications of electronic devices.
To study the application of analog ICs in the designing circuit

c) Prerequisite

Basic Electronics Engineering.

d) Related Courses

Sensors and Transducers, Circuit Theory.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Solve problems on small signal amplifiers biasing circuit Explain the working of large signal amplifiers	K2
CO2	Analyze the different configuration of the amplifier using h parameters	K3
CO3	Design simple mathematical circuits using op amp	K2
CO4	Design wave shaping circuits and oscillators	K3
CO5	Design circuits using 555 timer	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L										M	
CO2	H	M	L										M	
CO3	H	M	L										M	
CO4	H	M	L										M	

CO5	H	M	L										M	

f) Course content

UNIT I BJT & FET **9**

Transistor as an amplifier; Methods of Transistor biasing- fixed bias, voltage divider, Emitter feedback bias and Bias stability. Large signal amplifiers- Introduction; Classification based on biasing condition- Class A, Class B, Class AB, Class C. Construction and operation of N-Channel J-FET; Enhancement MOSFET & Depletion MOSFET; Biasing the FET; Biasing MOSFET.

UNIT II Analysis of Small signal Amplifiers and Multi-stage Amplifiers **9**

Introduction to 2-port devices and hybrid model of 2-port network; Analysis of transistor using h-parameters; Analysis of CB, CE and CC; Millers theorem; Multi stage amplifiers- Two stage RC coupled Amplifier- Transformer Coupled Amplifier- Darlington Amplifier- Cascode Amplifier.

UNIT III Introduction to Op-amp **9**

Introduction; Ideal Operational Amplifier; Operational Amplifier Stages; Operational amplifier parameters; Equivalent Circuit of Op-Amp; Ideal Voltage Transfer Curve; Open loop Op-Amp configurations; Closed loop Op-Amp Configurations; Noise; Frequency response and compensation; Op-Amp Applications- Summing Amplifier- Difference Amplifier- Differentiator- Integrator- Voltage Follower- Phase Inverter; Log and Antilog amplifiers.

UNIT IV Wave shaping circuits and Oscillators **9**

Clippers and Clampers; Comparator, Astable Multivibrators; Monostable Multivibrator. Oscillators- Classification of Oscillators, Barkhausen Criterion, General form of an LC Oscillator, Hartley oscillator, Colpitts oscillator, Tuned Collector Oscillator, RC oscillator, Wein-Bridge Oscillator, Triangular wave generator, Sine wave generator, Schmitt Trigger.

UNIT V 555 Timers and its applications **9**

Introduction to 555 timer; Astable and monostable operation of 555 timer; Schmitt Trigger using 555 timer; Applications of 555 in Astable and Monostable operation

Total: 45 Hrs.

g) Learning Resources

Text Books

1. Electronic Devices and Circuits – S Salivahanan, N Suresh Kumar. Mc Graw Hill Education 3rd edition.
2. D. Roy Chowdary, Sheil B Jani- Linear Integrated circuits- new age publication, 2003 edition.

Reference Books

1. Jacob Milliam Halkias- Electronic devices and circuits- printis hall of india 2010 edition.

2. Allan Mottershed- Electronic devices and circuits an introduction- printis hall of india 2011 edition.

Course Code	Course Title	L	T	P	C
1151BM106	Engineering Mechanics	2	2	0	3

a) Course Category

Program core

b) Preamble

This course provides an introduction to the basic concepts of forces, inertias, centroids, and moments of area and techniques of finding their effects on motion. It introduces the phenomenon of friction and its effects. It introduces students to cognitive learning in applied mechanics and develops problem-solving skills in both theoretical and engineering oriented problems.

c) Pre-Requisite

Engineering Mathematics - I

d) Related Courses

None

e) Course Outcomes

Upon the successful completion of the course, learners will be able to

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Solve engineering problems using the principles of statics of particles	K2
CO2	Establish the magnitude of forces and moments acting on rigid bodies	K2
CO3	Define properties and theories related to surfaces and solids	K3
CO4	Solve engineering problems using the principles of dynamics of particles	K3
CO5	Describe the principles of various types of friction	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	H									L		L
CO2	H	L	H									L	L	L
CO3	H	L	H									L	L	L

CO4	H	L	H									L	L	L
CO5	H	L	H									L	L	L

f) Course Content

UNIT I BASICS & STATICS OF PARTICLES L-6 T-6

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and Triangular Law of forces – Vectors – Vectorial representation of forces and couples – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II EQUILIBRIUM OF RIGID BODIES L-6 T-6

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS L-6 T-6

Determination of Areas and Volumes – First moment of area and the Centroid of sections – Second and product moments of plane area – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia

UNIT IV DYNAMICS OF PARTICLES L-6 T-6

Displacement, Velocity and Acceleration, their relationship – Relative motion – Curvilinear motion – Newton's laws – Work-Energy Equation of particles – Impulse and Momentum

UNIT V FRICTION L-6 T-6

Frictional force – Laws of Coulomb friction – simple contact friction – Belt friction – Roller friction. Translation and Rotation of Rigid Bodies – General Plane motion.

Total:60 Hrs

g) Learning Resources

Text Books

1. Hibbeller, R.C., Engineering Mechanics, Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., 2015.
2. S.Timoshenko, D.H.Young, J.V.Rao, Sukumar Pati, Engineering Mechanics, McGraw Hill Education (India) Private Limited., 2013.

References

1. Palanichamy, M. S., and Nagan, S., Engineering Mechanics (Statics and Dynamics),Tata McGraw Hill, New Delhi 2012.
2. Kumar, K. L., Engineering Mechanics, Tata McGraw- Hill, New Delhi, 2011.
3. Shames, I. H., and Krishna Mohana Rao, G., Engineering Mechanics (Statics and Dynamics), Dorling Kindersley India) Pvt. Ltd. (Pearson Education), 2011.

4. Beer, F. P., and Johnston, E. R., Vector Mechanics for Engineers – Dynamics and Statics, Tata McGraw-Hill, New Delhi, 2011.
5. Natarajan, K.V., Engineering Mechanics, Dhanalakshmi Publishers, 2011.
6. Rajasekaran,S. and Sankarasubramanian,G., Engineering Mechanics, Vikas Publishing House Pvt Ltd, 2011.

Course Code	Course Title	L	T	P	C
1151BM107	Bio Sensors and Transducers	3	0	0	3

a) Course Category

Program core

b) Preamble

The student should be able to explain how physiological parameters are being measured.

c) Prerequisite

None

d) Related Courses

Bio Medical Instrumentation

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the principles of electrodes	K2
CO2	Explain the methods of pressure measurements	K2
CO3	Explain the methods of flow measurements	K2
CO4	Explain the methods of motion and force measurements	K2
CO5	Explain the methods of temperature measurements	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L												M
CO2	H	L												M
CO3	H	L												M
CO4	H	L												M
CO5	H	L												M

f) Course content

UNIT I INTRODUCTION TO SENSORS AND TRANSDUCER 9

Transducer and Measurement system - Static Characteristics – Dynamic Characteristics – Standards and Calibration – Types of Error.Bioelectric and Biomagnetic Measurement: Bioelectric events, Biomangetic events. Electrode theory – Electrode-Electrolyte interface – Liquid junction potentials –Double layer – Electrode potenials. Surface Potential Electrodes: ECG electrodes – EMG electrodes – ECG electrodes. Glass electrodes – Metal Electrodes – Suction electrodes. Bio Magnetism: Biomagnetic fields – Magnetopneumography.

UNIT II PRESSURE MEASUREMENTS 9

Requirements of pressure measurements, Direct pressure measurement: Catheters and diaphragm type pressure measurement – Catheter tip pressure transducer, Pressure measurement in small vessels - Servo controlled, Pressure measurement in collapsible vessels – Interstitial pressure measurement – Differential pressure measurement. Indirect pressure measurement – Systolic, Diastolic and Mean blood pressure – Auscultatory and Oscillometric method.

UNIT III FLOW MEASUREMENT 9

Requirements of flow measurement, Blood flow meters in single vessel – Electromagnetic flow meter – Ultrasound flow meter – Indicator dilution method. Tissue blood flow meter – Venous Occlusion plethysmography. Respiratory Gas flow measurements – Gas flow sensors - Lung plethysmography.

UNIT IV MOTION AND FORCE MEASUREMENTS 9

Objects of Measurements, Motion Measurements: Displacement and rotation measurements by contact transducers - Displacement and rotation measurements of body in extracted tissue – Displacement measurement in vivo, Non contact measurement of displacement and rotation. Force measurements: Muscle contraction measurement – Force measurements in isolated muscles – In vivo measurement of muscle contraction.

UNIT V TEMPERATURE MEASUREMENT 9

Requirements of temperature measurement, Temperature transducers – Thermistor - Thermocouple– Thin film thermo resistive element – p-n junction diodes and transistors. Clinical thermometers: Indwelling thermometer probes – Rectal, Esophageal and Bladder temperature measurement, Tymphanic thermometer, Zero heat flow thermometer.

Total: 45 Hrs

g) Learning Resources

Text Books

1. Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg, “Biomedical Transducers and Instruments”, CRC Press.

Reference Books

1. Ernest O Doebelin and Dhanesh N Manik, Measurement systems, Application and design, 5th edition, Mc Graw-Hill, 2007. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw-Hill, New Delhi, 2003.
2. Leslie Cromwell, “Biomedical Instrumentation and measurement”, Prentice hall of India, New Delhi, 2007.
3. John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 2004.
4. L.A Geddas and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, John Wiley and Sons, Third Edition, Reprint 2008.
5. Albert D.Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques”, Prentice Hall of India, 2007

Course Code	Course Title	L	T	P	C
1151BM108	Signals And Systems	3	2	0	4

a) Course Category

Program core

b) Preamble

Biomedical Engineering deals with signals from human body which has to be processed to get useful output. The signal can be either analog or converted digital signal. Processing of both the signal type requires some mathematics. This course provides the basic knowledge on the required mathematics for further processing of signals

c) Prerequisite

Transforms and Partial differential Equations

d) Related Courses

Digital Signal Processing, Image Processing

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Classify the continuous/discrete time signals/systems from the given equation according to their properties	K3
CO2	Compute the spectrum of continuous periodic and aperiodic signals using Fourier series	K3
CO3	Compute the spectrum of discrete periodic and aperiodic signals using Z transform	K3
CO4	Solve problems on analog to digital signal conversion and Aliasing	K3
CO5	Analyzing state space model for signal flow graph	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M											M	
CO2	H	M											M	
CO3	H	M											M	
CO4	H	M											M	
CO5	H	M											M	

f) Course Content

UNIT-I Classification of signals and systems **15**

Continuous Time signals (CT signals) – Discrete Time signals (DT signals) – Elementary CT signals and DT signals – Basic properties of signals , Classification of CT and DT signals – Basic properties of systems – Classification CT systems and DT systems – Linear time invariant systems and properties

UNIT-II Continuous time system and signal analysis **15**

Fourier series analysis: Spectrum of Continuous Time signals – Physical meaning of Fourier series. Fourier Transform in signal analysis and system analysis: Differential equation – block diagram representation – convolution integral and impulse response.

UNIT-III Discrete time signal and system analysis **15**

Discrete Fourier series, Fourier transform of discrete sequence, Z-transform and its properties, inverse z-transforms; Stability analysis, frequency response – Convolution..

UNIT-IV Representation of discrete time signals **15**

Sampling of Continuous Time signals and aliasing – DTFT and properties –physical meaning of DTFT – z transform in Discrete Time signal analysis

UNIT-V State Space analysis of a discrete system **15**

State space model, parallel realization, cascade realization, time domain solution of the state equation, frequency domain solution of the state equation, linear transformation of state vectors.

Total : 75 Hrs

g) Learning Resources

Text Books

1. Haykin " Signals and Systems", Khanna Publishers, 2000

Reference Books

1. Ashok Ambardar, "Analog and Digital Signal Processing", Thomson Learning Inc., 1999
2. Douglas K.Lindner, "Signals and Systems", McGraw-Hill International, 1999.

3. Allan V. Oppenheim et al, “Signals and Systems”, 2nd edition, Prentice Hall of India Pvt. Ltd, 2004

Course Code	Course Title	L	T	P	C
1151BM109	Microprocessor and Microcontroller	2	2	0	3

a) Course Category

Program core

b) Preamble

Microcontrollers are the heart of all embedded system applications. Embedded system application ranges from Car appliances to Robotics. To transform the theory into some fruitful application microcontrollers are needed. This course gives the knowledge required for embedded engineers both in terms of coding and architecture

c) Prerequisite

Digital Electronics

d) Related Courses

Digital Signal Processing

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Write simple ALP for solving mathematical functions using 8086 and 8085 processor	K3
CO2	Design and write ALP for Interfacing various peripheral devices with 8086 microprocessor	K3
CO3	Compare the architecture of 8051 with 8086 microprocessor	K2
CO4	Write 8051 ALP coding for implementing mathematical functions and functions various peripheral devices	K3
CO5	Explain how Arduino is used in medical applications	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M			M										
CO2				M										
CO3														
CO4	M		M	M										
CO5			H	L	M	H							H	

f) Course Content

UNIT-I 8085 and 8086 Microprocessor **12**

Introduction to 8085 Architecture, Addressing Modes, Instruction Formats, and Instruction Set. Introduction to 8086 Architecture, Features, Signals, I/O & Memory Interfacing, Addressing Modes, Instruction Formats, Instruction Set, Assembler Directives, Interrupts, Minimum Mode & Maximum Mode Operation, Assembly Language Programming

UNIT-II Peripheral Devices and Interfacing **12**

Parallel Peripheral Interface (8255), A/D & D/A Interface, Timer / Counter (8253), Keyboard and Display Controller (8279), USART (8251), Interrupt Controller (8259), DMA Controller (8237).

.

UNIT-III 8051 Architecture **12**

Hardware features, Architecture, Internal RAM structure, Special Function Registers, Memory Organization, I/O Ports and Circuits, Timers, Interrupts, Serial Communication, Interfacing of External Memory, Interfacing LCD & Keyboard, Real Time Clock

UNIT-IV 8051 Programming **12**

Addressing Modes, Instruction Set, Assembly Language Programming and C Programming, Timer Counter Programming, Serial Communication Programming, Interrupt Programming

UNIT-V Microcontroller Applications **12**

Arduino based Heart rate monitor, Pulse rate monitor, oxymeter, EEG monitor, Breathe analyzer

Total: 60 Hrs

g) Learning Resources

Text Books

1. Proakis, J. G. and Manolakis, D. G "Digital Signal Processing Principles, Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 6th Edition, Penram International Publishing
2. A.K Ray & K.M. Burchandi, Advanced Microprocessor and peripherals Architectures, Programming and interfacing ", second edition, Tata McGraw-Hill
3. Muhammad Ali Mazidi, Janice GillispieMazidi and Rolin D McKinlay, The 8051 microcontroller and embedded systems using assembly and C, second edition Pearson education Asia.

Reference Books

1. Kenneth J Ayala, The 8051 Microcontroller Architecture Programming and Application, third Edition, Penram International Publishers

Web Resources

1. **http://duino4projects.com/projects/medical-health-based-projects/**

Course Code	Course Title	L	T	P	C
1151BM110	Digital Signal Processing	2	2	0	3

a) Course Category

Program core

b) Preamble

Biomedical Engineering deals with signals from human body which has to be processed to get useful output. Current technology processes everything in digital. This course provides basic knowledge on preprocessing algorithms like filtering and processors which are used to implement the same

c) Prerequisite

Signals and Systems

d) Related Courses

Microprocessor and Microcontroller, Image Processing

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Compute DFT and FFT of the given signal	K3
CO2	Design FIR filter for the given specification	K3
CO3	Design IIR filter for the given specification	K3
CO4	Compare the architecture of microcontroller and Digital Signal Processor	K2
CO5	Write DSP coding for basic DSP algorithms	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L										M	
CO2	H	M	M	M									M	

CO3	H	M	L									M	
CO4	H	M	L									M	
CO5		M	L		M							M	

f) Course content

UNIT-I Fast Fourier Transform **12**

Discrete Fourier Transform, (DFT), DFT for periodic sequence, Fast Fourier Transform (FFT), Butterfly Diagram, Convolution through FFT

UNIT-II Design of FIR Filters **12**

FIR design: Windowing Techniques - Rectangular, Hamming, Hanning – Need and choice of windows – Linear phase characteristics.

UNIT-III Design of IIR Filters **12**

IIR design: Analog filter design - Butterworth filter design using impulse invariant and bilinear transformation - Warping, prewarping - Frequency transformation..

UNIT-IV DSP processor **12**

Architecture and features of TMS 320C55 signal processing chip , comparison between microprocessor and DSP processor Overview of instruction set and addressing modes of TMS 320C55

UNIT-V Programming TMS320C55x **12**

Implementation of Convolution algorithm, FIR Filter, IIR filter and FFT using TMS320C55x

Total: 60 Hrs

g) Learning Resources

Text Books

1. Proakis, J. G. and Manolakis, D. G "Digital Signal Processing Principles, Algorithms and Applications", Pearson Publishers, 2003

Reference Books

1. Mithrs S.K, "Digital Signal Processing –A Computer Based Approach, Tata McGraw Hill Publications, New Delhi 2001
2. Douglas K.Lindner, "Signals and Systems", McGraw-Hill International, 1999.
3. Allan V. Oppenheim et al, "Signals and Systems", 2nd edition, Prentice Hall of India Pvt. Ltd, 2004

Course Code	Course Title	L	T	P	C
1151BM111	Bio Medical Instrumentation	3	0	0	3

a) Course Category

Program core

b) Preamble

To make the student to acquire knowledge on how to record and measure bio signals and to design bio amplifiers.

c) Prerequisite

Analog Electronics and Integrated Circuits

d) Related Courses

Bio transducers and sensors.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Compare the different types of electrodes and draw its equivalent circuit.	K2
CO2	Explain how record the various bio signals.	K2
CO3	Design amplifiers used for measuring biosignals.	K3
CO4	Explain the importance of Bio safety	K2
CO5	Explain the Bio chemical measurements	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L											M	M
CO2	H	L											M	M
CO3	H	M	M	M									M	M
CO4	H	L											M	M
CO5	H	L											M	M

f) Course content

UNIT I BIO POTENTIAL ELECTRODES 9

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half cell potential, impedance, polarization effects of electrode – nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.

