

B. S. in Medical Sciences and Engineering Curriculum



**Indian Institute of Technology Madras
Chennai - 600036**

SEMESTER-WISE CREDIT HOUR DISTRIBUTION

Semester	I	II	III	IV	SUM	V	VI	VII	VIII	Total
Credits	48	59	45	43	3	42	45	45	36	366

L: Lecture, T: Tutorial, P: Lab, O: outside class hours, C: credits.
 Cat: Category (S: Basic sciences, E: Basic Engineering, H: Humanities, P: Professional).

E – Category Courses:	50
H – Category Courses:	30 (18 electives)
S – Category Courses:	75
P – Category Core Courses:	148
P – Professional elective:	36
Free Electives:	72
Total:	438

SEMESTER I

No.	Title	L	T	P	O	C	Cat	Level	Core /Ele.
MS1	Mechanics for Medical Scientists	3	0	0	6	9	E	1000	C
MS2	Hierarchical Structure of Human body	3	0	0	6	9	S	1000	
MS3	Mathematical Foundations for Medical Scientists	3	0	0	6	9	S	1000	
MS4	Software Skills for Medical Scientists	3	0	3	6	12	E	2000	
MS5	Introduction to Anatomy	1	0	6	2	9	P	2000	
	Total	13	0	9	26	48			
	NCC/ NSS/ NSO	0	0	0	2	0			
	Life Skills	0	0	0	3	0			
	Ecology and Environment	2	0	0	0	0			

SEMESTER II

No.	Title	L	T	P	O	C	Cat	Level	Core /Ele.
MS6	Fluid Mechanics for Physiology	3	0	0	6	9	E	2000	C
MS7	Electrical Circuits and Bioelectricity	3	0	2	6	11	S	2000	
MS8	Medical Biochemistry	2	0	3	4	9	S	1000	
MS9	Mathematical Modelling in Physiology and Medicine	3	0	0	6	9	S	1000	
MS10	Medical Microbiology, Immunology and Pathology	3	0	3	6	12	S	2000	
HS	Humanities-I	3	0	0	6	9	H	-	Ele.
	Total	17	0	8	34	59			
	NCC/ NSS/ NSO	0	0	0	3	0			

SEMESTER III

No.	Title	L	T	P	O	C	Cat	level	Core /Ele.
MS11	Medical Genetics	2	0	3	4	9	S	2000	C
MS12	Physics of Medical Imaging	3	0	0	6	9	E	2000	
MS13	Introduction to Biomedical Signal Processing	3	0	0	6	9	E	2000	
MS14	Statistics for Clinical Research	2	0	3	4	9	S	2000	
MS15	Quantitative Human Physiology	2	0	3	4	9	P	3000	
	Total	12	0	9	24	45			

SEMESTER IV

No.	Title	L	T	P	O	C	Cat	Level	Core /Ele.
MS16	Basics of Pharmacology	3	0	2	6	11	P	3000	C
MS17	Introduction to Basic and Clinical Neuroscience	4	0	3	8	15	P	4000	
MS18	Physiology of the Sensory System – vision, Smell, Taste and Hearing	3	0	2	6	11	P	3000	
MS19	Introduction to Reproductive System	2	0	0	4	6	P	3000	
	Total	12	0	7	24	43			

SUMMER

No.	Title	L	T	P	O	C	Cat	level	Core /Ele.
MS20	Hospital Visits 1	0	0	3	0	3	P	3000	C

SEMESTER V

No.	Title	L	T	P	O	C	Cat	level	Core /Ele.
MS21	Introduction to Endocrinology	2	0	0	4	6	P	4000	C
MS22	Introduction to Surgery and Surgical Devices	2	0	3	4	9	P	4000	
MS23	AI in Medicine	2	0	3	4	9	P	5000	C
	Professional Elective I	3	0	0	6	9	P	4000	Elec.
HS	Humanities II	3	0	0	6	9	H	4000	
	Total	12	0	6	24	42			

SEMESTER VI

No.	Title	L	T	P	O	C	Cat	level	Core /Ele.
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MS24	Introduction to Nephrology & Gastroenterology	4	0	3	8	15	P	5000	C
MS25	Finite Element Method for Physiologists	3	0	0	6	9	P	5000	
	Professional Elective II	3	0	0	6	9	P	4000	
HS	Economics of Healthcare	4	0	0	8	12	H	6000	
	Total	14	0	3	28	45			

SEMESTER VII

No.	Title	L	T	P	O	C	Cat	level	Core /Ele.
MS26	Medical Image Analysis	2	0	3	4	9	P	5000	C
MS27	Cardiovascular & Respiratory Mechanics and Hemodynamics	4	0	3	8	15	P	5000	
MS28	Orthopaedic Biomechanics	3	0	3	6	12	P	5000	
	Professional elective III					9	P	4000	Ele.
	Total	9	0	9	18	45			

SEMESTER VIII

No.	Title	L	T	P	O	C	Cat	level	Core /Ele.
	Project	0	0	27	0	27	P		Ele.
	Professional Elective IV	3	0	0	6	9	P	5000	
	Total	3	0	27	6	36			

Course title	<i>Mechanics for Medical Scientists</i>									Course No	MS1			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	0	6	9						
Offered for	B.S. (Medical Sciences)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
To introduce the concepts of mechanics in a mathematical setting and expand to apply for physiological systems														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Mathematical Background										7			
2	One dimensional continuum mechanics – kinematics of motion and strain, balance laws and stress measures										8			
3	Mechanical behaviour of tissues, bones etc.										8			
4	Theory of beams, plates and shells										8			
5	Rigid body kinematics and rigid body dynamics										8			
Text Books														
<ol style="list-style-type: none"> 1. Yohan Payan and J. Ohayon, Biomechanics of living Organs, Academic Press, 2017 2. Jay Humphrey and Sherry L.O'Rourke, An introduction to biomechanics, Springer, 2004 														
Reference Books														
<ol style="list-style-type: none"> 1. Y.C. Fung, Biomechanics: Mechanical Properties of living tissues, Springer, 1981 														

Course title	Hierarchical Structure of the Human Body									Course No	MS2			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0		6	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Objective: To enumerate the six levels of structural organisation of the human body														
Unit	Content										Hrs			
1	The Organization of the human body										2			
2	Biomolecules: General structure overview of – a) carbohydrates; b) lipids; c) proteins; d) Enzymes – nomenclature, classification and mechanism of action; e) Amino acids structure and classification; single letter and triple letter code										4			
3	Cellular level Organisation – Cell Structure and functions – membrane proteins, cytoplasm and Organelles, Nucleus, protein synthesis, cell growth and cell death, cellular differentiation. Structure of Plasma Membrane Cellular structure in the cells of human body – nerve cell, blood cells, retinal rod cells etc Bioenergetics and metabolism overview: Energy concepts, Thermodynamics of phosphate compounds (Phosphoryl-transfer reactions, High energy compounds and biological energy transducers (ATP, NADH, NADPH, FADH, CoASH), ATP cycle, structural basis of free energy change during hydrolysis of ATP. Nernst equation and Redox-potentials. Metabolic concepts – overview of metabolism, classical subdivisions of metabolism, metabolic pathways.										13			
4	Tissue level Organization – types of tissues and its functions – epithelial, connective, muscle and nerve tissue										8			
5	Organ level organisation and organ systems of the body										11			
Text Books:														
1. Lauralee Sherwood, Human Physiology – from Cells to Systems , Cenage Learning, 2016														
2. Saladin K.S., Anatomy and Physiology, McGraw Hill, 2018														
Reference Book:														
1. Rod Phillips et al., Physical Biology of the Cell, Garland Science, 2013														

