Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	EC351	**Title of the Course**	Computational Methods for Signal and Image Processing	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	MT201	**Co-requisite**					
Course Objectives	To teach students time domain, frequency domain, discrete time signals, properties and digital filter design techniques To provide knowledge on basic concepts of image and its processing techniques To provide knowledge on Enhancement, Restoration, Segmentation techniques To provide hand on experience of signal & image processing techniques using MATLAB						

Course Outcomes	
CO1	Understand and appreciate the concept of a metric space and be able to recognize standard examples.
CO2	Write given function in terms of sine and cosine terms in Fourier series and also to get knowledge in Fourier transforms.
CO3	To enable the students to study Fourier Transforms and some concepts of infinite Fourier Sine and Cosine transforms, finite Fourier Sine and Cosine transforms and applications to solve some infinite and boundary value problems using finite and infinite transforms.
CO4	Understand wavelet basis and characterize continuous and discrete wavelet transforms
CO5	Design certain classes of wavelets to specification and justify the basis of the application of wavelet transforms to different fields

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to Metric and Normed Spaces	Metric Space, Normed Space, Inner Product Space, Orthogonality, L2 ,l2 and Lp spaces and their properties, concept of convergence, point wise and uniform convergence, different inequalities in L_2 ,l_2 and Lp spaces. The Bases - Best approximation, Orthogonal complement and projection theorem, Orthonormal basis and some common example, Orthogonal direct sums, Dual Spaces, and Adjoints.	8	CO-1
2	The Fourier Series	Historical perspective, Computation of fourier series - on interval [,] $-\pi$ π , on general interval, Cosine and Sine Expansion. The complex form of Fourier series. Convergence of Fourier series – Riemann-Lebesgue Lemma, Convergence at a point of continuity, Convergence at a point of discontinuity, Uniform convergence, Convergence in the Mean.	8	CO-2
3	The Fourier Transform (L1 (R) L2 (R),):	Development of Fourier transform, Fourier inversion theorem, Properties of the Fourier Transform – Basic properties, Poisson summation formula, Fourier transform of a convolution, approximate identity, Adjoint of the Fourier transform. Linear filters, Sampling theorem, and Uncertainty Principle. Idea of discrete Fourier	8	CO-3
4	Wavelet Analysis and Wavelet Transform	Why wavelets, Haar wavelet – Scaling function and its different properties. Haar decomposition and reconstruction algorithm. Daubechies wavelets - Daubechies construction; classification, Moments, and Smoothness; Computational issues; The scaling function at dyadic points. Wavelet Transform - Definition of Wavelet transform, Relation with Fourier Transform, Inversion formula for the Wavelet Transform, Local properties.	8	CO-4
5	Other Wavelet Topics	Idea of multiresolution analysis, Wavelets in higher dimensions, Wavelet packets, Orthogonality and Scaling equation via Fourier transform. Application: Signal enhancement, function approximation, deconvolution, image processing, speech processing etc.	8	CO-5

Reference Books:

Albert Boggess and Francis J. Narcowich, A First Course in Wavelets with Fourier Analysis, WILEY, 2009.

Stephen Mallat, A Wavelet tour of signal processing the sparse way, 3rd edition, Academic Press, 2009.

George Bachman, Lawrence Narici, Edward Beckenstein, Fourier and Wavelet Analysis, SPRINGER, 2000.

Ingrid Daubechies, Ten Lectures on Wavelets, SIAM, 1992.

e-Learning Source:

https://nptel.ac.in/courses/108101093

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	2		1	1		2	1		2	3	2	3
CO2	3	3	3	2	1	1			1	1		2	3	2	3
CO3	3	3	2	2		1			1		2	2	3	1	3
CO4	3	3	2	2		1	1		2	1		2	3	1	3
CO5	3	3	3	2				1	1			2	3	1	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	EC350	**Title of the Course**	Microprocessor System Lab	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	0	0	4	2
Pre-Requisite		**Co-requisite**					
Course Objectives	The main objective of this lab course is to gain the practical hands-on experience of programming the 8086 microprocessor and 8051 microcontroller and also to gain knowledge on interfacing of different peripherals to microprocessor. Microprocessor technology is an exciting, challenging and growing field which will pervade industry for decades to come. To meet the challenges of this growing technology, one has also to be conversant with the programming aspects of the microprocessor and microcontroller.						