UNIT II BIO SIGNAL RECORDING 10

ECG: origin, waveforms and their characteristics, Einthoven triangle, lead configurations, electrocardiograph, 12 lead ECG machine circuit, common mode and interference reduction circuits, Vector cardiograph, Recording of EMG, EEG : origin, waveforms and their characteristics, 10-20 electrode placement system, Electro encephalogram, Magneto encephalogram, EOG & ERG: origin, measurement of EOG, electroretinogram, Heart sounds: origin, phonocardiography.

UNIT III BIO AMPLIFIERS 9

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. Chopper amplifier. Power line interference.

UNIT IV BIO ANALITICAL EQUIPMENTS AND PATIENT SAFETY 10

Blood cell counters –microscopic method, automatic optical, method, coulter counter,automatic recognition and differential counting of cells, flow cytometer, Selective ion electrodes, ion analyzer, Electric shock hazards, micro current shock, leakage currents, Precautions to minimize electric hazards, safety codes for electro medical equipment, electrical safety analyzer.

UNIT V BIO CHEMICAL MEASUREMENTS 7

pH, pco2, po2, - calorimeter, spectrophotometer, flame photometer. Autoanalyser

Total:45 Hrs.

g) Learning Resources

Text Books

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2004.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, New Delhi, 2003.(Units II & IV)

Reference Books

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi, 2007. 2. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003. 3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.

Course Code	Course Title	L	T	P	C
1151BM112	Diagnostic and Therapeutic Equipments- 1	3	0	0	3

a) Course Category

Program core

b) Preamble

This course deals with the medical devices used for the measurement of parameters related to cardiology, neurology and the methods of continuous monitoring and transmitting them

c) Prerequisite

None

d) Related Courses

Bio medical Instrumentation and Radiological Equipments.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the concepts of various respiratory measurement techniques.	K2
CO2	Explain the concept and application of Diathermy	K2
CO3	Explain the concept and application of Ultrasound devices	K2
CO4	Explain the importance of various patient monitoring devices and biotelemetry	K2
CO5	Describe about the extra corporeal devices	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L			M	M	L				M		M
CO2	H	L	L			M	M	L				M		M
CO3	H	L	L			M	M	L				M		M
CO4	H	L	L			M	M	L				M		M
CO5	H	L	L			M	M	L				M		M

f) Course content

UNIT I Respiratory Measurement System 10

Mechanics of respiration, artificial ventilation, ventilators, types of ventilators, ventilator terms, classification of ventilators, pressure-volume-flow diagrams, modren ventilators, high frequency ventilators, humidifiers, nebulizers and aspirators. Pulmonary function measurements, spirometry, measurement of volume, pulmonary function analysers, respiratory gas analysers. Anaesthesia- Need for anaesthesia, anaesthesia machine, electronics in the anesthesia machine.

UNIT II Diathermy 9

Priciple of Surgical diathermy, surgical diathermy machine, surgical diathermy analysers. High frequency heat theraphy, short wave diathermy, micro wave diathermy, ultrasonic theraphy unit, Electrodiagnostic apparatus, pain relif through electrical stimualtion, diaphragm pacing by radio frequency for the treatment of chronic ventilatory insuffiency, bladder stimulators, cerebellar stimulators.

UNIT III Ultrasonic Technique 9

Diagnostic Ultrasound, physics of ultrasonic waves, medical ultrasound, basic pulse-echo apparatus, A- Scan, Echocardiograph (M-Mode), B- Scanner, Real time ultrasonic imaging systems, Multi Element linear array scanners, Digital Scan converter, Biological effects of ultrasound

UNIT IV Patient monitoring and biotelemetry 9

Patient monitoring systems- System concepts, Cardiac monitor, Bedside patient monitoring systems, central monitors, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiration rate, catheterization laboratory instrumentation. Telemetry- wireless, single channel, multi channel, Multiple patient telemetry, implantable telemetry system, Transmission of analog physiological signals, telemedicine

UNIT V Extra Corporeal Devices and Special Diagnostic Equipments 8

Haemodialysis Machines- Function of Kidneys, Artificial Kidney, Dialyzers, Membranes for Haemodialysis, Haemodialysis machine, Portable kidney machines. Lithotriptors- Introduction, First lithotriptor machine, Modern Lithotriptor System. Heart-lung machine, Oxygenator

Total:45 Hrs.

g) Learning Resources

Text Books

1. Handbook of Bio-Medical Instrumentation, 2nd Edition – R. S. Khandpur

Reference Books

1. The Biomedical Engineering- Handbook. - IEEE Press.

Course Code	Course Title	L	T	P	C
1151BM113	**Digital Electronics**	**3**	**0**	**0**	**3**

a) Course Category

Program core

b) Preamble

To understand the basics of the Digital systems

c) Prerequisite

None

d) Related Courses

Microprocessor and Microcontroller.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the basic digital logic circuits and number system.	K2
CO2	Explain the concept of circuit simplification using gates	K2
CO3	Explain the concept of filp flops.	K2
CO4	Explain the concept of counters	K2
CO5	Analyze important types of signal conversion	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L										L	
CO2	H	L	L										L	
CO3	H	L	L										L	
CO4	H	M	L										L	
CO5	H	L	L										L	

f) Course content

UNIT I Number system & Boolean algebra **9**

Number system; Base conversion methods; compliments- 1's and 2's compliment; Codes- BCD- 2421- Excess 3- Gray and ASCII; [Error detection and Error Correction using Hamming Code] Boolean Algebra: Basic theorems and properties- Boolean laws and De-Morgan's theorem; Canonical & Standard form; Introduction to logic gates; Boolean algebraic simplification and realizing using logic gates.

UNIT II Gate level minimization & Combinational logic **9**

Gate-level minimization: Introduction to Map Method- Three, four and five variable maps; Don't care conditions; Universal gate implementation. Combinational Logic: Introduction; Arithmetic circuits; Comparators; Decoders and encoders; Multiplexers and De-multiplexers.

UNIT III Sequential Machine Fundamentals **9**

Fundamentals of sequential machine operation; Storage elements- Latches & Flip-flops (D-Flip-flop, T-Flip-flop, J-K flip-flop and Clocked flip-flops); ROM; RAM; Programmable logic array and programmable array logic

UNIT IV Sequential Circuit Design & Analysis **9**

Counters-Design of single mod counter- ripple counter- ring counters; Registers- Shift register sequences. State Diagram; Approaches to the design of synchronous sequential finite state machines (ASM); State reduction steps.

UNIT V Signal Conversion **9**

A/D and D/A converters: Weighted-resistor D/A converter; R-2R Ladder D/A converter; Parallel comparator A/D converter; Successive-approximation A/D converter.

Total: 45 Hrs.

g) Learning Resources

Text Books

1. M. Morris Mano- Digital Design- pearson- fourth edition

Reference Books

1. Donald P Leach- Digital principles and applications-pearson- seventh edition

Course Code	Course Title	L	T	P	C
1151BM114	Diagnostic and Therapeutic Equipments - II	3	0	0	3

a) Course Category

Program core

b) Preamble

To make the student to acquire knowledge on the various medical equipments.

c) Prerequisite

Diagnostic and Therapeutic Equipments - I

d) Related Courses

Bio Medical Instrumentation, Radiological Equipments.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the cardiac equipment's for adult and foetal	K2
CO2	Explain the different methods for measuring physiological parameters	K2
CO3	Explain basic assist devices for rehabilitation	K2
CO4	Study automated drug delivery system	K2
CO5	Explain different applications of laser in biomedical	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L													
CO2	L	L												
CO3	L													L
CO4		L												L
CO5	L													

f) Course content

UNIT I CARDIAC EQUIPMENTS **12**

Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, Plethysmography. Cardiac Pacemaker- Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External.

Cardiotocograph, Methods of Monitoring Foetal Heart Rate, Monitoring Labour Activity, Recording System.

UNIT II OXIMETERS AND SENSORY MEASUREMENTS 9

Oximetry, Ear Oximeter, Pulse Oximeter, Skin Reflectance Oximeters,Intravascular Oximeter. Psycho Physiological Measurements - for testing sensory Responses, Electro occulograph, Electro retinograph, Audiometer-Pure tone, Speech. EGG (Electrogastrograph), galvanic skin resistance(GSR).

UNIT III ASSIST DEVICES 9

Common tests – audiograms, airconduction, bone conduction, masking techniques, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids. Hand and arm replacement – different types of models, externally powered upper limb prosthesis, feedback in orthodic system, functional electrical stimulation.

UNIT IV AUTOMATED DRUG DELIVERY SYSTEMS 6

Infusion Pumps, Components of Drugs Infusion Systems, Implantable Infusion Systems, Closed-loop Control in Infusion Systems, Examples of Typical Infusion Pumps.

UNIT V LASER APPLICATIONS IN BIOMEDICAL 9

The Laser-introduction, Pulsed Ruby Laser, Nd-YAG Laser, Helium-Neon Laser, Argon Laser, CO2 Laser, Excimer Lasers, Semiconductor Lasers, Laser Safety.

Total 45 Hrs.

g) Learning Resources

Text Books

1. R S Khandpur, “Handbook of Bio-Medical Instrumentation”, 3rd Edition, McGraw Hill Education (India) Private Limited, 2014
2. Anthony Y K Chan, “Biomedical Device Technology: Principles and Design”, 1st Edition, Charles C Thomas Publisher Ltd, 2008

Reference Books

1. R S Khandpur, “Compendium of Biomedical Instrumentation”, 1st Edition, John Wiley & Sons Ltd, 2020
2. Joseph J. Carr, John M. Brown, “Introduction to Biomedical Equipment Technology”, 4th Edition, 2008

Course Code	Course Title	L	T	P	C
1151BM115	Radiological Equipment	3	0	0	3

a) Course Category
Program core

b) Preamble
The course gives the basic knowledge on how radiological equipment are used for measuring physiological parameters and what are the safety measures need to be followed

c) Prerequisite
Basic Physics

d) Related Courses
Bio Sensors and Transducers, Bio-Medical Instrumentation

e) Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the production of X rays and its various components	K2
CO2	Explain how X rays are used for sectional imaging.	K2
CO3	Explain the underlying principles of NMR and its components.	K2
CO4	Describe the application of radionuclides in medical field	K2

CO5	Explain how body heat can be used as a diagnostic tool	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L												
CO2	M	L				L								
CO3	M	L				L								
CO4	L	L				L							L	
CO5	L	L				L								L

f) Course content

UNIT I DIAGNOSTIC X RAYS 9

Production of X-Rays – X-ray tubes, Visualization of x-rays – Fluorescent screen, Image intensifiers – construction and working principle. Digital radiography

UNIT II X-RAY COMPUTED TOMOGRAPHY 9

Principles of sectional imaging – scanner configurations, line integrals, projection sets. Image reconstruction techniques – overview of back projection and iteration methods

UNIT III MAGNETIC RESONANCE IMAGING 9

Principles of MRI – interaction of nuclei and static magnetic field and radio frequency wave, rotation and precision, induction of magnetic resonance signal, bulk magnetization. Components of MRI – Magnets, magnetic field gradients, RF system, transmit and receive coils, receiver and detection system.

UNIT IV NUCLEAR MEDICINE 9

Types of radioactive decay, Radiation detectors – gas detectors, Scintillation detectors, Semiconductor detectors. Gamma camera – principle of operation, Radiopharmaceuticals, Principles of PET and SPECT.

UNIT V THERMOGRAPHY 9

IR imaging system – pyroelectric imaging system, temperature measurement. Clinical thermography – physiological factors, applications.

Total: 45 Hrs.

g) Learning Resources

Text Books

1. Steve webb, The Physics of Medical Imaging, Adam Hilger, Philadelpia, 1988.

Reference Books

1. Gopal B. Saha "Physics and Radiobiology of Nuclear Medicine"- Third edition Springer, 2006.
2. B.H.Brown, PV Lawford, R H Small wood , D R Hose, D C Barber, "Medical physics and biomedical Engineering", - CRC Press, 1999.
3. Myer Kutz, "Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003.
4. P.Ragunathan, "Magnetic Resonance Imaging and Spectroscopy in Medicine

Course Code	Course Title	L	T	P	C
1151BM116	Diagnostic and Therapeutic Equipments- 1	3	0	0	3

a) Course Category

Program core

b) Preamble

This course deals with the medical devices used for the measurement of parameters related to cardiology, neurology and the methods of continuous monitoring and transmitting them

c) Prerequisite

None

d) Related Courses

Bio medical Instrumentation and Radiological Equipments.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the concepts of various respiratory measurement techniques.	K2
CO2	Explain the concept and application of Diathermy	K2
CO3	Explain the concept and application of Ultrasound devices	K2
CO4	Explain the importance of various patient monitoring devices	K2
CO5	Describe about the extra corporeal devices	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	L			M	M	L				M		M
CO2	H	L	L			M	M	L				M		M
CO3	H	L	L			M	M	L				M		M
CO4	H	L	L			M	M	L				M		M
CO5	H	L	L			M	M	L				M		M

f) Course content

UNIT I Respiratory Measurement System **9**

Mechanics of respiration, artificial ventilation, ventilators, types of ventilators, ventilator terms, classification of ventilators, pressure-volume-flow diagrams, modern ventilators, high frequency ventilators, humidifiers, nebulizers and aspirators. Pulmonary function measurements, spirometry, measurement of volume, pulmonary function analyzers, respiratory gas analyzers. Anesthesia- Need for anesthesia, anesthesia machine, electronics in the anesthesia machine.

UNIT II Diathermy **9**

Principle of Surgical diathermy, surgical diathermy machine, surgical diathermy analyzers. High frequency heat therapy, short wave diathermy, micro wave diathermy, ultrasonic therapy unit, Electrodiagnostic apparatus, pain relief through electrical stimulation, diaphragm pacing by radio frequency for the treatment of chronic ventilatory insuffiency, bladder stimulators, cerebellar stimulators.

UNIT III Ultrasonic Technique **9**

Diagnostic Ultrasound, physics of ultrasonic waves, medical ultrasound, basic pulse-echo apparatus, A- Scan, Echocardiograph (M-Mode), B- Scanner, Real time ultrasonic imaging systems, Multi Element linear array scanners, Digital Scan converter, Biological effects of ultrasound

UNIT IV Patient monitoring **9**

Patient monitoring systems- System concepts, Cardiac monitor, Bedside patient monitoring systems, central monitors, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiration rate, catheterization laboratory instrumentation.

UNIT V Extra Corporeal Devices and Special Diagnostic Equipments **9**

Haemodialysis Machines- Function of Kidneys, Artificial Kidney, Dialyzers, Membranes for Haemodialysis, Haemodialysis machine, Portable kidney machines. Lithotriptors- Introduction, First lithotriptor machine, Modern Lithotriptor System. Heart-lung machine, Oxygenator

Total:45 Hrs.

g) Learning Resources

Text Books

1. Handbook of Bio-Medical Instrumentation, 2nd Edition – R. S. Khandpur

Reference Books

1. The Biomedical Engineering- Handbook. - IEEE Press.

Course Code	Course Title	L	T	P	C
1151BM117	**Diagnostic and Therapeutic Equipments - II**	**3**	**0**	**0**	**3**

a) Course Category

Program core

b) Preamble

To make the student to acquire knowledge on the various medical equipments.

c) Prerequisite

Diagnostic and Therapeutic Equipments - I

d) Related Courses

Bio Medical Instrumentation, Radiological Equipments.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Differentiate the various cardiac equipment used in healthcare domain	K2
CO2	Classify the different types of infusion pumps	K2
CO3	Outline the basic assist devices for rehabilitation	K2
CO4	Outline the importance of telemetry systems and Electromagnetic Interference	K2
CO5	Summarize the different types of laser and its biomedical application	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L													
CO2	L	L												
CO3	L													L
CO4		L												L
CO5	L													

f) Course content

UNIT I CARDIAC EQUIPMENTS 12

Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Cardiac Pacemaker- Internal and External Pacemaker, Pacemaker Standard Codes, AC and DC Defibrillator

Cardiotocograph, Methods of Monitoring Foetal Heart Rate, Monitoring Labour Activity, Recording System.

UNIT II AUTOMATED DRUG DELIVERY SYSTEMS 6

Infusion Pumps, Components of Drugs Infusion Systems, Implantable Infusion Systems, Closed-loop Control in Infusion Systems, Examples of Typical Infusion Pumps.

UNIT III ASSIST DEVICES **9**

Common tests – audiograms, air conduction, bone conduction, masking techniques, Pure tone, Speech, Evoked response audiometry, Hearing aids – principles, DSP based hearing aids. Intra-aortic balloon pump, functional electrical stimulation, FES system controlled by electromyographic signal

UNIT IV TELEMETRY & EMI **10**

Telemetry- single-channel and multi-channel, radiotelemetry capsule, Transmission of analog physiological signals.

Electro Magnetic interference to medical electronic Equipment - Sources of EMI, EMI effects, EMI to Biomedical sensors and ECG equipment, IEC 60601

UNIT V Medical LASER **9**

The Laser-introduction, Pulsed Ruby Laser, Nd-YAG Laser, Helium-Neon Laser, Argon Laser- fibre-optic gastric photo-coagulator, CO2 Laser- Functional components of a surgical laser, Excimer Lasers, Semiconductor Lasers, Laser Safety.