Course title	<i>Mathematical Foundations for Medical Scientists</i>									Course No	MS3			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0		6	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
1. To lay the foundation for mathematical modelling in medicine														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Highlights of linear Algebra – Matrix multiplication and solving linear equations, vector spaces and subspaces, determinants, eigenvalues and eigenvectors										10			
2	Numerical differentiation										6			
3	ODE – Classification and examples, solution of linear time -invariant ODEs, convolution integral and Laplace Transform Methods										6			
4	Numerical Solution of ODEs										10			
4	Partial differentiation and examples of PDEs										8			
The course will have a practical session (e.g. numerical methods, solvers) of three hours a week														
Text Books														
1. G. Strang, Introduction to linear algebra, (6 th edition), Wellesley – Cambridge Press, 2016 2. L.V. Fausett, Applied Numerical Analysis using MATLAB, Pearson, 2009 3. E. Kreyzig, Advanced Engineering Mathematics,														
Reference Books														
1. Josph Distefano III, Dynamic Systems Biology Modelling and Simulation, Academic Press, 2013 2. C. Cobelli, E. Carson, Introduction to modeling in physiology and medicine, 2nd Edition, Academic Press, 2019														

Course title	Software Skills for Medical Scientists									Course No	MS4			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	T H	Old Credits	L	T	P	C
			3	0	0	3	6	12						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC		Date of approval by BAC						Date of approval by Senate					
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
1 To develop software skills for the students that are relevant to the discipline														
Course Contents														
Unit	Content									Teaching/contact hours				
1	Concepts of Object Oriented Analysis and Design									6				
2	Programming fundamentals - Python									6				
3	Programming in UNITY, SLICER, image processing and Visualization of medical images (e.g., by using ITK and VTK)									20				
4	Software skills in a mathematical software									8				
The course will have a practical session of three hours a week														
Text Books														
1. B. Dathan and S. Ramnath, Object – Oriented Analysis, Design and Implementation, Second Edition, Springer, 2015														
2. H. Ferrone, Learning C# by developing games with UNITY														

Course title	<i>Introduction to Anatomy</i>								Course No	MS5				
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			1	0	0	6	2	9						
Offered for	B.S. (Medical Sciences and Engineering)								Status	New				
Faculty									Type	P				
Pre-requisite	None								To take effect from	July 2023				
Submission date	Date of approval by DCC				Date of approval by BAC				Date of approval by Senate					
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To teach various modern methods of visualization techniques for medicine To introduce various imaging modalities in medical imaging To introduce normal adult and paediatric anatomy as visualised in medical images To bring out the normal imaging appearance of the structures and their relationships on planar radiographic, ultrasound, CT, MRI images To teach location, recognition and description of anatomical surface landmarks and relate this to the normal anatomical relationship of the structures of each region Virtual reality, Augmented Reality and Mixed Reality in medical visualisation 														
Course Contents														
Unit	Content									Teaching/contact hours				
1	Introduction of overall anatomical structure of the body									5				
2	Acquisition of medical image data – x-ray imaging, CT, MRI and Ultrasound									5				
3	Sectional Anatomy of cranium, facial bones and brain using CT, MRI (T1 and T2 weighted) and CTA and MRA of the cerebral arteries, CT venogram, cranial nerve system.									6				
4	Spine – Vertebrae, ligaments, muscles, spinal cord and nerve roots using CT, MRi and 2D X-ray									4				
5	Imaging of the neck									4				
6	<ul style="list-style-type: none"> Imaging of the thorax with detailed imaging of the heart and vasculature using CT, MRI, CTA and MRA Introduction to echocardiography 									6				
7	Imaging of the abdomen – liver, spleen, gallbladder and biliary system, pancreas, intestine and urinary system									6				
8	Imaging of the pelvis, upper and lower extremity									4				
The course will have a practical session of three hours a week														
Text Books														
<ol style="list-style-type: none"> Denise L. Lazo, Fundamentals of Sectional Anatomy, An Imaging Approach, Cengage Learning, 2015 Lorrie L. Kelley and Connie M. Peterse, Sectional Anatomy for Imaging Professional, Elsevier, 2018 														
Reference Books														
<ol style="list-style-type: none"> Jean Francios, J. Jorge, D.S. Lopes, Digital Anatomy, Springer, 2021 Spratt, J.D., Salkowski, I.R., Loukas, m. Turmezi, T., Weir, J. Abrahms, P.H., Imaging Atlas of Human Anatomy, Elsevier, 2021 														

Course title	<i>Fluid Mechanics for Physiology</i>									Course No	MS6			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	0	6	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	E			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
To introduce the concepts of fluid mechanics as it is applied to physiology														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Fluid as a continuum, state of stress and fluid motion in physiology –Conservation laws – Navier – Stokes equation, Bernoulli equation, first and second law of thermodynamics, introduction to heat transfer in physiology										7			
2	Anatomy of blood vessels, arterial wall mechanics, blood cells and plasma, blood rheology, blood flow in arteries and veins, wave propagation in arterial system, flow separation, turbulent flows in physiological systems, pulsatile flow - Wormersley flow										10			
3	Physiology of microcirculation – arterioles and local control, capillaries and mass exchange, heat transfer in microcirculation, lymphatic system – lymph physiology and lymphatic flow										10			
4	Measurement of pressure and flow in physiological system Pressure measurement - indirect measurement, direct – intravascular and catheter-transducer measuring system Flow measurement – indicator dilution method – Fick technique, dye dilution, thermodilution, electromagnetic flow meters, doppler flow meter										8			
5	Vascular Pathologies										3			
Text Books														
1. David A. Rubenstein et al., Biofluid Mechanics, 3rd Edition, Academic Press, 2022 2. L. White, Biofluid Mechanics in Cardiovascular System, McGraw Hill, 2006														
Reference Books														
1. C. Vlaschoppulos, Micheal O'Rourke and W. W. Nichols, McDonald's Blood Flow in Arteries, 6th edition, CRC Press, 2012														

Course title	Electrical Circuits and Bioelectricity									Course No	MS7			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	T H	Old Credits	L	T	P	C
			3	0	0	2	6	11						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
1 To introduce to the electrical circuits, and analysis of the circuits, and software tools for the same														
2. To understand the sources of bioelectric and magnetic signals and their biomedical applications														
Course Contents														
Unit	Content									Teaching/contact hours				
1	Basic concepts – electric current, voltage etc. Ohms law, Kirchoff laws, Delta – Wye conversion									4				
2	Analysis methods – Nodal analysis, mesh analysis, source transformation, Thevenin – Norton equivalent circuit									4				
3	Operational Amplifier based circuits									6				
4	Volume source and volume conductor – homogeneous volume conductor – inhomogeneous volume conductor – modelling of volume source and volume conductor									4				
5	Introduction to source field models and their applications to physiology									3				
6	Lead vector – definition – examples – and applications to ECG									3				
7	Magnetic fields and Bio magnetic measurements									3				
8	Introduction to electromyogram – electrical activity of muscle – surface EMG and its spectral analysis – modelling intramuscular EMG									5				
Laboratory will have electrical and electronics experiments reiterating the theoretical understanding.														
Text Books														
1. Boylestad, R, Introductory Network Analysis, 12 th Edition, Pearson, 2013														
2. Keskin, A.U., Electrical Circuits in biomedical Engineering, Springer, 2017														
3. Plonsey R., Barr R.C., Bioelectricity A. Quantitative Approach. New York, NY: Springer; 2007.														
4. L. Sornmo and P. Laguna, Biomedical Signal processing in cardiac and neurological applications, Elsevier, 2005														
5.J. Malmivuo, and R. Plonsey, Bioelectromagnetism, OUP, 1995														