Course Outcomes	
CO1	Ability to understand microprocessor basics.
CO2	Ability to understand and analyze different microprocessor and microcontroller architectures.
CO3	Ability to familiarize Instruction sets.
CO4	Ability to develop Programming skills.
CO5	Ability to understand different Simulation Environments

Experiment No	**Title of the Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-1	Write an assembly language program to add two 16 bit hexadecimal number without carry	4	CO-1
2	Exp-2	Write an assembly language program to add two 16 bit hexadecimal number with carry	4	CO-1
3	Exp-3	Write an assembly language program to multiply two 16 bit hexadecimal numbers.	4	CO-2
4	Exp-4	Write an assembly language program to Subtract Two Multibyte Numbers	4	CO-2
5	Exp-5	Write an assembly language program to Move a Block of Data without Overlap	4	CO-3
6	Exp-6	To write an assembly language program to convert a 16 Bit Hexadecimal Number to Decimal Number.	4	CO-3
7	Exp-7	Write an assembly language program to find largest no from the given array	4	CO-4
8	Exp-8	To write an alp to sort a given set of 16bit unsigned integers into ascending order using bubble sort algorithm.	4	CO-4
9	Exp-9	To write an alp to sort a given set of 16bit unsigned integers into descending order using bubble sort algorithm.	4	CO-5
10	Exp-10	To write an alp to find the square of a number	4	CO-5

Reference Books:

Ramesh S Goankar, “Micropocessor Architecture: Programming and Applications with the 8085”, Penram International, Fifth Edition, 2002.

Jochen Steve Furber, “ARM System-on-Chip Architecture”, Addison Wesley Trade Computer Publications, Second Edition, 2000.

e-Learning Source:

http://vlabs.iitb.ac.in/vlabs-dev/labs_local/microprocessor/labs/explist.php

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1		1	1			1	3	2	3
CO2	3	3	3	2	1	1			1			1	3	2	3
CO3	3	3	3	2	1	1			1				3	1	3
CO4	3	3	3	2	1				2				3	1	3
CO5	3	3	2	2					1				3	1	3

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	EC349	**Title of the Course**	Biomedical Signal Processing Lab	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	V	0	0	4	2
Pre-Requisite		**Co-requisite**					
Course Objectives	Developing advanced signal processing and estimation methods for analyzing and understanding biomedical signals. Advancing our knowledge of pathophysiology through the investigation of behavior that manifests in physiologic signals. Providing opportunities for student participation in rigorous research methodology and the dissemination of knowledge. Contributing to regional and national biomedical research.						

Course Outcomes	
CO1	Examine the frequency response and impulse response of discrete-time LTI systems.
CO2	Interpret discrete-time signals using DFT
CO3	Apply FFT algorithms for various signal processing operations
CO4	Analyze IIR and FIR digital filters
CO5	Design IIR and FIR digital filters for real time DSP applications

Experiment No	**Title of the Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Signal Conversion	Analog to Digital conversion &it's reconstruction back to analog signal.	4	CO-1
2	Multiplexing	To study 2 channels Time Division Multiplexing and sampling of analog signal and it's demultiplexing and reconstruction of the analog signal in receiving section.	4	CO-1
3	Coding Techniques	Study of data coding and decoding techniques for Non-return to Zero formats such as a) Non return to Zero-Level(NRZ-L) b) Non return to Zero-Mark(NRZ-M) c) Return to Zero(RZ)	4	CO-2
4	Shift Keying	Generation of ASK signals using MatLab and display the waveform.	4	CO-2
5	FFT	FFT method of signal analysis and signal frequency detection using MatLab.	4	CO-3
6	Noise	Identification of signal frequencies for a noisy signal usingperiodogram frequency analysis using MatLab	4	CO-3
7	Filter Design	To study the performance and design of the cheb2ord analysis Filters using MatLab	4	CO-4
8	Filter Design	To study of Linear convolution to find the system response using MatLab	4	CO-5

Reference Books:

Akay, Metin. Biomedical signal processing. Academic press, 2012.