Total: 45 Hrs.

g) Learning Resources

Text Books

1. R S Khandpur, "Handbook of Bio-Medical Instrumentation", 3rd Edition, McGraw Hill Education (India) Private Limited, 2014
2. Anthony Y K Chan, "Biomedical Device Technology: Principles and Design", 1st Edition, Charles C Thomas Publisher Ltd, 2008

Reference Books

1. R S Khandpur, "Compendium of Biomedical Instrumentation", 1st Edition, John Wiley & Sons Ltd, 2020
2. Joseph J. Carr, John M. Brown, "Introduction to Biomedical Equipment Technology", 4th Edition, 2008

Course Code	Course Title	L	T	P	C
1151BM201	**Pathology and Microbiology**	**2**	**0**	**2**	**3**

a) Course Category

Program core/Integrated

b) Preamble

To make the student to acquire knowledge on the structural and functional aspects of living organisms and to know the etiology and remedy in treating the pathological diseases

c) Prerequisite

Biology for Engineers

d) Related Courses

Biochemistry and Anatomy and Human Physiology.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Analyze structural and functional aspects of living organisms.	K2
CO2	Discuss the importance of public health.	K2
CO3	Explain the function of microscope	K2
CO4	Explain the growth of micro organisms	K2

CO5	Describe methods involved in treating the pathological diseases	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H			H	M			M				M		
CO2			M											
CO3		M			H		M							
CO4		H	M							H				
CO5	M			H						H				

f) Course content

UNIT I CELL DEGENERATION, REPAIR AND NEOPLASIA 6

Cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification, 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.

UNIT II FLUID AND HEMODYNAMIC DERRANGEMENTS 6

Edema, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas.

UNIT III MICROSCOPES 6

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.

UNIT IV MICROBIAL CULTURES 6

Morphological features and structural organization of bacteria, growth curve, identification of bacteria, culture media and its types , culture techniques and observation of culture.

UNIT V IMMUNOLOGY 6

Natural and artificial immunity, opsonization, phagocytosis, inflammation, Immune deficiency syndrome, antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused by bacteria, fungi, protozoa, virus and helminthes.

30 Hrs.

LIST OF EXPERIMENTS: 30 Hrs.

1. Urine physical and chemical examination (protein, reducing substances, ketones, bilirubin and blood)
2. Basic staining – Hematoxylin and eosin staining.
3. Special stains – cresyl fast Blue (CFV)- Trichrome – oil red O – PAS.
4. Simple stain.
5. Gram stain.
6. Bleeding time and clotting time.
7. Slides of malarial parasites, micro filaria and leishmania donovani.
8. Haematology slides of anemia and leukemia.

Total: 60 Hrs.

g) Learning Resources

Text Books

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2005 (Units I & II).
2. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2002 (Units III,IV & V).

Reference Books

1. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
2. Anthanarayanan & Panicker, "Microbiology" Orientblackswan, 2005.
3. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007

Course Code	Course Title	L	T	P	C
1151BM202	**Artificial Neural Networks**	**3**	**0**	**2**	**4**

a) Course Category

Program core/Integrated

b) Preamble

This course gives an introduction on classification using neural networks which is used in most biomedical applications.

c) Prerequisite

None

d) Related Courses

Brain Computer Interface, Image processing, Signal processing

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Represent given data in a neural network structure, and achieve the target by manual weight and bias updation	K2
CO2	Explain learning rules for neural nets.	K2
CO3	Apply the LMS algorithm for adaptive filtering.	K3
CO4	Achieve a target using back propagation network.	K3
CO5	Explain the difference in classifications using supervised and unsupervised techniques.	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H											H	L
CO2	H	M											H	L
CO3	H	M											H	M
CO4	M	L											M	M

CO5	M	M										H	L

f) Course content

UNIT I MODELS, FEEDBACKS AND ARCHITECTURE 9

Introduction to neural network-brain, benefits of neural net, Model of neuron, neural networks as directed graphs, Feedbacks, Network architecture – Single layer feed forward, multi-layer feed forward. Common activation functions, McCulloch Pitts neuron with examples – Logic gates.

UNIT II LEARNING PROCESS 9

Basic learning rules – Introduction, Error correction – delta rule, memory based, Hebbian – supervised and unsupervised rule, Competitive.
Fundamental learning paradigms: - learning process – supervised and unsupervised.

UNIT III SINGLE LAYER PERCEPTRON 9

Adaptive filtering problem, least mean square algorithm, perceptron convergence theorem, relation between the perceptron and Bayes classifier for a Gaussian environment.

UNIT IV MULTI LAYER PERCEPTRON 9

Back propagation algorithm- two passes, activation function, stopping criteria, summary. XOR problem

UNIT V RADIAL BASIS FUNCTION NETWORK 9

Interpolation problem, Radial basis function network, K-means clustering, Recursive least squares estimation of the weight vector, Design of support vector machines.

45 Hrs.

LIST OF EXPERIMENTS 30 Hrs.

1. Generation of Activation Functions
2. Mu-Culloch Pitts Neuron Simulation
3. Implementation of Logic gates using Hebb Learning rule
4. Training a network using Perceptron Learning rule.
5. Implementation of Gradient Descent algorithm
6. Implementation of ADALINE
7. Adaptive noise filtration using LMS algorithm
8. Backpropagation
9. K – means clustering
10. TOOLBOX practice examples

Total: 75 Hrs.

g) Learning Resources

Text Books

1. Simon Haykins, "Neural Networks and Learning Machines" ,3rd edition, Pearson publications.

Reference Books

1. Simon Haykins, "Neural Networks – A comprehensive foundation", 2nd Edition, Pearson Publications
2. Hagan, Demuth and Beale, "Neural network design", Vikas Publishing House Pvt Ltd., New Delhi, 2002
3. Freeman J.A., and Skapura B.M, "Neural Networks, Algorithms, Applications and Programming Techniques", Addison - Wesley, 2003.
4. Laurene Fausett, "Fundamentals of neural networks- Architectures, algorithms and applications", Prentice Hall, 1994

Web sources/videos:

1. https://in.mathworks.com/
2. https://towardsdatascience.com/
3. https://becominghuman.ai/

Course Code	Course Title	L	T	P	C
1151BM203	**Image Processing**	**3**	**0**	**2**	**4**

a) Course Category

Program core/Integrated

b) Preamble

To make the student to acquire knowledge on how images are processed digitally

c) Prerequisite

Signals and Systems.

d) Related Courses

Medical imaging, Digital signal processing.

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)

CO1	Describe how and image is acquired and how pixels are related with each other	K2
CO2	Explain how image enhancement is done both in Spatial and frequency domains	K2
CO3	Explain the different noise models applicable to image processing and discuss the various restoration methods and segmentation techniques.	K2
CO4	Compare and Explain the theory behind lossy and lossless image coding techniques under predictive and transform coding techniques	K2
CO5	Explain the methods for representing and describing the images	K2
CO6	Write MATLAB coding for basic image processing utilities	K3
CO7	Write MATLAB coding for applications of transform coding such as filtering	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L										L		L
CO2	H	L										L		L
CO3	H	L										L		L
CO4	H	L										L		L
CO5	H	L										L		L
CO6	L				H				L			M		L
CO7	L				H				L			M		L

f) Course content

UNIT I FUNDAMENTALS OF DIGITAL IMAGING 9

Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels – overview of mathematical tools

UNIT II IMAGE ENHANCEMENT 9

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..

UNIT III IMAGE RESTORATION AND IMAGE SEGMENTATION 9

Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering

Segmentation: Point detection – Line detection – Edge models and edge detection – Edge Linking and Boundary detection.

UNIT IV WAVELETS AND IMAGE COMPRESSION 9

Wavelets – Subband coding - Multiresolution expansions.

Compression: Fundamentals – Image Compression models – Bit-Plane Coding – Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding – Compression Standards – JPEG, JPEG 2000

UNIT V IMAGE REPRESENTATION AND RECOGNITION 9

Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments. Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

45 Hrs.

LIST OF EXPERIMENTS: **30 Hrs.**

1. Conversion between color spaces.
2. Histogram Equalization.
3. Filtering Technique.
4. Edge detection using Operators.
5. Wavelet Decomposition.
6. Image Compression.
7. Image Segmentation
8. Mini Project (Any Application).

Total: 75 Hrs.

g) Learning Resources

Text Books

1. Rafael C. Gonzales, Richard E. Woods, “Digital Image Processing”, Third Edition, Pearson Education, 2010.

Reference Books

1. Anil Jain K. “Fundamentals of Digital Image Processing”, PHI Learning Pvt. Ltd., 2011.
2. Willliam K Pratt, “Digital Image Processing”, John Willey, 2002.
3. Malay K. Pakhira, “Digital Image Processing and Pattern Recognition”, First Edition, PHI Learning Pvt. Ltd., 2011.

Course Code	Course Title	L	T	P	C
1151BM301	Biochemistry and Physiology Laboratory	0	0	2	1

a) Course Category

Program Core/ Laboratory

b) Preamble

Biomedical engineering deals with human physiological parameters. This course gives a hands on for understanding and quantifying the physiological parameters

c) Prerequisite

None

d) Related Courses

Bio Chemistry / Anatomy and Human Physiology

e) Course Outcomes

Upon successful completion of the course students will be able to

CO. Nos	Course outcome	Skill Level (Dave'sTaxonomy)
1	Measure physiological parameters to make a primary assessment of the sample	S2
2	Analyze a sample to know its contents	S2
3	Quantify the macromolecules present in a sample	S3
4	Demonstrate dissection to show important anatomical parts	S1

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L		M		M						M		M
CO2	H	M		M	M	M						M		M
CO3	H	M		M	M	M						M		M
CO4	H	L		L	L	M						L		L

LIST OF EXPERIMENTS

1. Blood Pressure Measurement
2. Hearing loss test
3. Blood grouping test

4. Bleeding and Clotting test
5. Qualitative Tests For Carbohydrates
6. Quantitative Tests For Carbohydrates
7. Qualitative analysis of proteins
8. Quantitative analysis of proteins
9. Separation of amino acids
10. Virtual dissection of arteries and vein
11. Virtual dissection to locate joints
12. Visual test

Total: 30 Hrs.

Course Code	Course Title	L	T	P	C
1151BM302	**Analog Electronics and Integrated Circuit Laboratory**	**0**	**0**	**2**	**1**

a) Course Category

Program Core/ Laboratory

b) Preamble

Biomedical engineering deals with designing of medical devices. This course gives a hands on for designing the amplifier and analog filters for medical devices

c) Prerequisite

Basic Electronics Engineering.

d) Related Courses

Sensors and Transducers, Circuit Theory, AEIC

e) Course Outcomes

Upon successful completion of the course students will be able to

CO. Nos	Course outcome	Skill Level (Dave'sTaxonomy)
1	Design and demonstrate the characteristic of basic electronics circuit basic amplifier circuit	S3
2	Design and demonstrate the characteristic of amplifier	S3
3	Design and demonstrate the function of different ICs	S3
4	Design and demonstrate the application of OP amp	S3
5	Design and demonstrate the working of multivibrator	S3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	M	L	L								M	
CO2	M	H	H	M	M								H	
CO3	M	M	M	M									M	
CO4	M	M	H	H	M								H	
CO5	M	L	H	M	M								H	

LIST OF EXPERIMENTS

1. Design and analysis of feedback amplifier hearing loss test
2. Zener regulator
3. Clipping and clamping circuit
4. Differential amplifier
5. RC oscillator
6. LC oscillator
7. Inverting and non inverting amplifier, comparator
8. Integrator and differentiator
9. Low pass filter and high pass filter
10. Schmitt trigger

11. Instrumentation amplifier
12. Multivibrator using IC 555

Total: 30 Hrs.

Course Code	Course Title	L	T	P	C
1151BM303	**Microprocessor and Microcontroller Laboratory**	**0**	**0**	**2**	**1**

a) Course Category

Program Core/ Laboratory

b) Preamble

Biomedical engineering deals with microprocessor and microcontroller for designing medical devices. This course gives hands on for programing micro-processor and microcontroller

c) Prerequisite

Digital Electronics

d) Related Courses

Digital Signal Processing

e) Course Outcomes

Upon successful completion of the course students will be able to

CO.Nos	Course outcome	Skill Level (Dave'sTaxonomy)
1	Write assembly language programming (ALP) for addressing modes of 8085, 8086, 8051	S2
2	Write ALP for various arithmetic logic operations of 8085	S2
3	Design and demonstrate sensor interfacing with 8051 microcontroller	S3
4	Demonstrate simple interfaces with 8051	S2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M			M								M	
CO2	M	M			M								M	
CO3	L	M	H	L	M			M	M	M			H	
CO4		M			M			M	M	M			H	

LIST OF EXPERIMENTS

1. Demonstration of addressing modes of 8085
2. 1's complement of 8 bit and 16 bit number using 8085
3. 2's complement of 8 bit and 16 bit number using 8085
4. Addition of two 8 bit and 16 bit number using 8085 microprocessor
5. Multiplication of 8 bit number using 8085
6. Division of 8 bit number using 8085
7. Traffic light control using emu8086
8. Interfacing of ADC with 8051 microcontroller
9. Interfacing of dual DAC with 8051 microcontroller
10. Interfacing of hex keypad with 8051 microcontroller
11. Seven segment display
12. 1's and 2's complement of 8 bit and 16 bit number

Total: 30 Hrs.

Course Code	Course Title	L	T	P	C
1151BM304	Digital Signal Processing Laboratory	0	0	2	1

a) Course Category

Program Core/ Laboratory

b) Preamble

Biomedical Engineering deals with signals from human body which has to be processed to get useful output. Current technology processes everything in digital. This course provides basic knowledge on preprocessing algorithms like filtering and processors which are used to implement the same

c) Prerequisite

Signals and Systems

d) Related Courses

Microprocessor and Microcontrollers, Image Processing

e) Course Outcomes

Upon successful completion of the course students will be able to

CO. Nos	Course outcome	Skill Level (Dave'sTaxonomy)
1	Generating different types of signal	S2
2	Analyze the signal	S2
3	Design filter for the EEG signal	S3
4	Comparing different filter configurations in GUI	S2
5	Write DSP coding in CCSTUDIO	S2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	M	L			M				L			L	M	L
CO2	M	L			M				L			L	M	L
CO3	H	M			M				L			L	H	L
CO4	M				M				L			L		L
CO5	H	M			H				L			L	M	L

LIST OF EXPERIMENTS

1. Waveform Generation
2. Basic operation on DT signal
3. Demonstration of sampling and aliasing
4. Spectrum estimation of EEG using FFT
5. Delta Frequency extraction from EEG
6. Classification of Brain Waves
7. Writing MATLAB filter coefficient to C header file
8. Comparing different filter configuration using DSP LIB GUI
9. Demonstration of Aliasing using MATLAB sound command
10. Creating file using CCSTUDIO for C6713 DSP processor

Total: 30 Hrs.

Course Code	Course Title	L	T	P	C

1151BM305	Biomedical Instrumentation Laboratory	0	0	2	1

a) Course Category

Program Core/ Laboratory

b) Preamble

Biomedical engineering deals with human physiology signals like ECG,EEG etc. This course gives a hands on for recording and measuring such waveforms for the diagnosis a

c) Prerequisite

Analog Electronics and Integrated Circuits laboratory.

d) Related Courses

Bio Medical Instrumentation.

e) Course Outcomes

Upon successful completion of the course students will be able to

CO. Nos	Course outcome	Skill Level (Dave'sTaxonomy)
1	Record the bio signals from various regions of the body	S2
2	Measure the bio signals.	S2
3	Design preamplifiers for measuring the bio signals in hardware and software.	S3
4	Measure non electrical parameters of the body.	S2
5	Demonstrate biofeedback system.	S3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	H	M	H							L	M	H
CO2	H	M	H	M	H							L	M	H
CO3	H	M	H	H	H							L	M	H
CO4	H	M	H	M	H							L	M	H
CO5	H	M	H	M	H							L	M	H

LIST OF EXPERIMENTS

1. Measurement of blood pressure
2. Design and testing of preamplifiers for various biomedical instruments

3. Development of ECG amplifiers and filters
4. Recording of ECG signal.
5. Measurement of respiratory parameters using spirometer
6. Recording of EMG-Signal
7. Recording of EEG-Signal.
8. Recording EEG with stimulus.
9. Heart sound measurement using PCG
10. Galvanic skin resistance (GSR) measurement

Total: 30 Hrs.

Course Code	Course Title	L	T	P	C
1152BM101	**Hospital Management**	**3**	**0**	**0**	**3**

a) Course Category
Programme Elective

b) Preamble
This course covers the conceptual and technical knowledge required to administer a hospital

c) Prerequisite
None

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Discuss the factors which differentiates the hospital administration from Industrial administration Comprehend and appreciate the significance and role of this course in the present contemporary world	K2
CO2	Explain how Human resource management is done in hospital environment Explain the principles, practices and areas of application in Hospital Management	K2
CO3	Apply various business strategies and behavioral models	K3
CO4	Discuss the role of different information systems and services in hospital environment	K2
CO5	Utilize the various quality and safety measure that has to be followed in hospital	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						M	L					H		
CO2								M	H		H	H		
CO3						H			M	H	H			
CO4						M		L			L			
CO5						H		M	L					

f) Course content

UNIT-I OVERVIEW OF HOSPITAL ADMINISTRATION 7

Distinction between Hospital and Industry, Challenges in Hospital Administration –Hospital Planning – Equipment Planning – Functional Planning - Current Issues in Hospital Management - Telemedicine - Bio-Medical Waste Management

UNIT-II HUMAN RESOURCE MANAGEMENT ON HOSPITAL 9

Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.

UNIT-III MARKETING RESEARCH & CONSUMER BEHAVIOUR 10

Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations - Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyer decision process - Model of business buyer behaviour - Major types of buying situations - global marketing in the medical sector.

UNIT-IV HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES 10

Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems – Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services.

UNIT-V QUALITY AND SAFETY ASPECTS IN HOSPITAL 9

Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO 13485, Environment Management Systems. NABA, JCI, NABL, NABH. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care - Medical Audit – Hazard and Safety in a hospital Setup.