Course title	Medical Biochemistry									Course No	MS8			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	3	4	9	S					
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	L & P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To understand the biochemistry of human body fluids To learn the disorders of carbohydrate, protein and lipid metabolism To appreciate enzymology and disease associated with it To acquire knowledge on organ specific biochemical tests To understand the significance of nutritional biochemistry in human health 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Introduction to medical biochemistry , Scope of clinical biochemistry Biochemistry of body fluids – Blood, Lymph, cerebrospinal fluid, synovial fluid, pleural fluid, peritoneal fluid, amniotic fluid, saliva, sweat, tears and urine										2			
2	Disorders of carbohydrate metabolism – Diabetes Mellitus, Galactosemia, Glycogen storage diseases, hereditary fructose intolerance, Hunter syndrome, Hurler syndrome, mucopolysaccharidoses. Disorders of protein metabolism – Phenylketonuria, Maple syrup urine disease, Homocystinuria, Tyrosinemia, Alkaptonuria, Lysosomal storage disorders. Protein folding disorders - Alzheimer's disease, Parkinson's disease, Huntington's disease, Creutzfeldt-Jakob disease, cystic fibrosis, Gaucher's disease, Spinal muscular dystrophy, Amyotrophic lateral sclerosis, Transthyretin amyloidosis. Disorders of lipid metabolism - Hyperlipidemia, Hypercholesterolemia, Familial hypercholesterolemia and Familial combined hyperlipidemia, lipoprotein lipase deficiency, Tangier disease, abetalipoproteinemia. Purine metabolism disorders – Lesch- Nyhan syndrome, adenosine deaminase deficiency, X – linked agammaglobulinemia, Hyperuricemia and gout. Pyrimidine metabolism disorders – Orotic aciduria, Dihydropyrimidine dehydrogenase deficiency, 5- fluorouracil toxicity, Tyrosinemia type I.										12			
3	Enzyme classification and nomenclature, enzyme kinetics and mechanism of enzyme action. Clinical significance of the following enzymes - transaminases (ALT & AST), creatine kinase, lactate dehydrogenase, alkaline phosphatase, carbonic anhydrase, aldolase, amylase, lactase, lipases, Glucose -6- phosphate dehydrogenase, glutamate dehydrogenase, choline esterase.										4			
4	Overview of organ specific tests.										6			

	<p><i>Cardiac function</i> – Troponin, creatinine kinase (CK), myoglobin, natriuretic peptides (BNP, NT – proBNP).</p> <p><i>Kidney function</i> - creatinine, urea, electrolyte balance, filtration rate, glomerular filtration rate (GFR).</p> <p><i>Liver function</i> – ALT, AST, ALP, GGT, bilirubin.</p> <p><i>Bone health</i> – ALP, calcium, phosphorus, parathyroid hormone (PTH), 25, hydroxyvitamin D.</p> <p><i>Pancreas</i> – Glucagon, insulin, c-peptide, blood glucose</p> <p><i>Gastrointestinal function</i> – Fecal occult blood, stool tests for fat, stool tests for reducing substances, stool tests for parasites</p> <p><i>Inflammatory markers</i> – C – reactive protein (CRP), Erythrocyte sedimentation rate (ESR), Interleukin – 6, Interleukin – 1 beta, Tumor necrosis factor alpha, white blood cell count (WBC)</p> <p><i>Lung Health</i> – Spirometry, Diffusion capacity of the lungs for carbon monoxide (DLCO), Arterial blood gases (ABG), Bronchodilator response test, serum surfactant protein D (SP-D).</p> <p><i>Brain Health</i> – Neurofilament light chain (NfL); Amyloid-beta (Aβ); Tau protein, Homocysteine, S100B, Brain derived neurotrophic factor (BDNF)</p> <p><i>Complete blood profile</i></p>	
5	<p>Nutritional Biochemistry: Fat soluble vitamins – general characteristics, classification, vitamin storage in the human body, daily requirements, avitaminoses, coenzyme Q, stigmaterol. Water soluble vitamins – Vitamin B complex, Vitamin C, Choline, Inositol, Para-aminobenzoic acid, Alpha – lipoic acid, Carnitine, Bioflavanoids, Vitamers (Isotels). Essential trace elements – Iron, Zinc, iodine etc., and their functions in the body; dietary sources of trace elements; factors affecting absorption and utilization of trace elements trace elements deficiency and diseases. Recommendations for daily intake of fat and water soluble vitamins and trace elements. Vitamin and essential minerals deficiency disorders.</p>	4
	Practical - can be rotated/shadowed in clinical laboratory in a hospital	Credits
1	<p>Enzyme assays – ALT, AST, Creatinine kinase</p> <p>Blood glucose levels, HbA1c measurement, complete lipid profile, Electrolyte analysis – sodium, potassium and chloride levels in blood. RFT and LFT, Thyroid function tests, vitamin analysis – vitamin B12 and folate. Calcium and phosphate measurement in blood. Blood haemoglobin, transferrin and ferritin</p>	3
Text books		
<p>Title – Medical Biochemistry. Authors: John W. Baynes and Marek H. Dominiczak. 7th Edition, 2020. ISBN: Hardcover: 978-0-7020-7317-1; eBook ISBN: 978-0-7020-7318-8</p> <p>Title: Biochemistry for Medical Professionals. Author: Michael W. King. 2nd Edition, 2017; Publisher: Jones & Bartlett Publishers. ISBN: Hardcover: 978-1284104993, eBook ISBN: 978-1284104993</p> <p>Title: Clinical Biochemistry: An Illustrated Colour Text. Authors: Allan Gaw, Michael J. Murphy, and Rajeev Srivastava. 7th Edition, 2020; Publisher: Churchill Livingstone. ISBN: Hardcover: 978-0702073663, eBook ISBN: 978-0702077456</p>		
Reference books		
<p>Title: Harper's Illustrated Biochemistry. Authors: Robert K. Murray, Dale A. Granner, Peter A. Mayes, and Victor W. Rodwell. 31st Edition, 2020; Publisher: McGraw-Hill Education; ISBN: Hardcover: 978-1260543270; eBook ISBN: 978-1260543362</p> <p>Title: Principles of Biochemistry; Authors: Albert L. Lehninger, David L. Nelson, and Michael M. Cox. 7th Edition, 2020; Publisher: W. H. Freeman. Hardcover: 978-1464187974; eBook ISBN: 978-1464187981</p>		

Course title	<i>Mathematical modelling in physiology and medicine</i>									Course No	MS9			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	0	6	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	S			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To teach a framework for physiological system modelling To expose the students to solve mathematical models using scientific software To introduce fundamental concepts of dynamical systems 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Physiological complexities and need for models										1			
2	Mathematical models in physiology, Examples of physiological models										2			
3	Static Analysis , time domain analysis , frequency domain analysis										3			
4	Stability analysis of systems, e.g. biosystem stability and biocontrol systems										3			
5	State Space representation										3			
6	Compartment models in physiology, distributed models										9			
7	Structural identifiability – Parameter estimation, modelling and identifiability										13			
8	Sensitivity Analysis fundamentals – Global sensitivity, Sobel etc										3			
9	Case studies and examples from physiology										10			
Assignments will expose the students to use scientific software (e.g, MATLAB) to solve physiology problems														
Text Books														
<ol style="list-style-type: none"> Jospeh Distefano III, Dynamic Systems Biology Modelling and Simulation, Academic Press, 2013 C. Cobelli, E. Carson, Introduction to modeling in physiology and medicine, 2nd Edition, Academic Press, 2019 Physiological control systems: Analysis, simulation, estimation, second edition, Wiely, 2018 														
Reference Books														
<ol style="list-style-type: none"> Jerry J. Batzel et al. , Mathematical Modeling and validation in Physiology, Springer 2012 														