Challis, R. E., and R. I. Kitney. "Biomedical signal processing (in four parts)." Medical and Biological Engineering and Computing 29.1 (1991): 1-17.

e-Learning Source:

https://bmsp-coep.vlabs.ac.in/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1		1	1			1	3	2	3
CO2	3	3	3	2	1	1			1			1	3	2	3
CO3	3	3	3	2	1	1			1				3	1	3
CO4	3	3	3	2	1				2				3	1	3
CO5	3	3	2	2					1				3	1	3

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	EC348	**Title of the Course**	Biomedical Signal Processing	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	MT201	**Co-requisite**					
Course Objectives	Understand the basic signal analysis (spectral analysis etc) of biological signal. Design IIR, and FIR filters for band pass, band stop, low pass and high pass filters.Analyze the spectral parameter of window functions. Analyze the ECG signal with the different sequence. Study the biological signals generated by the other part of body with the help of electronics instruments.						

Course Outcomes	
CO1	**Use** concepts of trigonometry, complex algebra, Fourier transform, z-transform to analyze the operations on signals and acquire knowledgeabout Systems
CO2	**Understand** time response of IIR Digital Filter with different methods
CO3	**Examine** the time response of the FIR filter with the help of windowing techniques.
CO4	**Able** to detect the patient response through the behavior of ECG signal
CO5	**Analyze** the human biological signals which are generated by the body such as EEG signal, PMG signal, EMG signal and VMG signal.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Fundamentals of Signal Processing**	Sampling and aliasing, simple signal conversion systems, spectral analysis FFT -decimation in time algorithm Decimation in Frequency algorithm Different types of bioelectric signals and its basic characteristics	8	CO-1
2	**IIR Filters**	IIR Digital Filter Design and its ApplicationsImpulse invariant method Bilinear transformation method Design of bilinear transformation method using Butterworth technique Design of impulse invariant method using Butterworth technique Design of bilinear transformation Method- using Chebyshev techniqueDesign of impulse invariant method using Chebyshev technique	8	CO-2
3	**FIR Filters**	FIR filter design using windowing techniques- rectangular window Hamming window Hanning window Blackmann window Time domain filters- synchronized averaging, moving average filters	8	CO-3
4		P-wave detection, QRS complex detection-derivative based method, PanTompkins algorithm Template matching method, Signal averaged ECG	8	CO-4
5		ECG rhythm analysis, normal and ectopic ECG beats, analysis of exercise ECG Analysis of respiration, spectral analysis of EEG signalsCase studies- in ECG and PCG PCG and carotid pulse,ECG and atrial electrogram d Cardio respiratory interaction EMG and Vibromyogram (VMG)	8	CO-5

Reference Books:

Rangaraj.M.Rangayyan, “Biomedical signal processing”, Wiley-IEEE press, 2nd Edition, 2015.

S.Salivahnan, C.Gnanapriya, “Digital signal processing”, Tata McGraw-Hill, New Delhi, 2nd Edition 2011

e-Learning Source:

https://nptel.ac.in/courses/108105101

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	2	2	2	3	1	-	-	-	-	3	3	-	-
CO2	3	3	2	2	2	3	2	2	-	-	-	-	2	3	-	-
CO3	3	3	3	2	2	3	3	3	-	-	-	-	3	3	-	-
CO4	3	3	2	2	2	3	3	3	-	-	-	-	3	3	-	-
CO5	3	3	3	3	2	2	3	3	-	-	-	-	3	3	-	-