Total: 45 Hrs.

g) Learning Resources

Text Books

1. R.C.Goyal, ―Hospital Administration and Human Resource Management‖, PHI –Fourth Edition, 2006
2. G.D.Kunders, ―Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007

References Books:

1. Cesar A.Caceres and Albert Zara, ―The Practice of Clinical Engineering, Academic Press, New York, 1977
2. Peter Berman ―Health Sector Reform in Developing Countries‖ - Harvard University Press
3. Health Care Management - Arnold D. Kalcizony & Stephen M. Shortell

Course Code	Course Title	L	T	P	C
1152BM102	Telehealth Technology	3	0	0	3

a. Course Category

Programme Elective

b. Preamble

This course helps the students to learn about the E Healthcare with their standards. Also this course gives the detail information about the security, transmission, and storage

c. Prerequisite

None

d. Related Courses

None

e. Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic principles of healthcare in telemedicine.	K2
CO2	Compare the different types of communication and networks	K2
CO3	Solve the ethical & legal issues involved in telemedicine.	K3
CO4	Apply the different types of data storage and communication standards used in telehealth system.	K3
CO5	Discuss the various applications of telemedicine.	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		**M**			**M**								
CO2	H		**L**			**H**								
CO3	L		**L**			**L**								
CO4	H		**L**			**H**								
CO5	H		**L**			**H**								

f. Course content

UNIT I History and Fundamentals of Telemedicine 9

History and Evolution of telemedicine, definition of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, benefits & limitations of telemedicine, Introduction of Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II Communication & Network 9

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Amplitude Modulation (Qualitative Analysis), Communication infrastructure for telemedicine – LAN and WAN technology.

UNIT III Ethical and legal aspects of Telemedicine 9

Ethical and legal aspects of Telemedicine (Case study) - Confidentiality, Social and legal issues (Case Study), Safety and regulatory issues (Case Study), the patient-doctor relationship, access to medical records, consent treatment - data protection & security.

UNIT IV Picture Archiving and Communication System 9

Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication.

UNIT V Applications of Telemedicine 9

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health care.

Total: 45 Hrs.

g. Learning Resources

Textbooks

1. Olga Ferrer-Roca, M.Sosa Ludicissa, “Handbook of Telemedicine”, IOS press 2002.
2. Norris A.C, “Essentials of Telemedicine and Telecare”, John Wiley & Sons, 2002.
3. Wootton R, Craig J, Patterson, “Introduction to Telemedicine” Royal Society of Medicine Press Ltd., (2nd ed.), 2006.

References Books:

1. Maheu M.M, Whitten P, Allen A, “E-Health, Telehealth, and Telemedicine” Jossy-Bass, 2001.
2. Keith J, Dreyer, David S, Hirschron, James Thrall H, Amit Mehta, PACS: “AGuide to the Digital Revolution”, 2nd Edition, Springer
3. Huang H K, “PACS and imaging informatics – Basic Principles & application”, Wiley-Blackwell
4. Latifi R, “Current Principles and Practices of Telemedicine and e-Health”. Washington DC: IOHS , 2008.
5. Bashshur R L, Shannon G W, “History of Telemedicine”. New Rochelle. NY, Mary Ann Liebert Publishers, 2009.

Course Code	Course Title	L	T	P	C
1152BM103	Medical Ethics	3	0	0	3

a. Course Category

Programme Elective

b. Preamble

- To achieve familiarity with some basic ethical framework& understand how these ethical frame works can help us to think through contemporary questions in medical ethics.
- To know about the legal and ethical principles and application of these in medical field.
- Gain knowledge about the medical standards that to be followed in hospitals

c. Prerequisite

None

d. Related Courses

None

e. Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the ethical codes applicable to hospitals.	K2
CO2	Apply the moral values and ethics in their work environment	K2
CO3	Maintain the confidentiality issues in medical practice.	K2
CO4	Choose and apply relevant standards.	K2
CO5	Explain the ethics in maintenance and disposal of equipments and materials in hospital use.	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L					M		H						
CO2	L					M		H						
CO3	L					L		H						
CO4	L					M		M						
CO5	L					H		H						

f. Course content

UNIT I INTRODUCTION TO MEDICAL ETHICS 9

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.

UNIT II ETHICAL THEORIES & MORAL PRINCIPLES 9

Theories-Deontology & Utilitarianism, Casuist theory, Virtue theory, The Right Theory. Principles - Non-Maleficence, Beneficence, Autonomy, Veracity, Justice.

UNIT III ETHICAL ISSUES 9

Autonomy & Confidentiality issues in medical practice, Ethical Issues in biomedical research, Bioethical issues in Human Genetics & Reproductive Medicine.

UNIT IV HOSPITAL ACCREDITATION AND SAFETY STANDARDS 9

Hospital accreditation standards, Accreditation- JCI Accreditation & its Policies. Patient centered standards, Healthcare Organization management standards.

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.

UNIT V WASTE AND SAFETY MANAGEMENT 9

Managing Hazardous Material and Waste, Maintaining Fire Safety Equipment, Features, Testing, Maintaining, and Inspecting Medical Equipment.

Total : 45 Hrs.

g. Learning Resources

Text Books

1. Domiel A Vallero “Biomedical Ethics for Engineers”, Elsevier Pub.1st edition, 2007

References Books:

1. 1. Biomedical Ethics: A Canadian Focus. Johnna Fisher (ed.), Oxford University Press Canada. 2009
2. 2. Robert M Veatch" Basics of Bio Ethics", Second Edition. Prentice- Hall,Inc. 2003

Course Code	Course Title	L	T	P	C
1152BM104	Body Area Networks	3	0	0	3

a. Course Category

Program Elective

b. Preamble

This course will help the students to understand about body area networks along with the various hardwares used and their applications.

c. Prerequisite

Analog and Digital Communication

d. Related Courses

None

e. Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain about working of Body Area Network	K2
CO2	Explain the hardware used for BAN with LAN/WAN	K2
CO3	Explain the wireless communication infrastructure used for BAN.	K2
CO4	Discuss the technical challenges involved in BAN	K2
CO5	Brief on the applications of BAN.	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L											L	
CO2	L													
CO3	L													
CO4		L												
CO5	L	M											M	

f. Course content

UNIT I INTRODUCTION 9

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BSN Architecture –Introduction

UNIT II HARDWARE FOR BAN 9

Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT III WIRELESS COMMUNICATION AND NETWORK 9

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1, IEEE P802.15.3, IEEE 802.15.4, Zigbee

UNIT IV COEXISTENCE ISSUES WITH BAN 9

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self protection-Bacterial attacks, Virus infection ,Secured protocols, Self protection.

UNIT V APPLICATIONS OF BAN 9

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhymia monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.

Total: 45 Hrs.

g. Learning Resources

Text Books

1. Annalisa Bonfiglio, Danilo De Rossi ,"Wearable Monitoring Systems", Springer, 2011

2. Sandeep K.S. Gupta,Tridib Mukherjee,Krishna Kumar Venkatasubramanian, “Body Area Networks Safety, Security, and Sustainability”, Cambridge University Press, 2013.
3. Guang-Zhong Yang, “Body Sensor Newtorks”, Springer, 2006

Course Code	Course Title	L	T	P	C
1152BM105	Introduction To Nanotechnology	3	0	0	3

a) Course Category

Program Elective

b) Preamble

The course introduces the underlying principles and applications of the emerging field of nanotechnology. It introduces tools and principles relevant at the nanoscale dimensions. Also it discusses current and future nanotechnology applications in biomedical engineering and electronics.

c) Prerequisite

Basic physics and material science.

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain about the underlying principles in nanotechnology	K2
CO2	Explain nanomaterials synthesis processes and fabrication techniques	K2
CO3	Explain different nanomaterial characterization techniques	K2
CO4	Describe the application of nanotechnology in biomedical engineering	K2
CO5	Describe the usage of nanotechnology in electronics	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	L	L			L							
CO2	M	M	L	H				H						
CO3	M	M	M	M										
CO4	M	M	M	H			M	M						
CO5	M	M	M	H			M	M						

f) Course content

UNIT I INTRODUCTION 9

History, background scope and interdisciplinary nature of nanotechnology, scientific revolutions, nano sized effects surface to volume ratio, crystal structure, atomic structure, molecules and phases, energy bands - insulators, semiconductors and conductors, Nanoscale - molecular and atomic size, quantum effects.

UNIT II NANOMATERIALS SYNTHESIS 9

Synthesis and nanofabrication, Bottom-Up and Top-Down approach with examples. Chemical Methods - Precipitation Method, Sol-Gel Method, Sonochemical Synthesis, Hydrothermal, Thermal Decomposition Process. Physical Methods - Ball milling, Physical Vapor deposition (PVD), Chemical Vapor deposition (CVD), Sputter Deposition, Lithography techniques. Biological methods - Synthesis using micro-organisms and bacteria, Synthesis using plant extract, use of proteins and DNA templates.

UNIT III MATERIAL CHARACTERIZATION TECHNIQUES 9

Compositional and Structural Characterization techniques: X-ray, Principles and applications of X-ray diffraction; electron diffraction, Surface characterization Techniques - High resolution microscopy; Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM). Spectroscopic techniques: Fourier Transform infrared (FTIR) spectroscopy, Raman spectroscopy techniques.

UNIT IV NANO IN BIOMEDICAL APPLICATIONS 9

Introduction, Biological building blocks - size of building blocks and nanostructures, Nanomaterials in drug delivery and therapeutics, Nanomedicine, Targeted nanoparticles for imaging and therapeutics

UNIT V NANO IN ELECTRONICS APPLICATIONS 9

Introduction, Electronic structure of Nanocrystals, Tuning the Band gap of Nanoscale semiconductors, Excitons, Quantum dot, Single electron devices, Nanostructured ferromagnetism, Effect of bulk nano-structuring of magnetic properties, Dynamics of nanomagnets, Nanocarbon ferro-magnets, Giant and colossal magnetoresistance, Introduction of spintronics, Spintronics devices and applications.

Total: 45 Hrs.

g) Learning Resources

Text Books

1. T. Pradeep , “NANO The Essential , understanding Nanoscience and Nanotechnology”. Tata McGraw-Hill Publishing Company Limited, 2007.
2. Introduction to Nanotechnology, Charles P. poole jr. and frank J.Owens, wiley interscience.
3. The Chemistry of nanomaterials: Synthesis, Properties and Applications, Vol-I by C.N.R. Rao, A. Muller and A.K. Cheetham
4. Fundamentals of Nanoelectronics by George W. Hanson (Pearson Education, New Delhi)

Course Code	Course Title	L	T	P	C
1152BM106	Rehabilitation Engineering	3	0	0	3

a) Course Category

Programme Elective

b) Preamble

Rehabilitation engineering will provide knowledge to design rehabilitation aid and apply them with confidence to help the challenged people.

c) Prerequisite

Engineering Mechanics

d) Related Courses

DTE

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the need of Rehabilitation Engineering	**K2**
CO2	Explain different types of Therapeutic Exercise Techniques	**K2**
CO3	Design of various orthotic & prosthetic devices in healthcare	**K3**
CO4	Explain the various assistive technology used for vision	**K2**
CO5	Design of different types of Hearing and Speech aids	**K3**

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		M			L		M	L			L		H
CO2	H		H	L		M	M					L		H

CO3	L		H		M	H	H	M				L		M
CO4	H		L		M	H	H	M				L		M
CO5	H		H		M	H	H	M				L		L

f) Course content

UNIT I INTRODUCTION TO REHABILITATION ENGINNERING 9

What is Rehabilitation, Medical Rehabilitation, Preventive Rehabilitation, Impairment disability and handicap, Sociovocational Rehabilitation, Rehabilitation team, Delivery of Rehabilitation care, Community Based Rehabilitation (CBR).

UNIT II THERAPEUTIC EXERCISE TECHNIQUE 9

Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.

UNIT III - ORTHOTIC & PROSTHETIC DEVICES 9

Anatomy of upper & lower extremities, Classification of amputation types, Prosthesis, Components of upper limb prosthesis, Fabrication of prosthesis, Components of lower limb prosthesis ,Orthoses, types – Lower extremity- and upper extremity orthoses .

UNIT IV – VISUAL AIDS 9

Anatomy of eye, Categories of visual impairment, Cortical & retinal implants,
Ultrasonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers.

UNIT V AUDITORY AND SPEECH ASSIST DEVICES 9

Anatomy of ear, Types of deafness, hearing aids, application of DSP in hearing aids, Cochlear implants, Voice synthesizer, speech trainer.

Total: 45 Hrs.

g) Learning Resources

Text books:

2. Sunder 'Textbook of Rehabilitation', Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007
3. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third edition-3 volume set, Taylor & Francis, 2006
4. Rory A Cooper, Hisaichi Ohnabe, Douglas A Hodson, "An Introduction to Rehabilitation Engineering", CRC Press, First edition, 2006.

References 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.
3. Warren E. Finn,Peter G. LoPresti; Handbook of Neuroprosthetic Methods CRC; edition 2002.
4. Levine.S.N.Editor, Advances in Bio Medical Engineering and Medical Physics, Inter University Publication, New York 1968.
5. Albert M.Cook and Webster J.G, Therapeutic Medical devices, Prentice Hall Inc., NewJersy,1982.
6. Reswick.J, What is Rehabilitation Engineering, Annual review of Rehabilitation-volume2, Springer-Verlag, New York 1982.

Course Code	Course Title	L	T	P	C
1152BM107	**Robotics in Medicine**	**3**	**0**	**0**	**3**

a) Course Category:
Program Elective

b) Preamble
This course helps the students to learn about the medical robots with their applications. Also this course gives the detail information about the design methodology in health care application.

c) Prerequisite
None.

d) Related Courses
Engineering mechanics

e) Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the various types of robot in health care application	K2
CO2	Describe and compare the various types of tracking mechanisms for medical robot	K2
CO3	Apply how robots actively coordinate in surgical system.	K3
CO4	Discuss the appropriate design methodology of medical robots based on their application.	K2
CO5	Identify the working principle of Assistive robots.	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L													
CO2	M	L	M	L		L						M		
CO3	M	L	M	L								M		
CO4	H	M	M	M								M		
CO5	M		L									M		

f) Course content

UNIT I INTRODUCTION 7

Types of medical robots - Navigation - Motion Replication - Imaging - Rehabilitation and Prosthetics - State of art of robotics in the field of healthcare.

UNIT II LOCALIZATION AND TRACKING 8

Position sensors requirements - Tracking - Mechanical linkages - Optical - Sound-based - Electromagnetic - Impedance-based - In-bore MRI tracking - Video matching - Fiber optic tracking systems - Hybrid systems.

UNIT III SURGICAL ROBOTICS 10

Minimally invasive surgery and robotic integration – surgical robotic sub systems - synergistic control. Control Modes - Radiosurgery - Orthopedic Surgery - Urologic Surgery and Robotic Imaging - Cardiac Surgery – Neurosurgery – case studies.

UNIT IV R EHABILITATION & DESIGN OF MEDICAL ROBOTS 14

Rehabilitation for Limbs - Brain-Machine Interfaces - Steerable Needles – case studies, Characterization of gestures to the design of robots- Design methodologies- Technological choices- Security.

UNIT V ROBOTS IN MEDICAL CARE **6**

Assistive robots –types of assistive robots – case studies.

Total: 45 Hrs

g) Learning Resources

Text Books:

1. R.D.Lele, "Computers in medicine progress in medical informatics", Tata McGraw Hill Publishing Ltd, 2005 (Units I, III & IV).
2. Mohan Bansal, "Medical informatics", Tata McGraw Hill Publishing Ltd, 2003 (Units II, IV & V).

References Books:

1. Orpita Bosu and Simminder Kaur Thukral, "Bioinformatics Databases, Tools and Algorithms", Oxford University press, 2007.
2. Yi Ping Phoebe Chen, "Bioinformatics Technologies", Springer International Edition, New Delhi, 2007.

Course Code	Course Title	L	T	P	C
1152BM108	Biomedical Informatics	3	0	0	3

a) Course Category:
Program Elective

b) Preamble
This course gives an ability to learn ICT applications in medicine with an introduction to health informatics. Understand the theories and practices adopted in Hospital Information Systems in the light of medical standards, medical data formats and recent trends in Hospital Information Systems.

c) Prerequisite
None.

d) Related Courses
DICOM, Telehealth Technology

e) Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the concept of various types of informatics and its application	K2
CO2	Relate the different levels of medical standards	K2
CO3	Illustrate the basic structure and formats of medical storage	K2
CO4	Explain the models of informatics and databases	K2
CO5	Explain the recent trends and activities of informatics	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L													
CO2	M	L	M	L		L						M		
CO3	M	L	M	L								M		

CO4	H	M	M	M								M		
CO5	M		L									M		

f) Course content

UNIT I MEDICAL INFORMATICS **9**

Introduction – Medical Informatics – Bioinformatics – Health Informatics - Structure of Medical Informatics –Functional capabilities of Hospital Information System - On-line services and off – line services - Dialogue with the computer, Application.

UNIT II MEDICAL STANDARDS **9**

History and Evolution of Medical Standards – IEEE 11073 - HL7 – DICOM – IRMA - LOINC – HIPPA –Electronics Patient Records – Healthcare Standard Organizations – JCAHO (Joint Commission on Accreditation of Healthcare Organization) - JCIA (Joint Commission International Accreditation) - Evidence Based Medicine - Bioethics.

UNIT III MEDICAL DATA STORAGE AND AUTOMATION **9**

Representation of Data, Data modeling Techniques, Relational Hierarchical and network Approach, Normalization techniques for Data handling - Plug-in Data Acquisition and Control Boards – Data Acquisition using Serial Interface – Medical Data formats – Signal, Image and Video Formats – Medical Databases - Automation in clinical laboratories - Intelligent Laboratory Information System – PACS and its significances.