Course title		<i>Medical Microbiology, Immunology and Pathology</i>								Course No	MS10			
Department	Biotech	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	3	6	12						
Offered for	B.S. (Medical Sciences and Engineering)								Status	New/Modified				
Faculty									Type	S – Basic Sciences				
Pre-requisite	None								To take effect from					
Submission date	Date of approval by DCC		Date of approval by BAC						Date of approval by Senate					
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To introduce basic principles of medical microbiology, clinical –immunology and –pathology. To appreciate the principles and application of microscopy in microbiology and pathology. To teach basic biology of bacteria, virus, fungi and other parasitic pathogens related with human diseases. To understand the role of the immune system in the development of immune-mediated diseases, including allergies, autoimmune diseases, and immunodeficiency disorders. To provide an understanding about the pathogenesis of human diseases caused by various pathogens. 														
Course Contents														
Unit	Content													Teaching/contact hours
1	<p>Microbiology and pathology</p> <p>i) History of microbiology, General Pathology – history and principles of pathology, Microscopic pathology</p> <p>Bacterial and Viral Pathology –</p> <p>i) General structure of bacteria and virus</p> <p>ii) Mechanism of bacterial and viral pathogenesis – an overview</p> <p>iii) Bacterial pathogens and the diseases – Staphylococcus, Streptococcus, Neisseria, Enterobacteriaceae (Escherichia, Klebsiella, Enterobacter, Proteus, Salmonella and Shigella). Campylobacter, Helicobacter. Vibrio cholera, Clostridia (spore-forming anaerobic bacteria), Pseudomonas, Mycobacteria. Brucella, Hemophilus species, Treponema, Leptospira, Legionella, Chlamydia and mycoplasmas</p> <p>iv) Basic Pathogenesis of specific virus families’ relevance to human diseases – Coronaviridae, Adenoviridae, Hepadnaviridae, Herpesviridae, Reoviridae, Retorviridae, Orthomyxoviridae, Paramyxoviridae, Papillomaviridae, Picornaviridae & Togaviridae</p> <p>Fungal Pathology –</p> <p>i) classification, structure, and function of fungi, fungal pathogenesis, and the host response to fungal infections, including aspergillosis, candidiasis, and cryptococcosis.</p> <p>Parasitic Pathology -</p> <p>i) classification, parasitic pathogenesis, and the host response to parasitic infections. Major medically important protozoa and associate diseases – Leishmania, Plasmodium malariae, Toxoplasma gondii, Trichomonas vaginalis, Trypanosomes, Entamoeba histolytica.</p> <p>ii) Emerging Infectious Diseases: recent advances in the understanding of newly emerging infectious diseases, including SARS, MERS, and COVID-19.</p>													18
2	<p>Immunology/Immuno-pathology</p> <p>i) Introduction to Immunology, structure and function of Immune system</p> <p>ii) Innate Immunity: Toll-like receptors, complement system, phagocytosis.</p> <p>iii) Acquired Immunity: T and B cell immunity, humoral and cell-mediated immunity, antibody structure and function. Passive Immunity and immune evasion strategies.</p>													16

	<p>iv) Antigenes and Antigen Presentation: antigen processing and presentation, Major Histocompatibility Complex (MHC) molecules, T cell receptor (TCR) structure and function. General structure of antibodies, antigen- antibody reactions.</p> <p>v) Immune Tolerance: central and peripheral tolerance, self-tolerance mechanisms, regulatory T cells.</p> <p>vi) Immunological Disorders: autoimmune diseases, immune-deficiencies and allergies – including mechanisms of allergy, type 1 hypersensitivity reactions, atopic diseases and food allergies.</p> <p>vii) Vaccines: Types of vaccines, vaccine development and production, vaccine efficacy and safety.</p> <p>viii) Immunotherapy – cancer and infectious diseases. Immunotherapy in combination with chemotherapy, radiation therapy or targeted therapy.</p> <p>ix) Transplantation Immunology: mechanisms of transplant rejection, tolerance induction, and immunosuppression.</p>	
3	<p>Introduction to -</p> <p>i) Hematology: red blood cells, white blood cells, platelets, anemias, leukemias, coagulation disorders.</p> <p>ii) Clinical Cytology: Pap smears, fine-needle aspiration, bronchial and urinary cytology, flow cytometry.</p> <p>iii) Transfusion Medicine: blood typing, cross-matching, compatibility testing, transfusion reactions, and transfusion transmitted infections.</p> <p>iv) Introduction to histology, Immunohistochemistry, bacterial, viral, fungal and cancer cell culture, tissue culture, biopsy, autopsy, flow cytometry.</p>	8
	Practical (pathology/microbiology labs in hospital)	3 credits
1	<p>i) Sample collection from humans, transport of specimens, isolation of bacteria, virus and fungi from clinical specimens.</p> <p>ii) Microscopy: light and electron microscopes to examine tissues and cells, and to identify the structures and features of cells and tissues; including endocrine tissue morphology, normal and abnormal morphology of liver, heart and kidney.</p> <p>iii) Histology: preparation of tissue specimens for microscopic examination, including embedding, sectioning, and staining techniques; including tumor tissues.</p> <p>iv) Immunohistochemistry: Antibodies and molecular biology techniques to detect specific antigens and markers in tissues. Example Ki67, Her2/neu antigen detection using antibody and quantification in tumor biopsy.</p> <p>v) Observing autopsies, collection and formalin preservation of organs, cold storage for further analysis.</p>	

Text Books

- Title:** Prescott's Microbiology. Authors: Joanne Willey, Linda Sherwood, Chris Woolverton. 10th edition, 2019. Publisher: McGraw-Hill Education. ISBN: 9781260299180
- Title:** Text book of Microbiology. Authors: R Ananthanarayan, CK Jayaram Paniker and Reba Kanungo. 11th edition, 2020. Universities Press (India) Pvt. Ltd..
- Title:** Essential Clinical Immunology. Authors: Helen Chapel, Mansel Haeney, Sir Graham Steven, and Trevor Lawley. 6th edition 2015, publisher - John Wiley & Sons. ISBN: 9781118442708.
- Title:** Immunology. Editors: David Male, Victoria Male, and Ray Stokes Peebles. 2020, Publisher: Elsevier. ISBN: 9780702078446
- Title:** Rapid Review Microbiology and Immunology. Authors: Ken S. Rosenthal & Michael J Tan y. 3rd Edition, 2010. Publisher Mosby; ISBN Number – 9780323069380
- Title:** Robbins & Cotran Pathologic Basis of Disease (Robbins Pathology). Authors - Vinay Kumar, Abul K. Abbas, Jon C. Aster. 10th edition, 2020; Publisher: Elsevier. ISBN: 978-0323531139.

Reference Books

- Title:** Medical Microbiology. Authors - Patrick R. Murray, Ken S. Rosenthal, and Michael A. Pfaller. 9th edition, 2020, Publisher – Elsevier. ISBN - 9780323673228.
- Title:** Medical Microbiology. Authors - David Greenwood, Richard CD., Slack, John Forrest Peutherer. 16th edition, 1992. ELBS with Churchill Livingstone.

3. **Title:** Clinical Immunology: Principles and Practice. Authors - Robert R. Rich, Thomas A. Fleisher, William T. Shearer, Henry M. Lederman, Michael F. Fanger, and Annette L. Baumeister. 3rd edition, 2018. Publisher – Elsevier. ISBN: 9780323552071.
4. **Title:** Kuby Immunology. Authors: Judy Owen, Jenni Punt, and Sharon Stranford. 8th edition, 2018; Publisher: W. H. Freeman and Company. ISBN: 978-1319114701.
5. **Title:** Underwood's Pathology: A Clinical Approach. Author: Simon Cross. Edition: 6th, 2017; Publisher: Churchill Livingstone. ISBN: 9780702051348
6. **Title:** Rapid Review Pathology. Author: Edward F. Goljan. 4th edition, 2019. Publisher: Elsevier. ISBN: 9780323528707

Course title	Medical Genetics									Course No	MS11			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	3	4	9	S					
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	L			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
1. To understand the genetic and epigenetic etiology of human diseases 2. To appreciate the structure of DNA, chromosome and significance of human genome project 3. To learn about the cytogenetic techniques and genetic diagnosis 4. To acquire knowledge on Gene therapy and gene delivery systems														
Course Contents														
Unit	Content										Teaching /contact hours			
1	Introduction to Clinical Genetics; History of Human Genetics; Pedigrees- gathering family history, pedigree symbols, construction of pedigrees, presentation of molecular genetic data in pedigrees. Genetic counselling. Chromosome structure; Watson and Crick model of DNA, primary, secondary, tertiary and quaternary structure of DNA, Hoogsteens base pairing, triplex DNA, Quadraplex DNA. Various forms of DNA. Human Chromosomes - Nomenclature and karyotypes; Molecular structure of chromosomes – nucleosomal, chromatin and higher order structures; Chromosomal aberrations. Human Genome Project. ISCN nomenclature of constitutional and acquired chromosomal abnormalities; Computer-assisted karyotyping system.										5			
2	Human Genetic disorders - Single gene – Sickle cell anemia, Huntington's disease, Myotonic dystrophy, Cystic fibrosis, DMD. Polygenic and multifactorial disorders - Cleft lip palate, asthma, autism, epilepsy, hypertension, obesity, diabetes and cardiovascular diseases; Disorders of the Autosomes and the Sex chromosomes - Trisomy 21, trisomy 18, trisomy 13 - Deletion 4p, deletion 5p - Turner and Klinefelter syndromes - Triple X, XYY - Fragile X syndrome – Genomic imprinting and Uniparental Disomy - Prader-Willi and Angelman syndromes. Infertility – genetic basis of male and female infertility. Congenital malformations and teratogenesis. Inborn errors of metabolism , molecular and biochemical pathways and their basis of Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Lesch-Nyhan syndrome, Gout, Tay-Sachs disease, Gaucher's disease, Mucopolysaccharidosis, Galactosemia.										15			