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	EC347	**Course**	Bio Control Systems	**L**	**T**	**P**	**C**
Year	III	**Semester**	V	**3**	**1**	**0**	**4**
Pre-Requisite	Mathematics, Basic Electrical Engineering	**Co-requisite**					
Course Objectives	❖ To understand the concepts of control system and their applications. To provide a systematic approach to interpret different physical systems, mechanical systems and electrical systems and construct the equivalent electrical model of mechanical system. To learn about the representation of a system by transfer function ❖ To learn the analysis of a system in time domain and predict the transient performance parameters of a system for different standard inputs. To understand the basic concepts of different types of controllers. ❖ To learn the analysis of a system in frequency domain by Polar Plots, Nyquist Plot and						

Course Outcomes	
CO1	Given a system, students shall be able to **represent** the system in mathematical form, **identify** type of the system**, apply** block reduction technique and Mason's Gain formula to obtain the transfer function of the given system, and **formulate** differential equation to represent the model of a mechanical system into equivalent electrical system and **solve** using Laplace transform.
CO2	For a given system, **student** shall be able to **analyze** and **evaluate** the system in time domain and **predict** the performance in time domain for different standard input signals. **Evaluate** the steady-state error.
CO3	For a given system, **student** shall be able to **analyze** and **evaluate** the stability of the system by different methods.
CO4	For a given system, student shall be able to **analyze** the system in frequency domain and explain the nature of stability. **Examine** and **analyze** the stability by Nyquist criterion and Bode Plot.
CO5	For a given a system, student shall be able to **understand** Cardiovascular Control System, Endocrine Control Systems, Pupil Control System, Skeletal Muscle

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**Introduction to Control Systems**	Types of systems - Open loop systems, closed systems, Effects of feedback, Block diagram algebra and Signal flow graphs, Mathematical Models of Physical systems: Differential equations, Transfer functions andblock diagrams of simple electrical networks, Translational and Rotational mechanical systems.	8	1
2	**Time Domain Analysis**	Standard test signals, Time response of first order and second order systems with unit step as input, Time domain specification, steady state errors and static error constants, P, PI, PD and PID controllers, Concept of stability	8	2
3	**Stability**	Concept of stability, Routh stability criterion qualitative stability andconditional stability. the Root locus concept, construction of root loci	8	3
4	**Frequency Domain Analysis**	Frequency response of the systems - Correlation between time and frequency responses - Gain and phase margins, Bode plots, Polar Plots, Nyquist stability Criteria.	8	4
5	**Bio Control**	Examples of Biological control Systems: Cardiovascular Control System,Endocrine Control Systems, Pupil Control System, Skeletal Muscle	8	5

Reference Books:

1. B.C Kuo, Automatic Control System, PHI
2. Katsuhiko Ogata, Modern Control Engineering, PHI
3. I.J.Nagrath & M.Gopal, Control System Engineering, New Age International Publisher

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO 1	3	3	2	1	1	1		1	1			1	3	3	2	1
CO 2	3	3	3	2	1	1			1			1	3	3	2	1
CO 3	3	3	3	2	1	1			1				3	3	2	1
CO 4	3	3	3	2	1				2				3	3	2	1
CO 5	3	3	2	2					1				3	3	2	1

Integral University, Lucknow

Effective from Session:							
Course Code	EC 346	**Title of the Course**	**Microprocessor System In Medicine**	**L**	**T**	**P**	**C**
Year	**THIRD**	**Semester**	FIFTH	**3**	**1**	**0**	**4**
Pre-Requisite		**Co-requisite**					

Course Objectives

- To produce skillful graduates to analyze, design and develop a system/component/process for the required that are helpful in the medical field.
- To train the students to approach ethically the challenges faced in treating anydisease by applying technology.
- To create awareness among the students about the need for application oftechnology in the medical field.

Course Outcomes

CO1	Students shall be able to understand the microprocessor's internal architecture and its operation, describe the memory organization, types of mapping, also analyze the design aspects of I/O and memory interfacingcircuits.
CO2	Students shall be able to understand the internal architecture and organization of 8086, design and developassembly language programs and will be able to Compare and select the appropriate Microprocessor (8085 & 8086) according to the applications.
CO3	. Students shall be able to analyze and compare the features of microprocessors and Micro controllers also they will be able to plan small circuits for various applications
CO4	Students shall be able to describe the functions of different peripherals and able to apply the concepts of interfacing microprocessors with peripheral devices(8255,8259 etc)..
CO5	Students shall be able to describe the functions of different biomedical devices using arm .