UNIT IV HEALTH INFORMATICS **9**

Bioinformatics Databases, Bio-information technologies, Semantic web and Bioinformatics, Genome projects, Clinical informatics, Nursing informatics, Public health informatics, Education and Training

UNIT V RECENT TRENDS IN MEDICAL INFORMATICS **9**

Medical Expert Systems, Virtual reality applications in medicine, Virtual Environment – Surgical simulation - Radiation therapy and planning – Telemedicine – virtual Hospitals - Smart Medical Homes – Personalized e-health services – Biometrics - GRID and Cloud Computing in Medicine.

Total: 45 Hrs

g) Learning Resources

Text Books:

1. R.D.Lele, “Computers in medicine progress in medical informatics”, Tata McGraw Hill Publishing Ltd, 2005 (Units I, III & IV).
2. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003 (Units II, IV & V).

References Books:

3. Orpita Bosu and Simminder Kaur Thukral, “Bioinformatics Databases, Tools and Algorithms”, Oxford University press, 2007.
4. Yi Ping Phoebe Chen, “Bioinformatics Technologies”, Springer International Edition, New Delhi, 2007.

Course Code	Course Title	L	T	P	C
1152BM109	Precision Healthcare Technology	3	0	0	3

a) Course Category:
Program Elective

b) Preamble
This course gives ability to approach the healthcare industry as a complex system, and apply relevant design and engineering principles and processes to advance improvements. It gives an insight to the science behind precision health innovations, ethical and patient related factors that cut across disciplines.It enables to understand policy positions within the healthcare sector, and novel informatics and IT fields that focus on health

c) Prerequisite
None.

d) Related Courses

Biomedical informatics, Telehealth Technology

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the concept of Precision medicines and Precision healthcare technology	K2
CO2	Explain howData science is applied for predictive analysis in health care	K2
CO3	Explain the molecular genetics and genetics in public health	K2
CO4	Explain how bioinformatics and machine learning is applied in medical sciences	K2
CO5	Explain the recent trends in consumer health informatics	K2

UNIT 1: PROGRESS AND CHALLENGES IN PRECISION MEDICINE 9

Introduction to Precision Medicine: Personalized medicine VS Precision medicine, Precision medicine in complex chronic disease-Precision medicine initiatives and Programs :The Role of electronic health record data-Small data, Big data and data analytics in precision healthcare technology-Mobile technology and EHRs in personalized healthcare technology:Role of mobile technology in diabetes control and other diseases,Remote patient monitoring.

UNIT 2: DATA SCIENCE AND PREDICTIVE HEALTH ANALYTICS 9

Data Science and Predictive Analytics-Scientific Methods for Health Sciences- Introduction to Health Informatics -Natural Language Processing on Health Data -Applied Biostatistics- Biostatistical Analysis for Health-Related Studies

UNIT3: HUMAN GENETICS IN HEALTH AND DISEASE/MOLECULAR MEDICINE 9

Molecular Genetics- Molecular Basis of Human Genetics in Disease - Biological Micro-and Nanotechnology-Advances in Tissue Engineering- Genetics in Public Health ,Genetic Epidemiology: The Role of Epigenetic in the developmental origins of health and disease, Methods in Genetic and Epigenetic Epidemiology - Principles of Nutritional Sciences

UNIT 4: BIOINFORMATICS AND COMPUTATIONAL GENOMICS 9

Foundations in Bioinformatics - Introduction to Bioinformatics & Computational Biology - Introduction to Signal Processing and Machine Learning in Biomedical Sciences -Managing Health Informatics- Machine Learning for Epidemiologic Analysis in the Era of Big Data

UNIT 5: CONSUMER HEALTH INFORMATICS AND HEALTHCARE SYSTEMS ENGINEERING FOR PRECISION HEALTH 9

Healthcare Operations Research: Theory and Applications-Knowledge Representation and Management in Health - Consumer Health Informatics -Health Infrastructures.

Total: 45 Hours

f) Reference Books:

1. Mukesh Verma; DebmalyaBarh .'Progress and Challenges in Precision Medicine', Saint Louis Elsevier Science 2017
2. PaulCerrato:John D Halamka."Realizing the Promise of precision medicine:the role of patient data,mobile technology and consumer engagement.London ,United Kingdom:Academic Press is an imprint of Elsevier,[2018].
3. Lisa F Berkman; Ichirō Kawachi ,"Social epidemiology",New York : Oxford University Press, ISBN Number:1012879385
4. **Peter Mc Caffrey,"An introduction to healthcare informatics building data-driven tools",Amsterdam:Academic press,2020.**
5. **PeterSpyns,"Natural language processing in medicine" Leuven Univ.Press 2000.**
6. Karin B Michels,"Epigenetic epidemiology",Dordrecht Springer,2012
7. Catherine Arnott Smith,"Consumer Health Informatics: Enabling Digital Health for Everyone", Alla Keselman ,2020

g) Web Resources:

1.https://medicine.umich.edu/dept/lhs/education/precision-health-graduate-certificate-program

2. https://www.wiley.com/en-us/Healthcare+Systems+Engineering-p-9781118971086

Course Code	Course Title	L	T	P	C
1152BM201	**Digital Imaging and Communication In Medicine**	**1**	**0**	**4**	**3**

a) Course Category

Program Elective/ Integrated

b) Preamble

This course gives an introduction to DICOM standards and will discuss the application of various imaging processing techniques to DICOM images.

c) Prerequisite

None

d) Related Courses

Image Processing

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the terminologies of DICOM and its standards.	K2
CO2	Demonstrate how medical images can be manipulated in DICOM	K2

CO3	Experiment with recent applications of DICOM	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		L		M	H		M	M	M		L		L
CO2	H	M	M		L		H	M		L		L		L
CO3	H	L	M	H	M	M		M				L		L

f) Course content

UNIT I INTRODUCTION TO DICOM **5**

What is DICOM? How does DICOM works, DICOM introduction and history, DICOM File Format, PACS, DICOM Security, DICOM Standards

UNIT II PREPROCESSING TECHNIQUE IN MEDICAL IMAGES **5**

Resize the Image, Conversion of Images, Noise addition, Noise Removal, Image Enhancement Technique.

UNIT III APPLICATIONS OF DICOM **5**

Image Registration, Image Fusion, Performance Evaluation, Image Compression

15 Hrs.

LIST OF EXPERIMENTS: **60 Hrs.**

1. Collection of dicom images
2. Read and display single and multiple images
3. Resizing of dicom image
4. Conversion of dicom image
5. Noise addition in dicom image
6. Noise removal using filteration in dicom image
7. Image enhancement
8. Histogram equalization
9. Image registration
10. Image fusion
11. Performance evaluation of image fusion
12. Image compression

Total:75 Hrs.

g) Learning Resources

Text Books

1. O.S Pianykh “Digital Imaging and Communication in Medicine (DICOM), Springer 2008.

Course Code	Course Title	L	T	P	C
1152BM202	Bio Signal Processing Instrumentation	1	0	4	3

a) Course Category
Program Elective/Integrated

b) Preamble
The course gives hands on experience to build their own simple signal processing medical devices to measure physiological parameters.

c) Prerequisite
Digital Signal Processing or Microprocessor and Microcontrollers

d) Related Courses
None

e) Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcome	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Write c code for port programing using MSP430	K3
CO2	Build ECG/EEG/EMG using MSP430 and interpret the waveform	K3
CO3	Describe the principles of ultrasonic and build simple application	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	M	H	H	M	M						L	H
CO2	L	L	M	H	H	M	M						L	H
CO3	L	L	M	H	H	M	M						L	H

f) Course Content

UNIT I MSP430G2553 **5**

16-bit low power MCU MSP430: Introduction to microcontrollers and embedded systems,Von Neumann and Harvard architecture, RISC and CISC machine, Introduction to MSP430: Architecture, Programming Techniques, Addressing Modes, Programming System registers and configuration I/O

ports pull up/down registers concepts, Configuring Peripherals in MSP430**,** interrupt programming, Timer/ counter interrupt, Programming MSP430 timer

UNIT II Electrocardiogram **5**
Working of heart, ECG waveform, AFE H/W, software flowchart,

UNIT III Ultrasound Imaging system **5**
Basics of ultrasound physics, Basic principle of ultrasound imaging, Ultrasund system block digram, Ultrasound DAQ, Digital ultrasound beam former, AFE5808A

15 Hrs.

LIST OF EXPERIMENTS: **60 Hrs.**

1. Creating Project using CCStudio for MSP430 board
2. Timer Mode 0 with MSP430
3. Timer Mode 1 with MSP430
4. Demonstration of GPIO interrupt (external button interrupt)
5. ADC programing using polling
6. ADC programing using interrupt
7. Multichannel ADC programing
8. Interfacing AD8232 with MSP430G2553
9. Interfacing SN 11574 with MSP430G2553
10. Temperature monitoring
11. Ultrasonic distance meter using MSP430G2553
12. Serial communication using UART
13. ECG simulation using MATLAB

Total: 75 Hrs.

g) Learning Resources

Text Books

1. https://circuitdigest.com/msp430-projects
2. TI Health Tech Applications Guide

Course Code	Course Title	L	T	P	C
1152BM203	**Brain Computer Interface**	**1**	**0**	**4**	**3**

a) Course Category
Programme Elective/Integrated

b) Preamble
This course helps to design the brain computer interface system using brain signals.

c) Prerequisite
None

d) Related Courses
Anatomy and Physiology of brain, Signals and systems and Digital signal processing

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the fundamentals and types of BCI	K2
CO2	Explain the different BCI signals input and stimulus design	K2
CO3	Explain the signal processing units of BCI	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L				L	L		L	M		L	L	L
CO2	H	M	L	L	L	L	L		L	M		L	M	L
CO3	H	M	M	M	M	L			M	M		L	H	L

f) Course content

UNIT-I Brain computer interface **5**

Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI, Brain signal acquisition systems- EEG, MEG, fNIRS, fMRI.

UNIT-II EEG features and stimulus design used in BCI **5**

EEG-Temporal characteristics, Spatial Characteristics, Oscillatory EEG activity, event-related potentials (ERP), slow cortical potentials (SCP), and neuronal potentials, Motor Imagery, Stimulus design-RSVP, checkerboard.

UNIT-III Signal processing of BCI and Medical applications **5**

Signal Processing-Spatial, temporal, spectral, spatio-temporal filters, Feature extraction-ICA, CSP, Classifier-LDA, SVM, Medical applications

15 Hrs.

LIST OF EXPERIMENTS: **60 Hrs.**

1. Study and collection of online EEG datasets
2. Study of BCILAB toolbox
3. Designing of filter
4. Designing of Common Spatial Filter
5. CSP-feature extraction
6. Topoplot
7. Linear Discriminant Analysis

8. Analysis of CSP parameters using BCILAB
9. LDA and SVM comparison
10. CSP and FBCSP comparison
11. OpenBCI ganglion board interface
12. Acquisition of EEG using ganglion board

Total: 75 Hrs.

g) Learning Resources

References:

1. Brain Computer Interfaces, a Review by Luis Fernando Nicolas-Alonso and Jaime Gomez-Gil
2. https://sccn.ucsd.edu/wiki/BCILAB
3. Spatially regularized common spatial patterns for EEG classification." Lotte, Fabien, and Cuntai Guan.
4. Introduction to Statistical Pattern Recognition 2nd Ed - Keinosuke Fukunaga.

Course Code	Course Title	L	T	P	C
1152BM204	Biomedical Computational Modelling	1	0	4	3

a) Course Category
Programme Elective/ Integrated

b) Preamble
This course gives a hands-on using computational modeling tool in biomedical applications

c) Prerequisite
None

d) Related Courses
Anatomy and Physiology of brain, Engineering Mechanics, BMI

e) Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Understand and design various flow models in COMSOL	K3
CO2	Understand and work with electric current modeling wizard in COMSOL	K3
CO3	Understand and work with RF and Heat Transfer modeling wizard in COMSOL	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L		H									
CO2	H	M	L		H									
CO3	H	M	L		H									

f) Course content

UNIT-I FLOW MODELLING **9**

Introduction to COMSOL Starting Screen; Making initial selections Theory for Laminar Flow interface- Laminar Flow interface in COMSOL- Fluid Structure interaction in network of blood

vessels: Introduction- Model Definition- Notes about COMSOL Implementation- Modeling Instructions- Results and Discussion.

UNIT-II ELECTRIC CURRENT MODELLING **3**

Introduction to the AC-DC branch in model wizard- The electromagnetic interfaces- Fundamentals of Electromagnetics- Theory of Electromagnetics- theory for the electrostatic interface- theory for the electric current interface- theory of magnetic and electric fields- Modeling a pacemaker electrode in COMSOL.

UNIT-III RF AND HEAT TRANSFER MODELLING **3**

Heat Transfer Branch: Theory for heat transfer interfaces- Joule heating interface- introduction to RF Module in COMSOL- Specific Absorption Rate (SAR) in the human head- Model definition- Modeling Instructions- Results and discussion.

15 Hrs.

LIST OF EXPERIMENTS: **60 Hrs.**

1. Fluid Structure interaction in network of blood vessels
2. Electro osmotic flow
3. Modeling a pacemaker electrode
4. Heat Tumor Ablation
5. Specific Absorption Rate (SAR) in the human head

Total: 75 Hrs.

g) Learning Resources

Text Books

1. COMSOL Multiphysics User's guide version 4.3

Reference Books

1. Introduction to Integrative engineering: a computational approach to biomedical problems. "GUIGEN ZHANG" CRC press 2017, ISBN: 9781315388465 (ebook)
2. https://www.comsol.com/learning-center
3. https://www.comsol.com/models?sort=publication

Course Code	Course Title	L	T	P	C
1152BM205	Biomedical Computational Modeling	1	0	4	3

a) Course Category

Programme Elective/ Integrated

b) Preamble

This course gives a hands-on using computational modeling tool in biomedical applications

c) Prerequisite

None

d) Related Courses

Engineering Mechanics

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain fundamentals of finite element method (FEM) and calculate stress and strain	K3
CO2	Apply discretization and shape function in FEM models	K3
CO3	Manipulate material types and apply boundary conditions in FEM models	K3

CO-PO Mapping

	PO1		PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		M	L	L	H		L	L	M	L	M	L		L
CO2	H		M	L	L	H		L	L	M	L	M	L		L
CO3	H		M	L	L	H		L	L	M	L	M	L		L

f) Course content

UNIT-I Introduction to Finite Element Method and Analysis 9 Hrs

Introduction – ordinary and partial differential equations and matrices, Calculation of Strain and Stress - Average Strain and Point Strain, Normal and Shear Strain, Calculation of Stress, Sample Matrix Structural Analysis (MSA), MSA to a Finite Element Mode

UNIT-II Meshing, Elements and Shape Functions 3 Hrs

Structure Idealization and Discretization, Node, Element – 1D, 2D and 3D Element types, Formation of Finite Element Mesh, Element Shape Functions and [B] Matrix, Isoparametric Formulation and Mesh Quality – Natural Coordinate System, Isoparametric Formulation of 1D and 2D Elements, Stiffness Matrix Formulation – Direct, Strong and Weak Formulation methods

UNIT-III Materials, Boundary Conditions and Multiphysics **3 Hrs**

Material Laws – Linear Elastic, Elastic-Plastic, Hyper-elastic and viscoelastic, Experimental Types for Biological Tissue Testing and List of Common Material Properties of Biological Tissues, Essential and Natural Boundary Conditions, Nodal Constraint and Prescribed Displacement and Natural Boundary/Loading Conditions, Basics of Heat Transfer and Structural Mechanics

.

15 Hrs.

LIST OF EXPERIMENTS: **60 Hrs.**

1. Making Initial Selections and Getting Familiar with Modelling Environment - Model Builder, Settings and Graphics, Practical Sense of Building Proper Models
2. Create 1D Geometry Models
3. Create 2D Geometry Models using Boolean Operations – A flange with 5 fillets
4. Create 3D Geometry Models using Boolean Operations – 3D heat sink model
5. Create and mesh 2D and 3D Geometry Models having Material Properties
6. Create and mesh a 3D layered Geometry Model having material Properties
7. Steady-State 2D Heat Transfer with Conduction and Convection
8. Axisymmetric 3D Transient Heat Transfer
9. 3D Thick Plate Stress Analysis
10. Microwave Heating of Cancer Tumor
11. Plastic Deformation of a Biomedical Stent
12. Fluid-Structure Interaction in a Network of Blood Vessels

Total: 75 Hrs.

g) Learning Resources

Text Books

1. Basic Finite Element Method As Applied To Injury Biomechanics - King-Hay Yang, Elsevier, 2018.

2. Introduction to Integrative engineering: A computational approach to biomedical problems, Guigen Zhang, CRC press 2017.
3. Heat and Mass Transfer: Fundamentals and Applications, Yunus A Cengel; Afshin J. Ghajar, 4e, 2017

Reference Books/Links

1. https://www.ansys.com/en-in/Case-Studies
2. https://www.comsol.com/learning-center

Course Code	Course Title	L	T	P	C
1152BM206	**Biomechanics**	**2**	**0**	**2**	**3**

a) Course Category

Program core/Integrated

b) Preamble

This course provides an introduction to the basic concepts of mechanics of physiological systems, laws of fluid dynamics that are applicable in human body and use of mechanics in medicine. To discover and also predict the mechanics of human bones, joints, orthopedic and cardiovascular implants.

c) Prerequisite

Engineering Mechanics

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the importance of biomechanics in medicine	K2
CO2	Illustrate the laws of fluid dynamic in biological fluid and mechanics of skeletal system	K3
CO3	Summarize the Muscular consideration for movement	K2
CO4	Discuss the functional anatomy for lower and upper Extermity	K2

CO5	Demonstrate the models specific to orthopedic applications.	K3

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	M	L	H		H	H			L	H			
CO2	H	H								H	L	M		
CO3	H	M	H			L								
CO4	H		M			L	L					H		
CO5	H	H	H					H	L	H				L

f) Course content

UNIT I INTRODUCTION TO BIO MECHANICS 6hrs

Biomechanics - Scope of mechanics in medicine - Mechanics of bone structure, Anatomy vs Functional Anatomy - Mechanical loads of the human body - Effects of loading - Movement Description - Basic movements: Specialized movement descriptors, Anatomical movements - Planes and axes

UNIT II BIOMECHANICS OF CIRCULATION AND SKELETAL SYSTEM 6hrs

Mechanics of Circulation : Dynamics of circulatory system - Dynamics of fluid flow in cardiovascular system - Rheology of blood and micro vessels

Mechanics of physiological system: Biomechanical characteristics of Bone - Bone modeling and remodeling - strength and stiffness of bone - Biomechanics of joints, Mechanical properties of Joints, Biomechanics of cartilage - Mechanical properties and failure of cartilage

UNIT III MUSCULAR CONSIDERATION FOR MOVEMENT 6hrs

Structure of an individual muscle fiber - Types of muscle; Force generation in the muscle - Motor unit, muscle Contraction - Mechanical Model of muscle - The musculo tendinous unit, skeletal muscles servo mechanism, Viscoelastic response of the tendon, Muscle injuries and prevention of injury to muscles.