	Behavioral Genetics - Fundamentals of molecular and behavioral genetics - genetics of cognitive disabilities, substance abuse, antisocial behavior and ADHD, Mood disorders, Schizophrenia.	
3	Oncogenes and human cancers - Mechanisms of oncogene activation – point mutations, fusion genes, gene amplification, chromosome rearrangements, promoter insertion. Tumor suppressor genes. Hereditary cancers - Retinoblastoma, Wilms’ tumour, Li-Fraumeni syndrome, colorectal cancer, breast cancer; Chromosome instability syndromes; DNA repair defects.	5
4	Cytogenetics - Chromosome preparation from leucocytes, bone marrow aspirates and skin biopsy; Differential and selective banding techniques – QFQ-, GTG-, RFA-, CBG- and AgNOR- banding, high resolution banding; Prenatal diagnosis - amniocentesis, chorionic villus sampling, percutaneous umbilical blood sampling, ultrasonography, maternal serum screening; Preimplantation genetic diagnosis. Chromosome analysis by flow cytometry. Chromosome analysis by flow cytometry; Fluorescence in situ hybridization – Multi-colour FISH - Spectral karyotyping - Comparative genomic hybridization - Chromosomal microarray analysis.	5
4	Gene therapy – definition, history, Somatic and Germ cell gene therapy. Gene therapy strategies - Gene augmentation Therapy, targeted cell killing – Prodrug activation, bystander effect, targeted inhibition of gene expression, Immunomodulation, Targeted gene correction - genome editing. Ethical considerations and limitations of gene therapy	4
5	Gene transfer/delivery systems overview – physical methods - Gene gun, naked DNA administration, Nebulization, Electroporation; Chemical methods – Transfection, Cationic lipids and liposomes, Antibody-mediated gene transfer; Biological methods - Adenoviruses, Adeno-associated viruses, Retroviruses, Mammalian artificial chromosome vectors.	2
6	Epigenetics - basic concepts – epigenome, epigenetic mechanisms of gene regulation – DNA methylation, histone modifications – acetylation, phosphorylation, deamination, ubiquitylation, sumoylation and ADP ribosylation, DNA binding proteins. Transcriptional gene silencing – Non coding RNAs (long and short), Micro RNAs (miRNA), small inhibitory RNA (siRNA). Genome imprinting and its defects in humans. Epigenetics and nutrition, role of epigenetics in major human diseases – cardiovascular, diabetes and cancer.	4

Text Books

- Title:** Clinical Genetics: A Case-Based Approach. Author(s): Vasilis K. Babikian, Alireza Baradaran-Heravi, R. Shane Tubbs, Marios Loukas Publisher: Thieme Medical Publishers; 2017. ISBN-10: 1626233380 ISBN-13: 978-1626233383
- Title:** Principles of Medical Genetics. Author: Sandy McCall Smith Publisher: Cambridge University Press, 2019. ISBN-10: 1108770995 ISBN-13: 978-1108770998
- Title:** Epigenetics in Medicine. Editor(s): Stephen B. Baylin and James E. Herman Publisher: Elsevier Science Publication date: 2018 Format: Hardcover ISBN-10: 0128116827 ISBN-13: 978-0128116824

Reference books

- Title:** Medical Genetics. Author(s): Lynn B. Jorde, John C. Carey, Michael J. Bamshad Publisher: Mosby Publication date: 2020 Format: Hardcover; ISBN-10: 0323527704 ISBN-13: 978-0323527700.
- Title:** Essential Medical Genetics. Author: Christopher A. Walsh Publisher: John Wiley & Sons, 2019. ISBN-10: 1119532954 ISBN-13: 978-1119532958

Course title	<i>Physics of Medical Imaging</i>									Course No	MS12			
Department	Medical Sciences	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0		6	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	S			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To introduce the fundamental physics of the imaging science To teach the physics of X-ray imaging, CT, MRI and ultrasonography Introduce nuclear medicine To familiarise the student with dosage and protocols of imaging 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Energy sources and tissue properties in medical imaging, fundamentals of electromagnetic radiation and its interaction with tissue, imparted energy, equivalent dose and effective dose										4			
2	Image quality – Measures, storage and medical image informatics										4			
3	Projection X-ray imaging – Components of the system including detectors, sensors and generators. Special considerations in x-ray imaging and breast mammography										4			
4	Computed Tomography – Fundamentals, CT system design, components, acquisition and reconstruction. CT radiation dose consideration. Advanced CT – Cardiac CT, CT perfusion and spectral CT										8			
5	Magnetic Resonance Imaging – Fundamentals of Magnetic resonance – MR signals, magnetisation properties of the tissue and image contrast. Fundamental image acquisition process k space – properties, data acquisition and image reconstruction. Signal from flow and Diffusion tensor imaging										8			
6	Ultrasonography – properties of sound, transducers and beam formation. Acquisition modes. Fundamentals of doppler imaging, artifacts in US										6			
7	Nuclear Imaging – radionuclides and counting systems Principles of Scintillation Camera Emitted Computed Tomography, SPECT and PET.										6			
Text Books														
<ol style="list-style-type: none"> Ehsan Samei and Donald Peck, Hendee's Physics of medical Imaging, 5th Edition, Wiley Blackwell, 2019 J.T. Bushberg, J.A. Seibert, E.M. Leidhdt and J.M. Boone, The Essential Physics of Medical Imaging, 4th Edition, Wolters Kluwer, 2020 														
Reference Books														
<ol style="list-style-type: none"> Slavik Tabakov et al., Encyclopaedia of Medical Physics : Two Volume Set, 2nd Edition, CRC Press, 2021 														

Course title	<i>Introduction to Biomedical Signal Processing</i>									Course No	MS13			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	0	6	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	S			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
To teach analysis of biomedical signals using mathematical techniques														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Introduction to important biomedical signals										3			
2	Fundamental concepts of signal processing – basic signals and signal comparisons,										9			
3	Fourier Transforms and power spectral density including data acquisition, truncation and applications										9			
4	Linear System analysis in frequency domain – transfer function and its representation , Laplace transform										8			
5	Linear system analysis in time domain										7			
6	Filters in biomedical signal processing										4			
Text Books														
1. John Semmlow, Signals and Systems for bioengineers, AP, 2012 2. Bruce E.N., Biomedical Signal Processing and Signal Modeling, Wiley, 2001														
Reference Books														
1. Rangayyan, R, Biomedical Signal Analysis, IEEE, 2015														

Course title	Statistics for Clinical Research									Course No	MS14			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	3	4	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	S			
Pre-requisite	MS3									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To teach the important statistical techniques used in clinical trials and research To expose the students to solve using tools such as R Introduce concepts through case studies 														
Course Contents														
Unit	Content									Teaching/contact hours				
1	Overview of clinical trials – Phases, and biostatistical aspect of a protocol									3				
2	Analysis of data in treatment comparison with and without covariates – statistical models including student's t-test, ANOVA etc									7				
3	Statistical models for time-to-event endpoints									4				
4	Statistical models and interpretation for longitudinal models									3				
5	Randomization, Sample size and Power calculation, incomplete data handling									7				
6	Bayesian Analysis of clinical trials									3				
7	Propensity Score Methods in Clinical Research									5				
8	Adverse events analysis									2				
9	Regulatory processes for approval									4				
Text Books														
<ol style="list-style-type: none"> Ding-Geng Chen and Peace K.E. Clinical Trial Data Analysis using R, CRC Press, 2011 Joe Shih W., Statistical Design and Analysis of Clinical Trials: Principles and Methods, Chapman & Hall, 2015 														
Reference Books														
<ol style="list-style-type: none"> Cleophas, T.J., Machine Learning in Medicine – A complete overview, Springer, 2020 														