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	**INTRODUCTI ON TO INTEL8085**	Evolution of Microprocessor and its importance in biomedical domain, -Architecture of 8085 - Instruction format - Addressing modes - Basic timing diagram of opcode fetch, memory read, memor write, I/O read and I/O write - Interrupts of 8085 - Software interrupts, Hardware interrupts	- y 8	1
2	**INTRODUCTION TO 8086**	**INTRODUCTION TO 8086** Architecture and signal description of 8086, Architecture of 8086 - Registers set of 8086 - Special function of general purpose register - Addressing modes of 8086 - Instruction set - pin diagram of 8086 - Timing diagram- memory read, memory write, I/O read and I/O write - Minimum and Maximum mode of operation Interrupts of 8086	8	2
3	**MICROCONT ROLLER**	**MICROCONTROLLER** Introduction to 8 - bit Microcontrollers - 8051 Microcontroller Architecture - Registers set of 8051 - modes of Timer operation - Serial Port operation - Interrupt Structure of 8051 - Memory and Input / Output Interfacing of 8051	8	3
4	**Interfacing devices-**	**Interfacing devices-** 8255 Programmable Peripherals InterfaceArchitecture & various modes of operation – 8251, DMA Controller Architecture & Programming features.Interfacing with ADC and DAC, LCD, keyboard Interface..	8	4
5	**Application In Medicine**	**Application In Medicine** Mobile phone based bio signal recording, pulse oximeter circuit using ARM microcontroller, pulse oximeter circuit using ARM microcontroller	8	5

Reference Books:

1. Ramesh S Gaonkar, Microprocessor Architecture, Programming and application with 8085, 4 th Edition, Penram International Publishing,
2. Kennith J Ayala, 8051 Microcontroller, Thomson, 2005.
3. Dougles V Hall, Microprocessor and Interfacing, Tata MC Graw Hill Publication, 2nd Edition, 1992.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	
CO1	**3**	**2**	**2**		**1**	**1**		**1**				**1**	**3**	**2**	**1**	
CO2	**3**	**3**	**3**	**2**	**1**	**1**			**1**			**1**	**3**	**3**	**1**	
CO3	**3**	**3**	**3**		**1**	**1**			**1**				**3**	**2**	**1**	
CO4	**3**	**3**	**3**	**2**	**1**				**2**			**1**	**3**	**3**		
CO5	**3**	**3**	**2**	**2**	**2**	**1**			**1**			**1**	**3**	**2**		

1-

Name & Sign of Program Coordinator	Sign & Seal of HoD

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	BE364	**Title of the Course**	Biomedical Nanotechnology	**L**	**T**	**P**	**C**
Year	3	**Semester**	5	3	1	0	4
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	To impart knowledge of principles of nanoscience and nanotechnology, synthesis characterization of nano-structured materials and equipment, promote innovation and foster translational research for the basic and applied biomedical applications.						