UNIT IV FUNCTIONAL ANATOMY FOR LOWER AND UPPER EXTERMITY 6hrs

Lower Extermity: Structure of Hip joints - Muscular action of Hip - Loads on the Hip - Structure of Knee Joint - Combined movements of Ankle and foot

Upper

Extermity: Shoulder complex- The elbow and radioulnar joints - The wrist and fingers, Movement Characteristics of the Elbow, Loads on the elbow, common injuries of upper Extermity

UNIT V ORTHOPAEDIC APPLICATIONS **6hrs**

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

30hrs

LIST OF EXPERIMENTS **30 Hrs.**

1. Determine the muscle strain by using dynamometer.
2. To study of neurological functions by using pinchmeter.
3. To measure the ground reaction forces generated by a body standing on, walking or moving across them by using force plates.
4. Determination of muscle elasticity using myometer.
5. Strength determination of using hand load cells.
6. Analysis the posture of feet in static and moving as well as behaviour of knees, hips and joints.

Total: 60 Hrs.

h) Learning Resources

1. Joseph-Hamill-Biomechanical-"Basis of Human-Movement" 2018, 4th Edition, Joseph Hamill, Kathleen M. Knutzen, Timothy R. Derrick
2. DUANE KNUDSON - FUNDAMENTALS OF BIOMECHANICS.-SPRINGER (2020)
3. Susan J.Hall, "Basics Bio Mechanics" 2014, 5th Edition, McGraw-Hill Publishing Co, USA.
4. Joseph D.Bronzino, "Biomedical Engineering Fundamentals", Taylor& Francis, 2006.
5. Peter M. McGinnis, "Biomechanics of sports and exercise", Human kinetics, 3rd Edition, 2013.

Course Code	Course Title	L	T	P	C
1153BM201	Bio Signal Processing Instrumentation	2	0	2	3

a) Course Category

Allied Elective/Integrated

b) Preamble

The course gives hands on experience to build their own simple signal processing medical devices to measure physiological parameters.

c) Prerequisite

It is added advantage if you have Microprocessor / C coding Knowledge

d) Related Courses

Microprocessor and Microcontrollers

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
1	Write c code for peripheral programing using MSP430	K3
2	Describe the signal acquisition challenges in designing Medical Instruments	K2
3	Build ECG using MSP430 and interpret the waveform	K3
4	Describe the principles of ultrasonic and build simple application	K3
5	Compare the architecture of DSP with Microprocessor	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L	M	H	H	M	M						L	H
CO2	L	L	M	H	H	M	M						L	H
CO3	L	L	M	H	H	M	M						L	H
CO4	L	L	M	H	H	M	M						L	H
CO5	L	L	M	H	H	M	M						L	H

f) Course Content

UNIT I MSP430G2553 **6**

16-bit low power MCU MSP430: Introduction to microcontrollers and embedded systems, Von Neumann and Harvard architecture, RISC and CISC machine, Introduction to MSP430: Architecture, Programming Techniques, Addressing Modes, Programming System registers and configuration I/O ports pull up/down registers concepts, Configuring Peripherals in MSP430**,** interrupt programming, Timer/ counter interrupt, Programming MSP430 timer

UNIT II Components of signal processing Instruments **6**

Medical Instruments, Signal Acquisition challenges, Instrumentation amplifier requirement, Analog front end (AFE) for bio potential measurements, Low noise and Low power AFE, Precision voltage references

UNIT III Electrocardiogram **6**

Working of heart, ECG waveform, AFE H/W, software flowchart,

UNIT IV Ultrasound Imaging system **6**

Basics of ultrasound physics, Basic principle of ultrasound imaging, Ultrasound system block diagram, Ultrasound DAQ, Digital ultrasound beam former, AFE5808A

UNIT V TMS320C5515 **6**

Architecture difference between Digital signal processor and microprocessor, System Block diagram, CPU core and peripherals, Program and data memory, external and I/O memory map,

30 Hrs.

LIST OF EXPERIMENTS: **30 Hrs.**

1. Creating Project using CCStudio for MSP430 board
2. Timer Mode 0 with MSP430
3. Timer Mode 1 with MSP430
4. Demonstration of GPIO interrupt (external button interrupt)
5. ADC programing using polling
6. Interfacing AD8232 with MSP430G2553
7. Ultrasonic distance meter using MSP430G2553
8. ECG simulation using MATLAB

Total: 60 Hrs.

g) Learning Resources

Text Books

1. TMS320C5515 User Guide http://www.ti.com/lit/ug/sprufx5e/sprufx5e.pdf
2. TI Health Tech Applications Guide.

Course Code	Course Title	L	T	P	C
1153BM202	**Brain Computer Interface**	**2**	**0**	**2**	**3**

a) Course Category
Allied Elective/Integrated

b) Preamble
This course helps to design the brain computer interface system using brain signals.

c) Prerequisite
None

d) Related Courses
Anatomy and Physiology of brain, Signals and systems and Digital signal processing

e) Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
1	Discuss in detail about the nervous system	K2
2	Discuss different types of BCI signals from instruments	K2
3	Discuss and compare different types of brain signals used for feature extraction	K2

4	Discuss the major components of BCI which makes up the system	K2
5	Applications of BCI system	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M		L									M	M	L
CO2	M	L	L									M	M	M
CO3	M	M	L	L	M							L	H	M
CO4	L	L	M	H	H							H	H	L
CO5	L	L	L									M	L	L

f) Course Content

UNIT-I Nervous System **5**

Anatomy and Physiology of Brain, Basic cells of the nervous system, functions of the nervous system, Regions of the Brain, Disorders of nervous system.

UNIT-II Brain computer interface **5**

Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, Non-invasive and Partially invasive BCI, Brain signal acquisition systems- EEG, MEG, fNIRS, fMRI.

UNIT-III EEG features and stimulus design used in BCI **5**

EEG-Temporal characteristics, Spatial Characteristics, Oscillatory EEG activity, event-related potentials (ERP), slow cortical potentials (SCP), and neuronal potentials, Motor Imagery.

UNIT-IV Signal processing of BCI **5**

Signal Processing-spatial and time domain, Feature extraction, Machine Learning.

UNIT-V BCI Application **5**

Medical Application-Rehabilitation, Brain controlled wheelchair, and Non-medical application-Monitoring Alertness, Gaming and entertainment.

30 Hrs.

LIST OF EXPERIMENTS **30 Hrs.**

1. Study and collection of online EEG datasets
2. Study of BCILAB toolbox
3. Designing of filter
4. Analysis of CSP parameters using BCILAB
5. CSP and FBCSP
6. Acquisition of EEG using ganglion board

Total: 60 Hrs.

g) Learning Resources

Reference Books:

1. Brain Computer Interfaces, a Review by Luis Fernando Nicolas-Alonso and Jaime Gomez-Gil
2. https://sccn.ucsd.edu/wiki/BCILAB
3. Spatially regularized common spatial patterns for EEG classification." Lotte, Fabien, and Cuntai Guan.
4. Introduction to Statistical Pattern Recognition 2nd Ed - Keinosuke Fukunaga.

Course Code	Course Title	L	T	P	C
1153BM101	**Body Area Networks**	**3**	**0**	**0**	**3**

a) Course Category

Allied Elective

b) Preamble

This course will help the students to understand about body area networks along with the various hardwares used and their applications.

c) Prerequisite

Analog and Digital Communication

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain about working of Body Area Network	K2
CO2	Explain the hardware used for BAN with LAN/WAN	K2
CO3	Explain the wireless communication infrastructure used for BAN.	K2
CO4	Discuss the technical challenges involved in BAN	K2
CO5	Brief on the applications of BAN.	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L											L	
CO2	L													
CO3	L													
CO4		L												
CO5	L	M											M	

f) Course content

UNIT I INTRODUCTION **9**

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BSN Architecture – Introduction.

UNIT II HARDWARE FOR BAN **9**

Processor-Low Power MCUs, Mobile Computing MCUs, Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT III WIRELESS COMMUNICATION AND NETWORK **9**

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies- IEEE 802.15.1, IEEE P802.15.3, IEEE 802.15.4, Zigbee

UNIT IV COEXISTENCE ISSUES WITH BAN **9**

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self protection-Bacterial attacks, Virus infection ,Secured protocols, Self protection.

UNIT V APPLICATIONS OF BAN **9**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhymia monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.

Total: 45 Hrs.

g) Learning Resources

Text Books

1. Annalisa Bonfiglio, Danilo De Rossi ,"Wearable Monitoring Systems", Springer, 2011
2. Sandeep K.S. Gupta,Tridib Mukherjee,Krishna Kumar Venkatasubramanian, “Body Area Networks Safety, Security, and Sustainability”, Cambridge University Press, 2013.
3. Guang-Zhong Yang, “Body Sensor Newtorks”, Springer, 2006

Course Code	Course Title	L	T	P	C
1153BM102	**Environmental Conservation**	**3**	**0**	**0**	**3**

a) Course Category

Allied Elective

b) Preamble

To provide a basic understanding of occupancy of the ecosystem in line with Biodiversity. Its conservative measures taken by the agencies as well as the federal Government.

c) Prerequisite

None

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course Outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Illustrate the elements and types of biodiversity.	K2

CO2	Contrast the threats and damages to biodiversity.	K2
CO3	Classify the bio diversity conservation and protection measures.	K2
CO4	Outline the sustainable management of bio diversity.	K2
CO5	Summarize the legal aspects for environmental conservation.	K2

CO PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						M								
CO2						M	M							
CO3						M	M							
CO4						M	M							
CO5							M							

f) Course content

UNIT -I Types, functions and benefits of biodiversity 9

Types of Biodiversity: Species, Genetic and Ecosystem diversity – Alpha, beta, and gamma diversity – Biodiversity and ecosystem function – Megadiversity zones and Biodiversity Hot Spots in India – Ecologically Sensitive Areas (ESA) in India - Use of Biodiversity: Source of food, medicine, raw material, aesthetic and cultural uses – Biodiversity Prospecting: Significance of Indigenous Knowledge Systems

UNIT II Threats To Biodiversity 9

Natural and anthropogenic threats to biodiversity – Human-Animal conflict with special reference to elephants and tigers - IUCN Threat Categories – Red Data Book – Wildlife exploitation - Species extinctions – Endangered and endemic species of flora and fauna in India - Over-harvesting and Climate change on biodiversity - Causes and Impacts of Invasive species to biodiversity

UNIT III Conservation Strategies 9

Current practices in conservation: Habitat or Ecosystem Approaches - Species-based Approaches - Social Approaches: Chipko Movement – In-situ conservation: Afforestation, Social Forestry, Agroforestry, Botanical gardens, Zoos, Biosphere Reserves, National Parks, Sanctuaries, Protected Area Network, Sacred Groves and Sthalavrikshas – Ex-situ conservation: Cryopreservation, Gene Banks, Seed Banks, Pollen Banks, Sperm Banks, DNA Banks, Tissue Culture and Biotechnological Strategies

UNIT IV Sustainable Management Of Bio Resources 9

National Biodiversity Authority (NBA) – Functions of State Biodiversity Board (SBB) and Biodiversity Management Committee's (BMC) – The role of WWF, FAO, UNESCO, UNDP and UNEP for biodiversity conservation – An elementary account on WTO, GAAT and TRIPS – Biopiracy rights of farmers, breeders and indigenous people –Biodiversity informatics with special reference to plant genetic resources

UNIT V Policies, Programmes And Acts For Conservation 9

Status and protection of species in National and International levels – Role of CITES and IUCN – Convention on Biological Diversity (CBD) – Nagoya Protocol – Man and Biosphere Programme (MAB) – Policies implemented by MoEF for biodiversity conservation – Salient features of Biological Diversity Act 2002.

TOTAL: 45 Periods

g) Learning Resources:

a) Text Books:

1. Chaudhuri AB and Sarkar DD, "Mega diversity Conservation: Flora, Fauna and Medicinal Plants of India's Hot Spots" - Daya Publishing House, New Delhi, 2003.
2. Dadhich LK and Sharma AP, "Biodiversity: Strategies for Conservation" - APH Publishing Corporation, New Delhi, 2002.

b) References:

1. Gary K Meffe and Ronald Carroll C, "Principles of Conservation Biology" - Sinauer Associates Inc. Massachusetts, 1994.
2. Groombridge B (Ed.) "Global Biodiversity Status of the Earths Living Resources" - Chapman & Hall, London, 1992.
3. Khan TI, Dhari N and Al Ajmi, "Global Biodiversity: Conservation Measure" - Pointer Publishers, Jaipur 1999.

Course Code	Course Title	L	T	P	C
1153BM103	Telehealth Technology	3	0	0	3

a. Course Category

Allied Elective

b. Preamble

This course helps the students to learn about the E Healthcare with their standards. Also this course gives the detail information about the security, transmission, and storage

c. Prerequisite

None

d. Related Courses

None

e. Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic principles of healthcare in telemedicine.	K2
CO2	Compare the different types of communication and networks	K2
CO3	Solve the ethical & legal issues involved in telemedicine.	K3
CO4	Apply the different types of data storage and communication standards used in telehealth system.	K3
CO5	Discuss the various applications of telemedicine.	K2

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		M			M								
CO2	H		L			H								
CO3	L		L			L								
CO4	H		L			H								
CO5	H		L			H								

f. Course content

UNIT I History and Fundamentals of Telemedicine **9**

History and Evolution of telemedicine, definition of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, benefits & limitations of telemedicine, Introduction of

Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II Communication & Network **9**

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Amplitude Modulation (Qualitative Analysis), Communication infrastructure for telemedicine – LAN and WAN technology.

UNIT III Ethical and legal aspects of Telemedicine **9**

Ethical and legal aspects of Telemedicine (Case study) - Confidentiality, Social and legal issues (Case Study), Safety and regulatory issues (Case Study), the patient-doctor relationship, access to medical records, consent treatment - data protection & security.

UNIT IV Picture Archiving and Communication System **9**

Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication.

UNIT V Applications of Telemedicine **9**

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health care.

Total: 45 Hrs.

g. Learning Resources

Textbooks

1. Olga Ferrer-Roca, M.Sosa Ludicissa, “Handbook of Telemedicine”, IOS press 2002.
2. Norris A.C, “Essentials of Telemedicine and Telecare”, John Wiley & Sons, 2002.
3. Wootton R, Craig J, Patterson, “Introduction to Telemedicine” Royal Society of Medicine Press Ltd., (2nd ed.), 2006.

References Books:

1. Maheu M.M, Whitten P, Allen A, “E-Health, Telehealth, and Telemedicine” Jossy-Bass, 2001.
2. Keith J, Dreyer, David S, Hirschron, James Thrall H, Amit Mehta, PACS: “AGuide to the Digital Revolution”, 2nd Edition, Springer
3. Huang H K, “PACS and imaging informatics – Basic Principles & application”, Wiley-Blackwell
4. Latifi R, “Current Principles and Practices of Telemedicine and e-Health”. Washington DC: IOHS , 2008.
5. Bashshur R L, Shannon G W, “History of Telemedicine”. New Rochelle. NY, Mary Ann Liebert Publishers, 2009.

Course Code	Course Title	L	T	P	C
1153BM104	Remote Health Technology	3	0	0	3

a. Course Category

Allied Elective

b. Preamble

This course helps the students to learn about the E Healthcare with their standards. Also this course gives the detail information about the security, transmission, and storage

c. Prerequisite

None

d. Related Courses

None

e. Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic principles of healthcare in telemedicine.	K2

CO2	Compare the different types of communication and networks	K2
CO3	Solve the ethical & legal issues involved in telemedicine.	K3
CO4	Apply the different types of data storage and communication standards used in telehealth system.	K3
CO5	Discuss the various applications of telemedicine.	K2

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		M			M								
CO2	H		L			H								
CO3	L		L			L								
CO4	H		L			H								
CO5	H		L			H								

f. Course content

UNIT I History and Fundamentals of Telemedicine 9

Origin and development of telemedicine, definition of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, benefits & limitations of telemedicine, future of telemedicine

UNIT II Communication & Network 9

Principles of Multima edia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Amplitude Modulation (Qualitative Analysis), Communication infrastructure for telemedicine – LAN and WAN technology.

UNIT III Ethical and legal aspects of Telemedicine 9

Ethical and legal aspects of Telemedicine (Case study) - Confidentiality, Social and legal issues (Case Study), Safety and regulatory issues (Case Study), the patient-doctor relationship, access to medical records, consent treatment - data protection & security.

UNIT IV Picture Archiving and Communication System 9

Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication.

UNIT V Applications of Telemedicine 9

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health care.

Total: 45 Hrs.

g. Learning Resources

Textbooks

[1] Olga Ferrer-Roca, M.Sosa Ludicissa. *Handbook of Telemedicine*. IOS press, 2002.