Course title	<i>Quantitative Human Physiology</i>									Course No	MS15			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	3	4	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	MS2, MS3 and MS9									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To teach physiology from a modelling perspective To serve as a background for other physiology courses in higher semesters To emphasis the physical and chemical foundations of physiology 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	The core principles of physiology, Physical and Chemical foundations – pressure driven flow, Osmosis and Osmotic pressure, electrical force, potential etc., chemical foundations - Concentration and kinetics- Passive transport and facilitated Diffusion, Electrochemical potential and free energy										4			
2	Biological Electricity– The role of electricity – Nernst equation, Active transport – pumps and exchangers, The action potential – Membrane depolarization, The cable equation. Hodgkin – Huxley Model and membrane transport. FutzHugh-Nagumo model										4			
3	Skeletal Muscle Mechanics – Generation of muscle force, contractile mechanism, force – velocity relationship, cross-bridge model, smooth muscle – Hai – Murphy model. The excitation – contraction coupling and muscle energetics										6			
4	Metabolism: Energy, Heat, Work and Power, energy content of the body, metabolic rates, heat conduction and body temperature										8			
5	Case studies from physics based models of physiological systems										4			
The tutorial session will introduce software used in systems biology to solve the mathematical models														
Text Books														
<ol style="list-style-type: none"> J. Keener and J. Sneyd, Mathematical Physiology, Vol.1 & 2, Second Edition, Springer, 2009. Joseph Feher, Quantitative Physiology, Second Edition, AP, 2017 I.P. Herman, Physics of the human body, Second Edition, Springer, 2016 Michael C.K. Khoo, Physiological Control Systems, Wiley, 2018 														
Reference Books														
<ol style="list-style-type: none"> L. Sherwood, Human Physiology, Cenagage Learning, 2016 														

Course title	Basics of Pharmacology									Course No	MS16			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	2	6	11						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	MS10									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To understand the pharmacological concepts such as pharmacokinetics and pharmacodynamics of drugs. As well pharmacotherapy. To appreciate the mathematical modelling of pharmaco -kinetics and –dynamics. To acquire skills to calculate the combinatorial efficacy of therapeutic drugs and predict their outcome. To distinguish among the body of pharmacological agents and substances, based on their generic name, pharmacological classification, mechanism of action, clinical effects and side effects (adverse events and severe adverse events). Define various models representing rates and order of reactions and calculate pharmacokinetic parameters (eg, zero- and first-order) from experimental data based on these models. To attain hands on skill in pharmacological investigations (in vitro and pre-clinical) 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	i) Introduction, definitions and scope of pharmacology ii) Routes of administration of drugs –(Enteral route – Oral, Sub lingual & Rectal, Parenteral – Intra venous, intra muscular, subcutaneous, intra-arterial, intra thecal, Topical – dermal, transdermal, Ophthalmic, Otologic, Nasal) iii) Pharmacokinetics (absorption, distribution, metabolism and excretion) iv) Pharmacodynamics (physiological receptors, specificity of drug responses, signalling pathways, mechanism of drug action) v) Factors modifying drug effects (route of administration, rate and degree of absorption, rate of elimination, effect of other drugs, tolerance, idiosyncrasy and allergy) vi) Drug toxicity – (Acute, sub- acute and chronic toxicity) vii) Pre-clinical evaluations – (in vitro and in vivo studies – Animal studies) viii) Drug interactions – (synergism, antagonism & additive)										7			
2	Mathematical Pharmacology: i) Models to analyse the efficacy of combination therapy ii) Target Mediated Drug Disposition (TMDD) model iii) Mathematical analysis of ligand – receptor system iv) Pharmacokinetic – pharmacodynamic modelling and simulation v) Mathematical analysis of the pharmacokinetic-pharmacodynamic (PKPD) behaviour of therapeutic agents vi) Mathematical models in drug design and development vii) Free Energy Calculations in Rational Drug Design										13			
3	Chemotherapy i) Introduction – General principles of anti-microbial therapy, Sulfonamides and co-trimoxazole – Pharmacokinetics and Pharmacodynamics, Uses										10			

	<ul style="list-style-type: none"> ii) Penicillin's and Cephalosporin's – Classification of drugs, Mode of action, Mechanism of resistance, Anti-bacterial Spectrum, Dosage. iii) Tetracycline and Chloramphenicol - Mode of action, anti-bacterial Spectrum, Dosage. iv) Macrolides, Amino glycosides, Polyene & Polypeptide antibiotics - Classification of drugs, Mode of action, Anti -bacterial Spectrum, Dosage. v) Quinolines and Fluroquinolines - Classification of drugs, Mode of action, Anti-bacterial Spectrum, Dosage. vi) Antifungal antibiotics - Classification of drugs, Mode of action, Anti-fungal spectrum, Dosage. vii) Antiviral agents - Classification of drugs, Mode of action, Dosage, Uses viii) Chemotherapy of tuberculosis and leprosy – First line and second line Drugs, Mode of action, Dosage, Uses ix) Chemotherapy of Malaria – Classification of drugs, Pharmacokinetics and Pharmacodynamics, Dosage, Guidelines for Prophylaxis and therapy for malaria x) Chemotherapy of protozoal infections (amoebiasis, Giardiasis) - Classification of drugs, Mode of action, Dosage. xi) Pharmacology of Anthelmintic drugs - Classification of drugs, Mode of action, Dosage xii) Chemotherapy of cancer (Neoplasm's) – General Principles in Pharmacotherapy for cancer, Classification of drugs, Pharmacokinetic and Pharmacodynamic Parameters, Dosage, Uses. 	
4	<p>Cardiovascular drugs: Classification, mode of action and dosage of the following</p> <ul style="list-style-type: none"> i) Antihypertensive ii) Anti-anginal drugs iii) Anti-arrhythmic drugs iv) Drugs used for therapy of Congestive Heart Failure v) Drugs used for hyperlipidaemias <p>CNS drugs:</p> <ul style="list-style-type: none"> i) Adrenergic and anti-adrenergic drugs – types of Adrenergic receptors, endogenous catecholamine Classification of drugs, Pharmacokinetics and pharmacodynamics, Uses. ii) Cholinergic and anticholinergic drugs - types of cholinergic receptors, Classification of drugs, Pharmacokinetics and pharmacodynamics, Uses iii) Neuromuscular blockers – Classification of drugs & uses iv) Mydriatics and miotics - Classification of drugs & uses v) Drugs used in myasthenia gravis - Classification of drugs, Mode of action, Dosage vi) Drugs used in Parkinsonism - Classification of drugs, Mode of action, Dosage <p>Renal Drugs – Diuretics & anti-diuretics</p>	10
Text Books		
<ol style="list-style-type: none"> 1. Steven Strauss, David W.A. Bourne (1995). Mathematical Modeling of Pharmacokinetic Data. CRC Press; 1st edition. 2. A. Pecile (2013). Pharmacokinetics: Mathematical and Statistical Approaches to Metabolism and Distribution of Chemicals and Drugs: 145 (Nato Science Series A:); Springer. 3. Arkadiy Pitman, Oleksandr Sverdlov, L. Bruce Pearce (2019). Mathematical and Statistical Skills in the Biopharmaceutical Industry: A Pragmatic Approach (Chapman & Hall/CRC Biostatistics Series). Chapman and Hall/CRC; 1st edition. 4. M. Rami Reddy & Mark D. Erion (2001). Free Energy Calculations in Rational Drug Design. Springer. 5. Peter L. Bonate (2005). Pharmacokinetic-Pharmacodynamic Modeling and Simulation. Springer. 6. KD Tripathi (2016). Essentials of Medical Pharmacology. Jaypee Brothers Medical Publishers (P) Ltd. 7. Derek G. Waller, Anthony Sampson & Andrew Hitchings (2021). Medical Pharmacology and Therapeutics. Elsevier Health Sciences; 6th edition. 8. Bertram G Katzung & Anthony J Trevor (2020). Basic and Clinical Pharmacology. McGraw Hill Medical; Fifteenth edition (India edition). 		
Reference Books		
<ol style="list-style-type: none"> 1. Lawrence H. Lash (2010). Drug Metabolism and Transport: Molecular Methods and Mechanisms (Methods in Pharmacology and Toxicology). Humana (publisher). 		