Course Outcomes	
CO1	The students will be equipped with interdisciplinary knowledge of physics, chemistry and biology in the field of nanotechnology at a single platform. They will understand the principles of nanotechnology and change in properties at nanoscale.
CO2	The students will acquire the knowledge of synthesis and characterization of nanomaterials for its various biomedical applications.
CO3	They will develop the understanding of utilizing biomolecules for designing tools and equipment (diagnostic tool, biosensors, smart drug delivery systems) for various applications in food, medicine and health science.
CO4	To gain knowledge about the principle, working and applications of nanobiosensors in biomedical, diagnosis and environmental sector.
CO5	Develops the ability to incorporate nanotechnology in the existing technology for the welfare of human and society. The also aware about the potential risks and ethical regulations associated with the emerging technology before their real-world application.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Introduction to nanobiotechnology	Introduction to nanotechnology, Physical and Chemical properties of materials at nanoscale, Classification based on dimensionality, Challenges and opportunities associated with biology on the Nanoscale, Types of Nanomaterials, Biological and medical applications of Bionanomaterials.	8	CO1
2	Classification & Synthesis of Nanomaterials & Characterization Techniques	Physical, Chemical and Biological Methods of Nanomaterial Synthesis, Characterization of Nanomaterials – Surface Potential and DLVO theory, SEM, TEM, STM, AFM, Confocal and TIRF Imaging.	8	CO2
3	Biomolecules Based Nanostructures	DNA nanotechnology, DNA nanowires, Protein & Glyco nanotechnology, Lipid nanotechnology, Bio-nanomachines, Carbon nanotube and its bio-applications.	8	CO3
4	Nanobiosensors	Introduction to Nanobiosensors, Types of Nanobiosensors: Magnetic biosensors, Electrochemical biosensors, Nanotube based sensors, Nanowire based sensors, Applications of Nanobiosensors: Biomedical, Diagnostic & Environmental Applications.	8	CO4
5	Nanotechnology in Medicine and Health Science	Nanocircuitry, Ultra sound triggered Nano/Microbubbles, Bioconjugation of Nanomaterials, Nano particle Based Drug delivery systems, Nanotoxicology: Toxicity and Environmental Risks of Nanomaterials	8	CO5

Reference Books:

1. Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
2. Niemeyer C. M., "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley –VCH, 2006.
3. Mirkin, C.A. and Niemeyer, C.M., "Nanobiotechnology II: More Concepts and Applications", Wiley-VCH. (2007).
4. Kumar, C. S. S. R., Hormes, J. and Leuschner C., "Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact", WILEY -VCH Verlag GmbH & Co. (2005).
5. Lamprecht, A., "Nanotherapeutics: Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing Pte. Ltd. (2009).
6. Jain, K.K., "The Handbook of Nanomedicine", Humana press. (2008).
8. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004.

e-Learning Source:

1. https://nptel.ac.in/courses/102107058
2. Malik, Parth, et al. "Nanobiosensors: concepts and variations." International Scholarly Research Notices 2013 (2013).
3. Cavalli, Roberta et al. "Nanobubbles: A promising efficient tool for therapeutic delivery." Therapeutic delivery 7.2 (2016): 117-138.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1	1				3	3	2	1
CO2	3	1	3	2	3	2	2	1				3	2	2	1
CO3	3	2	3	2	3	3	1	1				3	2	3	2
CO4	3	3	3	2	3	3	2	1				3	2	3	2
CO5	3	2	3	2	3	3	3	2				3	3	3	2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	BE363	**Title of the Course**	THERAPEUTIC EQUIPMENTS LAB	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	5th	**0**	**0**	**4**	**2**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	To familiarize students with different types of medicalequipments To make them understand about the working principle of versatile medicalequipments To familiarize students with the application of suchequipments						

Course Outcomes	
CO1	To familiarize students with different types of medical equipments
CO2	To make them understand about the working principle of versatile medical equipments
CO3	To familiarize students with the application of such equipments
CO4	Describe different types of medical equipments
CO5	Explain the working principle of versatile medical equipments

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	DEFIBRILATOR	Study on simulated DC Defibrillator	3	1
2	MUSCLE STIMULATOR	Study on muscle stimulator	3	1
3	ECG	Study on ECG heart rate monitor with alarm system	3	3
4	PULSE RATE MONITOR	Study on peripheral pulse rate monitor with alarm system	3	4
5	SKIN MONITORING SYSTEM	Study on digital body/skin temperature monitoring system	3	1
6	FOETAL MONITOR	Study on US Doppler / Foetal monitor	3	3
7	AUDIO METER	Study on hearing aid and audiometer: air and bone conduction	3	1
8	EMG	Study on EMG bio-feedback system	2	5
9	ECG SIMULATION	Study on ECG simulator and servicing of ECG machine	2	1
10	INFUSION PUMP	Study on Baby incubator / Infusionpump	2	1

Reference Books:

R. S. Khandpur "Handbook of Bio-Medical Instrumentation", 2nd Edition, Tata McGraw Hill

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	BE361	**Title of the Course**	HOSPITAL MANAGEMENT	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	5th	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	Identify various areas of hospitals. Identify various activities of departments like out/in patient and nursing. Discuss about critical care departments of hospital like iccu, icu and activities of central sterile supply department.						