[2] Norris A.C. *Essentials of Telemedicine and Telecare*. John Wiley & Sons, 2002.

[3] Wootton R, Craig J, Patterson. *Introduction to Telemedicine*, Royal Society of Medicine Press Ltd., 2nd ed., 2006.

References Books:

[1] Maheu M.M, Whitten P, Allen A. *E-Health, Telehealth, and Telemedicine*. Jossy-Bass, 2001.

[2] Keith J, Dreyer, David S, Hirschron, James Thrall H, Amit Mehta. *PACS: AGuide to the Digital Revolution*. 2nd Edition, Springer, 2006.

[3] Huang H K. *PACS and imaging informatics – Basic Principles & application*. Wiley Blackwell, 2019.

[4] Latifi R. *Current Principles and Practices of Telemedicine and e-Health*. Washington DC: IOHS, 2008.

[5] Bashshur R L, Shannon G W. *History of Telemedicine*. New Rochelle. NY, Mary Ann Liebert Publishers, 2009.

Course Code	Course Title	L	T	P	C
1154BM101	**Brain Computer Interface**	2	0	0	2

a) Course Category
Institute Elective

b) Preamble
This course helps to understand the components of the brain computer interface system.

c) Prerequisite
None

d) Related Courses
AEIC

e) Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
1	Discuss different types of BCI signals from instruments	K2
2	Discuss and compare different types of brain signals used for feature extraction	K2
3	Discuss the major components of BCI which makes up the system	K2
4	Explain the applications based on BCI	K2
5	Use the toolbox BCILAB	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	L										M	L	M
CO2	M	L	M	L	M	M						M	H	L
CO3	H	L	M	M	H							M	H	L
CO4	L	L	L		M							M	M	L
CO5	L	M	L	L	H							M	H	L

f) Course Content

UNIT-I Brain computer interface **6**

What is BCI? How do BCI works, Brain computer interface types-Invasive, Partially invasive, Non-invasive, Brain signal for BCI signal-EEG, MEG, fNIRS, fMRI , Non brain signals for BCI

UNIT-II EEG features used in BCI **6**

EEG Process, Temporal characteristics, Spatial Characteristics, Oscillatory EEG activity, event-related potentials (ERP), slow cortical potentials (SCP), and neuronal potentials. Motor Imagery BCI

UNIT-III Major components of BCI **6**

Signal Processing-Spatial, temporal, spectral, spatio-temporal filters, Feature extraction, Machine Learning

UNIT-IV BCI system **6**

BCI monitoring hardware and hardware, BCI application-P300 speller, neuro prosthetic devices

UNIT-V BCI LAB Tool Box **6**

Toolbox Architecture, Plug-in concepts, Implementing ERP Based BCI, ERP Analysis in BCI Lab

Total: 30 Hrs.

g) Learning Resources

Text Books

1. R. Wolpaw and Elizabeth Winter Wolpaw, "Review of "Brain-Computer Interfaces, principles and practice", Biomed Engineering online
2. Christian Kothe,"Introduction to Modern Brain Computer Interface design video lectures, **https://sccn.ucsd.edu/wiki/Introduction_To_Modern_BrainComputer_Interface_Design**

Reference Books

1. "Brain Computer Principles and Practices",Jonathan Wolpaw ,Elizabeth Winter Wolpaw, Oxford University Press

Course Code	Course Title	L	T	P	C
1154BM102	**Plant Biodiversity, Bioprospecting and the Sustainable Development**	1	0	0	1

a) Course Category

Institute Elective

b) Preamble

This course helps to understand the biodiversity of the plants, sustainable development

goals.

c) Prerequisite

None

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
1	Explain the plant explorations and role of medicinal plants	K2
2	Explain Hydroponics and Aquaponics	K2
3	Explain the role of Remote sensing and GIS	K2
4	Explain the Smart Agriculture 4.0	K2
5	Explain the role of ANN in agriculture	K2

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			H				M							L
CO2					L		H							L
CO3					M									M
CO4					H									M
CO5	H		L	L	M	M	M	L	M			L		L

f) Course Content

UNIT-I UNIT 1. Plant Exploration in the World and Role of Medical Plants in Healthcare 3

Ethno-Botanical Exploration, Investigation of Useful Plants and Development of Plant Resources, United Information for New-Agroforestry, Plant Inventory through 1st to 4th Steps as fundamental to Commercial.

UNIT 2. CSR helps social development and poverty alleviation through Agro- medicine and Hydroponics/Aquaponics 3

Labeling of Functional Food in Japan, Plant Production, Integrated Aquaculture, Aquaponics Nutrient Patterns, Aquaponics- Components, Biofilters, Aquaponics vs Hydroponics, Smart Aquaponics System, Advantages of aquaponiocs-hydroponics and integrated system in medical plant productions.

UNIT 3. Remote Sensing and GIS 3

Introduction of RS and GIS, GIS Technology, Role of RS in Agriculture, Role of RS in Medical Plants, Development of Geospatial Models- Development of Cultivation Area, Plant Phenology- Monitoring.

UNIT 4. Smart Agriculture 4.0 3

Precision agriculture, Internet of Things (IoTs)- Internet of Plants (IoPs), Artificial Intelligence (AI), Robotics, Sustainable Agriculture 4.0.

UNIT 5. Development of Projects 3

Development of An Integrated System using UAV, AI and IoTS for; -Plant Monitoring System, Selection of Suitable Cultivation Land, Aquaponics Monitoring , Artificial Neural Network (ANN) based Wheat Yield Production Estimation, Artificial Neural Network (ANN) based Chlorophyll a Concentration Estimation, Medicinal Plant Identification, Distribution and Biomass Estimation

Total: 15 Hrs

Course Code	Course Title	L	T	P	C
1154BM103	**Telehealth Technology**	**3**	**0**	**0**	**3**

a. Course Category
Institute Elective

b. Preamble
This course helps the students to learn about the E Healthcare with their standards. Also this course gives the detail information about the security, transmission, and storage

c. Prerequisite
None

d. Related Courses
None

e. Course Outcomes
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic principles of healthcare in telemedicine.	K2
CO2	Compare the different types of communication and networks	K2
CO3	Solve the ethical & legal issues involved in telemedicine.	K3
CO4	Apply the different types of data storage and communication standards used in telehealth system.	K3

CO5	Discuss the various applications of telemedicine.	K2

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		M			M								
CO2	H		L			H								
CO3	L		L			L								
CO4	H		L			H								
CO5	H		L			H								

f. Course content

UNIT I History and Fundamentals of Telemedicine 9

History and Evolution of telemedicine, definition of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, benefits & limitations of telemedicine, Introduction of Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.

UNIT II Communication & Network 9

Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Amplitude Modulation (Qualitative Analysis), Communication infrastructure for telemedicine – LAN and WAN technology.

UNIT III Ethical and legal aspects of Telemedicine 9

Ethical and legal aspects of Telemedicine (Case study) - Confidentiality, Social and legal issues (Case Study), Safety and regulatory issues (Case Study), the patient-doctor relationship, access to medical records, consent treatment - data protection & security.

UNIT IV Picture Archiving and Communication System 9

Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication.

UNIT V Applications of Telemedicine 9

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health care.

Total: 45 Hrs.

g. Learning Resources

Textbooks

4. Olga Ferrer-Roca, M.Sosa Ludicissa, “Handbook of Telemedicine”, IOS press 2002.
5. Norris A.C, “Essentials of Telemedicine and Telecare”, John Wiley & Sons, 2002.
6. Wootton R, Craig J, Patterson, “Introduction to Telemedicine” Royal Society of Medicine Press Ltd., (2nd ed.), 2006.

References Books:

6. Maheu M.M, Whitten P, Allen A, “E-Health, Telehealth, and Telemedicine” Jossy-Bass, 2001.
7. Keith J, Dreyer, David S, Hirschron, James Thrall H, Amit Mehta, PACS: “AGuide to the Digital Revolution”, 2nd Edition, Springer
8. Huang H K, “PACS and imaging informatics – Basic Principles & application”, Wiley-Blackwell
9. Latifi R, “Current Principles and Practices of Telemedicine and e-Health”. Washington DC: IOHS , 2008.
10. Bashshur R L, Shannon G W, “History of Telemedicine”. New Rochelle. NY, Mary Ann Liebert Publishers, 2009.

Course Code	Course Title	L	T	P	C
1154BM104	Telehealth Technology	3	0	0	3

a. Course Category

Institute Elective

b. Preamble

This course helps the students to learn about the E Healthcare with their standards. Also this course gives the detail information about the security, transmission, and storage

c. Prerequisite

None

d. Related Courses

None

e. Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Explain the basic principles of healthcare in telemedicine.	K2
CO2	Compare the different types of communication and networks	K2
CO3	Solve the ethical & legal issues involved in telemedicine.	K3
CO4	Apply the different types of data storage and communication standards used in telehealth system.	K3
CO5	Discuss the various applications of telemedicine.	K2

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H		M			M								
CO2	H		L			H								
CO3	L		L			L								
CO4	H		L			H								
CO5	H		L			H								

f. Course content

UNIT I History and Fundamentals of Telemedicine **9**

Origin and development of telemedicine, definition of telemedicine, Functional diagram of telemedicine system, Telemedicine, Tele health, Tele care, benefits & limitations of telemedicine, future of telemedicine

UNIT II Communication & Network **9**

Principles of Multima edia - Text, Audio, Video, data, Data communications and networks, PSTN, POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Amplitude Modulation (Qualitative Analysis), Communication infrastructure for telemedicine – LAN and WAN technology.

UNIT III Ethical and legal aspects of Telemedicine **9**

Ethical and legal aspects of Telemedicine (Case study) - Confidentiality, Social and legal issues (Case Study), Safety and regulatory issues (Case Study), the patient-doctor relationship, access to medical records, consent treatment - data protection & security.

UNIT IV Picture Archiving and Communication System **9**

Types of image formats, DICOM standard, PACS system: Block diagram, Storing & retrieving images, Algorithm for retrieving images, Compressions and its significance, Lossless data Storage and in-house communication.

UNIT V Applications of Telemedicine **9**

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health care.

Total: 45 Hrs.

g. Learning Resources

Textbooks

[1] Olga Ferrer-Roca, M.Sosa Ludicissa. *Handbook of Telemedicine*. IOS press, 2002.

[2] Norris A.C. *Essentials of Telemedicine and Telecare*. John Wiley & Sons, 2002.

[3] Wootton R, Craig J, Patterson. *Introduction to Telemedicine*, Royal Society of Medicine Press Ltd., 2nd ed., 2006.

References Books:

[1] Maheu M.M, Whitten P, Allen A. *E-Health, Telehealth, and Telemedicine*. Jossy-Bass, 2001.

[2] Keith J, Dreyer, David S, Hirschron, James Thrall H, Amit Mehta. *PACS: AGuide to the Digital Revolution*. 2nd Edition, Springer, 2006.

[3] Huang H K. *PACS and imaging informatics – Basic Principles & application*. Wiley Blackwell, 2019.

[4] Latifi R. *Current Principles and Practices of Telemedicine and e-Health*. Washington DC: IOHS, 2008.

[5] Bashshur R L, Shannon G W. *History of Telemedicine*. New Rochelle. NY, Mary Ann Liebert Publishers, 2009.

Course code	Course Title	L	T	P	C
1154BM301	**BIOMEDICAL LABORATORY**	**0**	**0**	**2**	**1**

Course category
Institute Elective

Preamble
Biomedical engineering deals with human physiological parameters. This course gives a hands on for understanding basic anatomy and measurement of a few vital signs

Prerequisite
None

Related Courses
Biology for Engineers

Course Outcomes
Upon successful completion of the course students will be able to

S.No	Course outcome	Skill Level (Dave'sTaxonomy)
1	Explain the arrangement of human body to execute normal functions	S1
2	Measure a few vital parameters	S2

Course Contents

List of Experiments

1. Study of body organization – cavities and organs
2. Visualization of cell using microscope
3. Blood group test
4. Bleeding and clotting time
5. Hearing loss test
6. Measurement of Blood pressure
7. Recording of ECG
8. Visual test and Eye anatomy.

Total Periods: 30

Course Code	Course Title	L	T	P	C
1156BM401	**Medical Biomaterials**	**2**	**0**	**0**	**2**

a) Course Category

Independent Learning

b) Preamble

To make the student to acquire knowledge on this cell to biomaterials interaction and its applications

c) Prerequisite

Biomaterials – Tissue interaction

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the classification of Biomaterials and its properties	K2
CO2	Discuss the cell to biomaterial interaction and animal trials	K2
CO3	Explain the Medical implantation and its application	K2
CO4	Explain the types of polymers and its types	K2
CO5	Describe the metals and ceramic implantation	K2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			L	L			M				L		M	
CO2			L	L			M				L		M	

CO3			M		M	H	H				M		H	M
CO4			H		H	H	H				M		H	M
CO5			H		H	H	H				M		H	M

f) Course content

Unit 1 Introduction to Biomaterials

History and background of Biomaterials, Mechanical and Physico-chemical properties, Resorbability, Biodegradation

Unit II Cell – Biomaterial interaction

Introduction to Biofilm, Material characterization, Analytical instruments, Biological response, compatibility, Cytotoxicity, Cell biomedical interaction, Animal trials

Unit III Medical Implants and its Applications

Metal – Types, classification, applications, properties, Polymers – Types, classification, Application

Unit IV Polymers and its Types

Polymer blends, Natural biopolymers, Biopolymers – Proteins, Hydrogels

Unit V Metals and Ceramic Implantation

Surface Modification, Ceramics, Cardiovascular and other ocular biomaterials, Sterilization, and Device Failure

g) Learning Resources

Text Books

1. Biomaterials Science: An Introduction to Materials in Medicine, 2nd edition
2. Biomaterials Science: An Introduction to Materials in Medicine Hardcover – 12 December 2012

Reference Books

3. An Introduction to Materials in Medicine, Third Edition- 2013
4. Biomaterials science – An introduction to materials in medicine, 3rd edition – October 2012

Course Code	Course Title	L	T	P	C
1156BM402	**AI for Medical Diagnosis**	**1**	**0**	**0**	**1**

a) Course Category

Independent Learning

b) Preamble

To make the student to acquire knowledge and opportunity to join in this transformation of modern medicine.

c) Prerequisite

Neural Network

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the classifying diseases on chest x-rays using a neural network	K2
CO2	Discuss the disease detection using computer technology	K2
CO3	Explain the Evaluating Models	K2
CO4	Explain the implement an appropriate loss function for image segmentation	K2
CO5	Describe a pre-trained U-net model to segment tumor regions in 3D brain MRI images.	K2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M				L						M	L	L	M
CO2	M	M			M						M	L	M	M
CO3	M	M			M						M	M	M	H
CO4	M	H			M						H	M	H	H
CO5	M		H		M		H				H	M		

f) Course content

Unit 1 Introduction to AI

Medical Image Diagnosis, Eye Disease and Cancer Diagnosis, Building and Training a Model for Medical Diagnosis, Training, prediction, and loss Image Classification and Class Imbalance

Unit II Disease detection with computer vision

Binary Cross Entropy Loss Function, Impact of Class Imbalance on Loss Calculation, Resampling to Achieve Balanced Classes, Multi-Task, Multi-task Loss, Dataset size, and CNN Architectures, Working with a Small Training Set, Generating More Samples

Unit III Evaluating models

Sensitivity, Specificity, and Evaluation Metrics, Accuracy in terms of conditional probability, Sensitivity, Specificity and Prevalence, PPV, NPV, Confusion matrix, ROC curve and Threshold, Varying the threshold, Sampling from the Total Population.

Unit IV Image segmentation on MRI images

Medical Image Segmentation, MRI Data and Image Registration, Segmentation, 2D U-Net and 3D U-Net, Data augmentation for segmentation, Loss function for image segmentation

Unit V Testing and Diagnostics

Model Testing, Splitting data by patient, Sampling, Ground Truth and Consensus Voting, Additional Medical Testing, Different Populations and Diagnostic Technology, External validation, Measuring Patient outcomes

g) Learning Resources

Text Books

1. Rajae El Ouazzani, Mohammed Fattah, “An Introduction to Materials in Medicine, 2013
2. Artificial Intelligence in Decision Support Systems for Diagnosis in Medical Imaging, 1 st ed. 2018 Edition, Kindle Edition
3. Artificial intelligence in medicine – Technical basics and clinical applications, 1st Edition, 2015

Reference Books

4. Arvin Agah: Medical Applications of Artificial Intelligence, 2014
5. Medical Diagnostic Systems Using Artificial Intelligence (AI) Algorithms: Principles and Perspectives

Course Code	Course Title	L	T	P	C
1156BM403	**Data Management for clinical research**	**1**	**0**	**0**	**1**

a) Course Category

Independent Learning

b) Preamble

To make the student to acquire the concepts and practical methods to support planning, collection, storage, and dissemination of data in clinical research.

c) Prerequisite

Clinical Data Management

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the basic concepts in clinical research and clinical data collection	K2
CO2	Discuss the concepts for regulatory compliance, and electronic data capture fundamentals.	K2
CO3	Explain the Data collection and standardization by using EDC technique	K2
CO4	Explain the process of planning data elements for a real-world research study.	K2
CO5	Describe the key data quality operations	K2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M					L								
CO2	M					M					L			
CO3	M			M		M					L			
CO4	M				M	M								
CO5	M				M	M								

f) Course content

Unit 1 Introduction to Research Data Collection Strategy **3**

Introduction, Defining the Space, Research Data Planning, Approaches to Data Collection

Unit II Electronic Data Capture Fundamentals **3**

Standardization of Study Processes, Validated Instruments, Data Standards, IRB, HIPAA, and FISMA, GCP and 21 CFR Part

Unit III Data Collections and management **3**

Introduction to Electronic Data Capture, EDC Concepts: Data Exports, Logging, User Rights, Project Creation, Data Imports, Scheduling, Reports, Internationalization

Unit IV Planning a Data Strategy for a Prospective Study **3**

Baseline Data and Demographics, Review of Variables and Forms, Logging in to Redcap, Creating a Project and Adding the First Variables, Adding Fields to the Baseline Form and formatting

Unit V Implementation of EDC **3**

Copying Variables, Renaming Forms, Using the Shared Library, Longitudinal Events, Optional Modules, and User Rights, Testing the Redcap Project, Data Quality Monitoring, case studies

TOTAL : 15 periods

g) Learning Resources

Text Books

1. Dr. Fernandez, S, "The Fundamentals of Clinical Data Management" 8 August 2015
2. Richard K. Rondel, Sheila A. Varley, Colin F. Webb, "Clinical Data Management" 10 December 1999

Reference Books

3. Medical Data Management. A Practical Guide. Authors; (view affiliations). Florian Leiner; Wilhelm Gaus; Reinhold Haux; Petra Knaup-Gregori. Book.