2. Patrick F. D'Arcy, James C. McElnay & Peter G. Welling. Mechanisms of Drug Interactions: 122 (Handbook of Experimental Pharmacology); Springer.
3. KD Tripathi (2019). Pharmacological Classification of Drugs: With Doses and Preparations. Jaypee Brothers Medical Publishers; Sixth edition.
4. Qutaiba A Ibrahim (2011). Handbook of Drug Interaction and the Mechanism of Interaction. Xlibris (publisher).
5. Tara Shanbhag, Smita Shenoy (2020). Pharmacology for Medical Graduates. Elsevier India; 4th edition.
6. Ritter (2019). Rang & Dale's Pharmacology, International Edition, 9e. Relx India Pvt. Ltd (publisher).
7. Janet L. Stringer (2022). Basic Concepts in Pharmacology: What You Need to Know for Each Drug Class, Sixth Edition. McGraw Hill / Medical; 6th edition.
8. Ntambwe Malangu (2018). Pharmacokinetics and Adverse Effects of Drugs: Mechanisms and Risks Factors. IntechOpen (publisher).

Basics of Pharmacology – Practical		
S. No.	Content	Teaching/ contact hours
1	Animal handling and Different routes of administration in animals	6
2	In-silico pharmacokinetics of various drugs	3
3	In – Silico pharmacodynamics of various drugs	3
4	Analysis of pharmacopeial compounds and their formulations by UV-VIS (commonly used drugs (tablets/capsules) can be dissolved and quantified)	3
5	Techniques of blood sampling, anaesthesia, and euthanasia of experimental animals	6
6	Evaluation of CNS stimulant, depressant, anxiogenics and anxiolytic	3
7	Evaluation of analgesic, anti-inflammatory, local anaesthetic, mydriatic and miotic activity.	6
8	Record the concentration response curve (CRC) of acetylcholine using rectus Abdominus muscle preparation of frog	6
9	Evaluation of antiulcer activity by pylorus ligation method. Oral glucose tolerance test.	6
10	Study the effect of autonomic drugs on rabbit's eye	3

Course title	<i>Introduction to Basic and Clinical Neuroscience</i>									Course No	MS17			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			4	0	0	3	8	15						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To understand brain's components and understanding its function To enumerate cognitive neuroscience To understand the diseases of the brain To teach diagnostic measurements of neuroscience 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	The brain – neurons and glia, the neuronal membrane, action potential and synaptic transmission, neurotransmitter system and the structure of the nervous system										10			
2	Sensory and motor system – The eye, taste and smell, the auditory and vestibular system, the somatic sensory system, the brain and movement										12			
3	Neurobiology of human behaviour – Motivation, sex, sleep, language, attention and mental illness. Electroencephalogram										10			
4	Wiring of the brain, memory systems and learning										8			
5	Diseases of the brain – Diseases of the peripheral nerve and motor unit, seizures and epilepsy, schizophrenia, disorders of mood and anxiety, neurodegenerative diseases										8			
6	Diagnostic Measurements in neuroscience										6			
The student will spend half a day a week in the hospital to connect theory and practice														
Text Books														
<ol style="list-style-type: none"> Eric Kandel, J.D. Koester, S.H. Mack and S.A. Siegelbaum, Principles of Neuroscience, McGrawHill, 2021 M.K. Bear, B.W. Connors and Michael A. Paradiso, Neuroscience, Exploring the brain, 2016 														
Reference Books														
<ol style="list-style-type: none"> J. Jankovic et al., Neurology in Clinical Practice, Two Volumes, 8th edition, Elsevier, 2021 														

Course title	<i>Physiology of the Sensory System – Vision, Smell, Taste and Hearing</i>									Course No	MS18			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	2	6	11						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
To understand the physiology of the sensory system and the diagnostic tools used														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Physiology & physics of the eye – image formation and focussing, eye as a compound lens, optical aberration and accommodation										6			
2	Anatomy of the retina, visual processing in the retina, cornea, sclera, vitreous, lens. Three dimensional rotations of the eye and protection to the eye. Ocular fluid dynamics										10			
3	Visual perception										4			
4	Diseases of the eye and devices such as fundus scope, OCT etc										4			
5	Sound, speech and hearing – speech production – types of sound, systems in speech production, energetics										6			
6	Structure and function of the major components of the ear										3			
7	Testing of the ear and prosthetic devices of the ear										3			
8	Chemical Senses – taste and smell – taste receptors and structure of olfactory receptors, odour discrimination										4			
Suitable laboratory realting to the eye, ear testing instruments will be conducted at the hospital.														
Text Books														
1. Leonard A. Levin et al., ADLER’S Physiology of the eye, Saunders Elsevier, 2011 2. I.P. Herman, Physics of the human body, 2nd edition, Springer, 2015														
Reference Books														
1. Guyton and Hall, Medical Physiology, Elsevier, 2008														

Course title	<i>Introduction to Reproductive system</i>									Course No	MS19			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	0	4	6						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
1. To educate on the tests done in endocrinology and reproductive medicine														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Reproductive systems – male and female reproductive physiology										3			
2	Reproductive endocrinology -										3			
3	Fertilisation and pregnancy										3			
4	Electronic foetal monitoring and foetal ultrasound										10			
Text Books														
1. Linda J. Heffner and Daniel J. Schust, Reproductive system at a glance, Wiley Blackwell, 2014. 2. Lauralee Sherwood, Human Physiology, 9th edition, Cengage, 2016. 3. X. Guo (ed), Electronic foetal monitoring, Springer, 2021														
Reference Books														
1. Shlomo Melmed et.al, Williams Textbook of Endocrinology, 14th edition, Elsevier, 2019														

Course title	<i>Introduction to Endocrinology</i>									Course No	MS21			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	0	4	6						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
1. To expose the students to the clinical aspects of endocrinology and reproductive medicine.														
Course Contents														
Unit	Content										Teaching/contact hours			
1	An overview of endocrinology										3			
2	Hypothalamus & Pituitary – its functions and cooperation										3			
3	Growth Hormones and other factors for growth, bone growth, pineal gland and circadian rhythms										3			
4	The peripheral endocrine glands – thyroid & adrenal										3			
5	Control of fuel metabolism – mechanism, role of pancreas and liver, diabetes mellitus. Mathematical modelling of diabetes mellitus, insulin and non-insulin agents for diabetes										8			
6	Parathyroid and control of calcium metabolism										3			
7	Hypothalamus and pituitary gland										3			
8	Neuroendocrine control of the release of gonadotropin, prolactin and thyroid hormone										3			
9	Hypothalamic control of food intake - obesity										4			
10	Neuroendocrine control of stress axis, Neuroendocrine control of biological rhythms										5			
Text Books														
1. Linda J. Heffner and Daniel J. Schust, Reproductive system at a glance, Wiley Blackwell, 2014. 2. Lauralee Sherwood, Human Physiology, 9th edition, Cengage, 2016. 3. X. Guo (ed), Electronic foetal monitoring, Springer, 2021														
Reference Books														
1. Shlomo Melmed et.al, Williams Textbook of Endocrinology, 14th edition, Elsevier, 2019														

Course title	<i>Introduction to Surgery and Surgical Devices</i>									Course No	MS22			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	3	4	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To introduce various equipments used in surgery Familiarise the student with surgical procedures Introduce post operative care 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Surgical instruments used in general surgery, cardiothoracic, ENT, Orthopaedics, Urology.										3			
2	Anaesthetic equipment										4			
3	Surgical techniques and likely complications of common surgeries Common surgeries where technology places a significant role, etc. Cardiac, Nero, Gastrointestinal, orthopaedic, etc.										17			
The student will spend half a day per week in the hospital														
Text Books														
<ol style="list-style-type: none"> Umut Sarpel, Surgery- an introductory guide for medical students, Springer, 2021 Kelvin Yan, Surgical and Anaesthetic instruments for OSCEs, CRC Press, 2021 														
Reference Books														
<ol style="list-style-type: none"> Paul A. Iaizzo, Handbook of Cardiac Anatomy, Physiology and Devices, Springer, 2009 														