Course Outcomes	
CO1	Identify various areas of hospitals.
CO2	Identify various activities of departments like out/in patient and nursing.
CO3	Discuss about critical care departments of hospital like iccu, icu and activities of central sterile supply department.
CO4	Discuss about effective hospital management.
CO5	Maintain various medical records and waste management.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Healthcare System	Health organization of the country, health technology and challenges in maintaining normal health, Indian hospitals- challenges and strategies, modern techniques of hospital management.	8	1
2	Hospital Organization	Classification of hospital, Hospital- social system, location of hospital, site selection of new hospital, Line services, Supportive services and Auxiliary services of hospital.	8	2
3	Engineering Services of hospital	Biomedical engineer's role in hospital, Maintenance department, MRO, Clinical engineering preventive maintenance of equipment, Electrical system, Power supply system, Electrical safety, Centralized gas supply system, Air conditioning system, Hospital waste management system, Fire safety and threat alarm system.	8	3
4	Hospital Management and Information System	Role of HMIS, Functional areas, Modules forming HMIS, HMIS and Internet, Centralized data record system, computerized patient record system, Health information system.	8	4
5	Regulation and planning of new hospital	FDA regulation, ISO certification, Fire protection standard, Planning and designing of new hospital.	8	5

Reference Books:

R.C. Goyal, Handbook of Hospital Personal Management, Prentice Hall of India,1993

Hans Pfeiff, Vera Dammann (Ed.), Hospital Engineering in Developing Countries,Zreport Eschbom, 1986

Cesar A. Caceres and Albert Zara, The practice of clinical engineering, Academic Press,1977.

Webster, J. G and Albert M. Cook, Clinical Engineering Principles and Practices, Prentice HallInc. Englewood Cliffs,1979

e-Learning Source:

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1	1	2	3	3	3	3	3	3	2		
CO2	1	1	3	1	1	2	3	3	3	3	3	3	2		
CO3	3	3	3	1	1	2	3	3	3	3	3	3	3		1
CO4	1	1	3	1	3	2	3	3	3	3	3	3	2	1	1
CO5	1	1	3	1	1	2	3	3	3	3	3	3	2		

1- **Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation**

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021						
Course Code	BE362	Title of the Course **THERAPEUTIC EQUIPMENTS**	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester** 5th	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite** NONE				
Course Objectives	This course will provide to students brief review of physiology and common pathology from an engineering point of view for understanding of therapeutic medical devices.					

Course Outcomes

CO1	This course will provide to students brief review of physiology and common pathology from an engineering point of view for understanding of therapeutic medical devices.
CO2	The lectures will focus on function of therapeutic medical devices so that the students will gain the ability to contribute in their design, development and effective usage in their future careers.
CO3	To study the concept of various assist devices so as to enable the students to develop new assist devices.
CO4	To develop an understanding of the physiotherapy and diathermy equipment so that the student can learn to operate.
CO5	This course is also focus on function of therapeutic medical devices so that the students will gain the ability to contribute in their design, development and effective usage in their future careers.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	Cardiac pacemakers and defibrillators	Effects of electric field on cardiac muscles and laws of stimulation, need for pacemaker, external pacemakers, implantable pacemakers and types, codes for pacemakers, pulse generator and power sources, electrodes and leads system, pacing system analyzer, programmable pacemakers, rate responsive and ventricular synchronous pacemakers, microprocessor based modern pacemakers, need for defibrillators, DC defibrillator, synchronous operation, implantable defibrillator, defibrillator analyzer and safety.	8	1
2	Ventilators and an aesthetic system	Artificial ventilations, ventilators and types, terminology of ventilators, classification of ventilators and modern ventilators, need for anaesthesia, anaesthesia gases and vapours, anaesthesia delivery system, humidifiers, nebulizers and aspirators.	8	2
3	Physiotherapy and Electrotherapy Equipments	IR diathermy, UV diathermy, short wave diathermy, microwave diathermy, ultrasonic diathermy, electrotherapy and different waveforms, electrode system, electrical stimulator and types, nerve muscle stimulator, ultrasonic stimulators, pain relief through electrical stimulators.	8	3
4	Surgical diathermy and LASER	Principles and applications of surgical diathermy, electrosurgery machine, electrosurgery circuits, different electrodes, electrosurgery techniques, solid state electrosurgery, generator circuits, testing of electrosurgery units, electrosurgery safety, basic principle of ultrasonic lithotripter and extracorporeal shock wave lithotripter, principle operation of LASER, various application of CO_2, Ar, He-Ne, Nd–YAG and pulsed ruby LASER, application of LASER in surgery.	8	4
5	Neonatal Drug Delivery	Baby incubator, radiant warmer and phototherapy unit, suction apparatus, infusion pumps, syringe pumps, peristaltic pumps, implantable infusion pumps, programmable volumetric pumps.	8	5