4. Susanne, “Practical guide to clinical data management” 3rd edition, October 2011

Course Code	Course Title	L	T	P	C
1156BM404	**Tissue Engineering**	**2**	**0**	**0**	**2**

a) Course Category

Independent Learning

b) Preamble

To make the student to acquire knowledge and understanding the applications of engineering and life science principles in the field of tissue engineering.

c) Prerequisite

Basics of Cell Biology

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the components of the tissue architecture	K2
CO2	Discuss the stem cell characteristics and their relevance in medicine	K2
CO3	Explain the basis of cell growth, differentiation and cell to cell signaling	K2
CO4	Explain the Protection and host integration of tissue engineering	K2
CO5	Describe the clinical applications of tissue engineering	K2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1			M		H	M					M		L	
CO2	M		H		H	M					M		L	
CO3	M	M	L		H	M		M			M		L	
CO4	L					M					M		L	
CO5	M						H						M	

f) Course content

Unit 1 Introduction to Tissue Engineering

Basics of Tissue Engineering, Scaffolds: extracellular matrix, natural and synthetic polymers

Unit II

Hydrogels, bio ceramics, scaffold fabrication, Material characterization

Unit III Cell Biology, the basis of growth and differentiation

Cell source, isolation, growth, differentiation, Cell adhesion, migration, signaling, bioreactors and challenges in tissue engineering

Unit IV

Host integration, bioethics, Applications: Skin tissue engineering

Unit V Clinical Applications

Applications: Bone tissue engineering, Vascular tissue engineering, and Corneal tissue engineering

g) Learning Resources

Text Books

1. Bernhard O.Palsson, Sangeeta N.Bhatia, ”Tissue Engineering” Pearson Publishers 2009.
2. Meyer, U.; Meyer, Th.; Handschel, J.; Wiesmann, H.P. .Fundamentals of Tissue Engineering and Regenerative Medicine.2009
3. Bernard N. Kennedy (editor). Stem cell transplantation, tissue engineering, and cancer applications, Nova Science Publishers, 2008.

Reference Books

4. R. Lanza, J. Gearhart etal (Eds), Essential of Stem Cell Biology, Elsevier Academic press,2006
5. J. J. Mao, G. Vunjak-Novakovic et al (Eds), Translational Approaches In Tissue Engineering & Regenrative Medicine” Artech House, INC Publications, 2008.
6. Naggy N. Habib, M.Y. Levicar, , L. G. Jiao,.and N. Fisk, Stem Cell Repair and Regeneration, volume-2, Imperial College Press,2007.

Course Code	Course Name	L	T	P	C
1156BM405	BioMEMS and Microfluidics	1	0	0	1

a) Course Category:
Independent Learning

b) Preamble:
To make the student acquire knowledge on BioMEMS & Microfluidics and its fabrication.

c) Prerequisite:
Nil

d) Related Course:
MEMS

e) Outcome:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
1	Describe the principle of BioMEMS & Microfluidics	K2
2	Discuss the sensing technologies and electrochemistry.	K2
3	Explain the fundamentals and application of Microfluidics	K2
4	Explain the fundamentals of cell biology, DNA, Proteins for diagnostics & Polymerase chain reaction (PCR)	K2
5	Microelectronic-fabrication processes	K2

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L					L					M	L		
CO2	H			H		L					H	M		

CO3	**H**			**H**		**M**					**H**	**M**		
CO4	**L**					**H**	**M**				**M**			
CO5	**L**					**H**	**M**				**M**			

f) Course Content

UNIT-I Introduction to BioMEMS and Microfluidics **3**

UNIT-II Sensing Technologies and Basic Biochemistry **3**

UNIT-III Fundamentals and Applications of Microfluidics **3**

UNIT-IV Introduction to Cell Biology, DNA, Proteins for diagnostics & Polymerase chain reaction (PCR) **3**

UNIT-V Applications of Biomicrofluidics **3**

TOTAL : 15 periods

g) Learning Resources

TEXT BOOKS

1. Fundamentals of Microfabrication (Second Edition), Marc J. Madou, CRC press Taylor and Francis Group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL33487-2724, 2002.
2. BioMEMS Technologies and Applications, Edited by Wanjun Wang, Steven A. Soper, CRC press Taylor and Francis Group, 6000 Broken Sound Parkway.
3. Biomolecular sensing, processing and analysis, Rashid Bashir, Steve T. Werely, Mauro Ferrari, Springer Science and Business Media LLC, 233 Spring Street, New York, NY10013, USA, 2006.
4. Fundamentals and applications of Microfluidics, Nam-Trung Nguyen, Steve T. Werely, Artech house Inc., 685 Canton Street, Norwood, MA02062, 2002.
5. The Science and Engineering of Microelectronic Fabrication (Second Edition), Stephen A. Cambell, Oxford University Press, 198, Madison Avenue, New York 10016, 2001.
6. Molecular Biology of the Cell (fourth edition), Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Kate Roberts, Peter Walter, Garland Sand, Taylor and Francis group, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL33487-2724, 2002.

Course Code	Course Title	L	T	P	C
1156BM406	**Biophotonics**	**1**	**0**	**0**	**1**

a) Course Category

Independent Learning

b) Preamble

To make the student acquire the knowledge of light-based technologies are utilized to reveal biological mechanisms, and diagnose several diseases along with finding their treatments.

c) Prerequisite

Fundamentals of light Source

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
CO1	Describe the basic concepts and fundamentals of Biophotonics	K2
CO2	Discuss the concepts for cell biology and light matter interaction	K2
CO3	Explain the Principle and operation of bio imaging and bio photonics	K2
CO4	Explain the applications of biosensors and light active therapy	K2
CO5	Describe the concepts of nanotechnology in Biophotonics	K2

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L			L		M					L			M
CO2				L		M					L			M
CO3	L		M	H		H					M		H	
CO4	M		M	H		H	H				H		H	

CO5	L		H	H		H					H		H	

f) Course content

Unit 1 Introduction to Biophotonics

Introduction, Nature of Light, Fundamentals of Light, Fundamentals of matter, Fact of Matter, Basic of Light – Matter Interaction, Molecular materials, Introduction to Fluorescence

Unit II Basic Biology and Light Matter interaction

The cell, the central Dogma, Genetic Code, Building Blocks, Light – Matter interactions in Molecules, Basics of Spectroscopy, Interaction of Light with cells, Interaction of light with tissue, Photo processes in Biopolymers

Unit III Lasers for Biophotonics and Bioimaging

Laser Principles and operation, Types of Lasers, Nonlinear Optical Processes, In vivo Photoexcitation and its application, Introduction of Bio imaging, Microscopy Techniques, Near field Microscopy and optical coherence Tomography, Fluoroscopes and fluorescence Microscopy techniques

Unit IV Optical Biosensors and Light active therapy

Bio sensing Background, Optical fiber sensors, Metamaterials, Metamaterials as Biosensors, Bio sensing with optical Nano –antennas, Introduction to photodynamic Therapy, Application of PDT, Light irradiation for photodynamic therapy, Laser based tissue engineering, Laser tissue countering: Dermatological Application, laser tissue welding and tissue regeneration, Laser tissue contouring: ophthalmic Application

Unit V Tissue Engineering and Nanotechnology in Biophotonics

Laser in Dentistry, Tools for micromanipulation, The optical/ Laser Tweezer, Design of optical Tweezer, optical scissors, Introduction and process of nanotechnology and ontogenesis, Nano-Lithography, Thin film Deposition, Bionanophotonics Applications, Controlling the brain with light, optical neuro imaging and tomography, Functional near infrared spectroscopy of the brain

g) Learning Resources

Text Books

1. Dr. Paras D.Paras, “Introduction to Biophotons” 3rd edition 2003
2. Dr. Meglinski,” Biophotonics for medical application” 1st edition, 2014

Reference Books

3. Gerd Keiser, “Biophotonics: Concepts to Applications” Springer 2018
4. Wiley S, “Nanotechnology for Biophotonics” 2nd edition, 2003

Course Code	Course Name	L	T	P	C
1156BM407	Epidemiology: The basic science of public health	1	0	0	1

a) Course Category:
Independent Learning

b) Preamble:
This course covers the basics of epidemiology and its relevant concepts.

c) Prerequisite:
Nil

d) Related Course:
Nil

e) Outcome:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
1	Explain the history and field of epidemiology.	K2
2	Describe the measures of disease frequency.	K2
3	Explain the various study designs.	K2
4	Explain the measures of association and confidence intervals.	K2
5	Describe the concept of causality.	K2

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1				L		M								
CO2	L				M						L			

CO3	**L**	**L**			**M**	**M**					**L**			
CO4	**L**				**M**						**L**			
CO5				**L**										

f) Course Content

UNIT-I History of Epidemiology and Epidemiology Research 3

Introduction and History of Epidemiology, Pioneers of Epidemiology, Examples of Research Areas using Epidemiology. Definition, Person, Place, Time and Population Perspective.

UNIT-II Understanding Measures of Disease Frequency 3

Introduction to Measures of Disease Frequency, Prevalent vs Incident Cases, Prevalence, Risks, Rates, Odds.

UNIT-III Study Designs 3

Experimental study design, Cohort Study Design, Case Control Study Design, Cross-Sectional Study Design, Ecological studies.

UNIT-IV Measures of Association 3

Measures of Association- Odds ratio, Interpreting Measures of Association, Confidence Intervals.

UNIT-V Causality 3

Introduction to Causality, Bradford Hill Criteria.

TOTAL : 15 periods

g) Learning Resources

TEXT BOOKS

1. Bonita Beaglehole, "Basic Epidemiology", World Health Organization, ISBN 9241544465

LEARNING RESOURCES

2. Kenneth J Rothman, "Modern Epidemiology", Lippincott Williams & Wilkins, ISBN 9780781755641.
3. Leon Gordis, "Epidemiology, 4th Edition", Saunders, ISBN 9781416040026.

Course Code	Course Name	L	T	P	C
1156BM408	Population Health during a pandemic: Contact tracing and beyond	1	0	0	1

a) Course Category:

Independent Learning

b) Preamble:

This course covers the basics of COVID-19 protocols being followed and prevention strategies to be followed.

c) Prerequisite:

Nil

d) Related Course:

Nil

e) Outcome:

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

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
1	Understand the basic principles and methods of epidemiology and past pandemics that have applications for the current COVID-19 pandemic.	K2
2	Describe the why and how of contact tracing during the COVID-19 pandemic and the role of antibodies and vaccine.	K2
3	Understand the ethical, legal, and regulatory considerations that arise in the context of contact tracing and the mental health impact of COVID-19.	K2
4	Describe the disproportionate impact of COVID-19 on vulnerable population and pregnancy-related issues regarding the COVID-19 pandemic.	K2
5	Examines the current and evolving knowledge around the effects of COVID-19 in the pediatric population and how to find resources for vulnerable populations.	K2

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1						**H**								
CO2	**L**					**H**				**M**				
CO3						**H**		**H**						
CO4						**H**								
CO5						**H**							**L**	

f) Course Content

UNIT-I Epidemiology and History **3**

Epidemiology of COVID-19. History of Pandemics. COVID-19 testing. Public health.

UNIT-II Contact Tracing and Vaccination of population **3**

What is contact tracing? Communication skills for contract tracers, Helping the distressed contact. What is a vaccine? Strategies for vaccine development, Developing a COVID-19 vaccine.

UNIT-III Issues in contact tracing and Importance of mental health **3**

Ethical, legal and regulatory considerations in contact testing, Protecting and disclosing data. Mental health and mental illness, Managing anxiety during COVID-19, Explaining fear and stigma associated with COVID-19, Mental health in special populations in the COVID-19 era.

UNIT-IV Risk of Pregnant women **3**

Defining Health enquiry, COVID-19's impact and diverse populations. Overview of pregnancy care amidst COVID-19, Pregnancy risks with COVID-19 and prevention and protection, Breastfeeding during COVID-19, Mental health of pregnant women during COVID-19.

UNIT-V COVID-19 and public **3**

COVID-19 and children. Educating ourselves and the public, Contact tracer community, Community partnerships. Community resources- Community resources for vulnerable communities.

TOTAL : 15 periods

g) Learning Resources

TEXT BOOKS

1. Maxwell Smith, "Pandemic Disease, Public health, and ethics", The Oxford Handbook of Public Health Ethics.

Course Code	Course Name	L	T	P	C
1156BM409	Biomicrofluidics	1	0	0	1

a) Course Category:
Independent Learning

b) Preamble:
This course covers the concept of biomicrofluidics and its mechanism.

c) Prerequisite:
None

d) Related Course:
None

e) Outcome:
Upon the successful completion of the course, students will be able to:

CO Nos.	Course outcomes	Knowledge Level (Based on Revised Bloom's Taxonomy)
1	Explain the importance of fluidics and its applications in the biological systems.	K2
2	Describe the driven flows and modulate surface tension.	K2
3	Understand the concept of kinetics and cell culture.	K2
4	Understand the importance of microfluidics in the living environment.	K2
5	Explain the various applications of microfluidics in biology.	K2

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L					L					M	L		
CO2	H			H		L					H	M		
CO3	H			H		M					H	M		
CO4	L					H	M				M			
CO5	L					H	M				M			

f) Course Content

UNIT-I Introduction to Biomicrofluidics **3**

Introduction, Engineer's guide to the cell, Fluidics in living systems and mechanobiology.

UNIT-II Driven flows **3**

Pressure driven flows, Surface tension driven flows, Modulating surface tension.

UNIT-III Electrokinetics and Cell culturing **3**

Introduction to Electrokinetics, Microfluidic cell culture, On-chip cellular assay techniques.

UNIT-IV Microfluidics in Biology **3**

Microfluidics for understanding biology, Organ-on-a-chip, Lab on a CD.

UNIT-V Applications of Biomicrofluidics **3**

Lab-on-a-chip for genetic analysis, Microfluidic technology for monoclonal antibody production.

TOTAL : 15 periods

g) Learning Resources

TEXT BOOKS

1. Jeffery D Zahn, "Biomicrofabrication and Biomicrofluidics", Artech House Methods in Bioengineering Series, ISBN 9781596934009

LEARNING RESOURCES

2. Suman Chakraborty, "Microfluidics and Microfabrication", Springer US, ISBN 9781441915429.
3. Wei-Cheng Tian, "Microfluidics for Biological Applications", Springer, ISBN 9780387094793.

Course Code	Course Title	L	T	P	C
1156BM501	Technical Seminar I				1

a) Course Category

Independent learning

b) Preamble

This course enables the students to improve their technical and communication

c) Prerequisite

None

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course Outcomes
CO1	Use appropriate vocabulary, and will demonstrate command of voice modulation, voice projection, and pacing
CO2	Show competence in identifying relevant information for explaining their topics under discussion
CO3	Speak clearly and audibly in a manner appropriate to the subject

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										H		M		
CO2	M											H		
CO3										H				

Course Code	Course Title	L	T	P	C
1156BM502	Technical Seminar II				1

a) Course Category

Independent learning

b) Preamble

This course enables the students to improve their technical and communication

c) Prerequisite

None

d) Related Courses

None

e) Course Outcomes

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

CO Nos.	Course Outcomes
CO1	Demonstrate paid attention to what others say
CO2	Present information in a captivating, well-structured, and logical sequence to perform critical analysis
CO3	Articulate oral arguments, showing an understanding of the unique demands of oral presentation as opposed to writing
CO4	Write effective reports on their chosen topics

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1										H		L		
CO2	M	M								M		M		
CO3										H				
CO4										H		M		

Course Code	Course Title	L	T	P	C
1156BM601	Minor Project				4

a) Course Category

Independent learning

b) Preamble

This course enables the students to integrate and apply the theoretical knowledge they gained in their earlier semesters for solving some practical problems and this improves their technical skills

c) Prerequisite

None

d) Course outcomes

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

CO Nos.	Course Outcomes
CO1	Articulate the problem definition
CO2	Organize various resources and integrate information for completing the project in time
CO3	Collaborate with others as they work on intellectual projects
CO4	Write a report to communicate to others effectively their findings

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	H	M			L			M	H	M	H	H	H
CO2	H	H	M		M	L	L		M	M	H	H	L	L
CO3	H	H							H	H	M	H		
CO4	M	M						H	H	H	H	H		

Course Code	Course Title	L	T	P	C
1156BM701	Major Project				12

a) Course Category

Independent learning

b) Preamble

This course enables the students to explore edge-cutting technology through literature survey and provides an opportunity to explore real world problems by integrating their previous learnings from key areas

c) Prerequisite

All the courses per curriculum must have been completed

d) Course Outcomes

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

CO Nos.	Course Outcomes
CO1	Design and develop a system using comprehension of concepts of their earlier semester courses
CO2	Evaluate the designed system with respect to different performance criteria
CO3	Analyse the variety of issues in design concept through environmental issues and quality
CO4	Write a report to communicate to others effectively their findings

CO PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	H	L	H		M	M						L	H	H
CO2	H	L		H		M	L						H	H
CO3	H	H			H	H							H	H
CO4	H	M						H	H	H	H	H		