Course title	AI in Medicine									Course No	MS23			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	3	4	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	S			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
To teach the techniques and underlying mathematics of machine learning in medicine														
Course Contents														
Unit	Content									Teaching/contact hours				
1	Introduction to ML in medicine and overview of type of medical data and pre-processing and cleaning of data. Interpretation of results									5				
2	Supervised learning in medicine – Classification, Linear models, decision trees, random forests, SVMs etc.									10				
3	Unsupervised learning – Clustering algorithms, dimensionality reduction and non-negative matrix factorization									7				
4	Theory of Neural Network, CNN etc. and applications in medicine									8				
5	Application of ML in medicine such as diagnosis, prognosis, clinical decision etc.									8				
6	Ethics in ML in medicine									1				
Text Books														
1. Cleophas, T.J., Machine Learning in Medicine – A complete overview, Springer, 2020 2. Subhi JA et. al, Machine learning in cardiovascular medicine, Academic Press, 2020														
Reference Books														
1. Field Clay, Data Science Handbook, Wiley, 2017														

Course title	<i>Introduction to Nephrology & Gastroenterology</i>									Course No	MS24			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			4	0	0	3	8	15						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
To teach physiology and the pathology of nephrology and gastroenterology														
Course Contents														
Unit	Content										Teaching/contact hours			
1	The anatomy of the renal system and its function										3			
2	Renal physiology – Glomerular filtration and renal blood flow, tubular functions, Sodium – Potassium balance, Water balance, Acid – base balance. Mathematical modelling of renal function										15			
3	Diseases of the kidney and diagnostic measurements. Dialysis – concept and the machine										6			
4	Gastrointestinal anatomy										3			
5	General aspects of digestion – mouth, pharynx and oesophagus, stomach, pancreatic and biliary secretion, intestines and GI hormones										0			
6	Introduction to gut microbiome										4			
7	Diseases of the GI system and the diagnostic tools.										8			
8	Mathematical models of the GI system										3			
Text Books														
1. J Larry Jameson and J. Loscalzo Harrison's Nephrology and Acid – Base Disorders, McGrawHill, 2010														
2. L. Sherwood, Human Physiology, 9th edition, Cengage, 2016														
Reference Books														
Moinuddin, Irfan K., and David J. Leehey. Handbook of Nephrology. Wolters Kluwer Health/Lippincott Williams & Wilkins, 2013.														

Course title	<i>Finite Element Method for Physiologists</i>									Course No	MS25			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	0	6	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
To introduce the fundamentals of finite element method for physiology modelling														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Introduction to finite element methods – One dimensional Element and Computational Procedures. Formulation techniques – Variational Methods and virtual work principle Isoparametric Elements – Formulation. Introduction to structural elements.										8			
2	Non-linear finite element – solution procedure, Total Lagrangian, Updated Lagrangian and Arbitrary Eulerian Lagrangian										10			
3	Element formulations – hybrid, reduced integration and hourglass stabilization. Shell element formulation										8			
4	Contact Algorithms with examples from anatomy and physiology										3			
5	Computational Fluid Dynamics for modelling physiological systems.										8			
6	Algorithms for Fluid Structure Interaction and applications in physiological modelling										4			
Text Books														
<ol style="list-style-type: none"> Yohan Payan and J. Ohayon, Biomechanics of living Organs Hyperelastic Constitutive laws for finite element modelling, Academic Press, 2017 Ted Belytschko et al., Non-linear Finite Elements for Continua and Structures 2nd Edition, Wiley, 2013 														
Reference Books														
<ol style="list-style-type: none"> Rene de Borst et al., Non-linear finite element analysis of solids and structures, Wiley, 2012 														

Course title	<i>Medical Image Analysis</i>									Course No	MS26			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			2	0	0	3	4	9						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To introduce mathematical and software tools to analyse medical images – MRI/CT/X-rays/Ultrasound. To teach traditional techniques in analysing medical images To demonstrate deep learning-based methods in medical image analysis To illustrate case studies and encourage students to carry out a research project 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Fundamentals of Mathematics in image analysis - Image transformations										4			
2	Classical image processing techniques – Noise removal, Image enhancement, classification, segmentation, registration, and visualization										12			
3	Fundamentals of deep learning principles in image analysis – Convolutional neural networks										6			
4	Deep learning-based image analysis techniques in noise removal, object detection, segmentation, registration, visualization and rendering										12			
5	Research based case studies in analysing X-rays/ CT/ MRI and Ultrasound										6			
Text Books														
<ol style="list-style-type: none"> Bankman, Isaac, ed. Handbook of medical image processing and analysis. Elsevier, 2008. Zhou, Kevin, Hayit Greenspan, and Dinggang Shen, eds. Deep learning for medical image analysis. Academic Press, 2017. 														
Reference Books														
<ol style="list-style-type: none"> Toennies, Klaus D. Guide to medical image analysis. Springer London, 2017. 														

Course title	<i>Cardiovascular & Respiratory Mechanics & Hemodynamics</i>									Course No	MS27			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			4	0	0	3	8	15						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To introduce cardiac and respiratory mechanics To familiarise the students with the diseases of the heart and lungs To impart knowledge of devices and therapies 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Anatomy and physiology of the heart – Cardiovascular system, electrical activity of the heart, ECG and its interpretation										13			
2	Cardiac muscle mechanics, function & cycle, Neurohumoral control of the heart. Wave travel and reflection, heart as a pump, Ventriculo-Arterial coupling, arterial and pulmonary hemodynamics. Mathematical Modelling of the circulatory system										13			
3	Respiratory physiology and mechanics of respiration, alveolar – capillary exchange, oxygen and carbon dioxide transport, control of respiration. Mathematical models in respiratory mechanics										13			
4	Diseases of the heart and lungs. Diagnostic measurement tools										8			
5	Familiarising with Devices and therapies – pharmacotherapy, cardiac ablation and arrhythmias, cardiac pacemakers, surgical interventions, LVADS and ECMO										5			
The student will spend half a day per week in the hospital														
Text Books														
<ol style="list-style-type: none"> Nocolas Westerhof et al., Snapshots of hemodynamics, Springer, 2019 Richard E. Klabunde, Cardiovascular Physiology Concepts, Lippincot, Willims & Wilkins, 2005 														
Reference Books														
<ol style="list-style-type: none"> Paul A. Iaizzo, Handbook of Cardiac Anatomy, Physiology and Devices, Springer, 2009 														

Course title	Orthopaedic Biomechanics									Course No	MS28			
Department	Medical Sciences and Technology	New Credits	L	T	E	P	O	C	TH	Old Credits	L	T	P	C
			3	0	0	3	6	12						
Offered for	B.S. (Medical Sciences and Engineering)									Status	New			
Faculty										Type	P			
Pre-requisite	None									To take effect from	July 2023			
Submission date	Date of approval by DCC			Date of approval by BAC						Date of approval by Senate				
Description														
L: Lecture, T: Tutorial, E: extended tutorial, P: Lab, O: outside class hours, C: credits.														
Objectives														
<ol style="list-style-type: none"> To familiarise the students with the musculoskeletal system To expose the students to Kinesiology and software such as OpenSim To understand the concept of fracture healing To teach the fundamentals of sports biomechanics 														
Course Contents														
Unit	Content										Teaching/contact hours			
1	Kinematic and kinetic concepts for analysing human motion, the biomechanics of human bone growth, human skeletal articulation and human skeletal muscles										10			
2	Introduction to Opensim – Kinesiology of the upper and lower extremities and axial skeleton										7			
3	Trauma Biomechanics – the science of fracture healing, fracture fixation devices										6			
4	Designing of prosthetics – total hip and knee replacements.										6			
5	Fundamentals of sports biomechanics										6			
6	Diseases of the musculoskeletal system										5			
Open Sim for simulation in the lab. Lab includes hospital visits.														
Text Books														
<ol style="list-style-type: none"> Susan J. Hall, Basic Biomechanics 8th Edition, McGrawHill 2015 Donald A. Neumann, Kinesiology of the Musculoskeletal System, 3rd Edition, Elsevier, 2017 S.S. Malik and S.S. Malik, Orthopaedic Biomechanics, Cambridge Univ. Press, 2015 														
Reference Books														
<ol style="list-style-type: none"> I.P. Herman, Physics of the Human Body, 2nd Edition, Springer 														