Reference Books:

1. Joseph Bronzino, " Biomedical Engineering and Instrumentation", PWS Engg , Boston.
2. Willard Van Nostrand, "Instrumental Methods of Analysis"
3. Sharms, "Instrumental Methods", S Chand & Co.

Course Articulation Matrix: (Mapping of COs with POs and PSOs)

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	3	3	1	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	1	3	3	3	3	3	3	3	3	3
CO3	3	3	2	2	3	3	1	3	3	3	3	3	3	3	3
CO4	3	3	2	2	2	3	1	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	1	3	3	3	3	3	3	3	2

Name & Sign of Program Coordinator **Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	BE365	**Title of the Course**	TISSUE ENGINEERING	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	6th	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	This course will provide an overview of cell biology fundamentals, an extensive review on extracellular matrix and basics of receptors, followed by topics on cell-cell and cell-matrix interactions at both the theoretical and experimental levels. Subsequent lectures will cover the effects of physical (shear, stress, strain), chemical (cytokines, growth factors), and electrical stimuli on cell function, emphasizing topics on gene regulation and signal transduction processes. Tissue engineering will be introduced by reviewing tissue structure and function and the clinical need for tissue repair. An overview of scaffold design and processing for tissue engineering will be reviewed and the application of tissue engineering to specialized tissues and organs will then be addressed in depth. Specific organ systems include skin, muscular skeletal system (vascular grafts, blood substitutions, cardiac patch, and heart valve), nervous system (peripheral and central nervous systems), liver, pancreas, and kidney.						

Course Outcomes	
CO1	This course will provide an overview of cell biology fundamentals, an extensive review on extracellular matrix and basics of receptors, followed by topics on cell-cell and cell-matrix interactions at both the theoretical and experimental levels.
CO2	Subsequent lectures will cover the effects of physical (shear, stress, strain), chemical (cytokines, growth factors), and electrical stimuli on cell function, emphasizing topics on gene regulation and signal transduction processes.
CO3	Tissue engineering will be introduced by reviewing tissue structure and function and the clinical need for tissue repair.
CO4	An overview of scaffold design and processing for tissue engineering will be reviewed and the application of tissue engineering to specialized tissues and organs will then be addressed in depth.
CO5	Specific organ systems include skin, muscular skeletal system (vascular grafts, blood substitutions, cardiac patch, and heart valve), nervous system (peripheral and central nervous systems), liver, pancreas, and kidney.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	INTRODUCTION TO TISSUE ENGINEERING	Introduction – definitions - basic principles - structure-function relationships –Biomaterials: metals, ceramics, polymers (synthetic and natural) – Biodegradable materials - native matrix - Tissue Engineering and Cell-Based Therapies –Tissue Morphogenesis and Dynamics- Stem Cells and Lineages- Cell-Cell Communication	8	1
2	TISSUE CULTURE BASICS	Primary cells vs. cell lines - sterile techniques – plastics – enzymes - reactors and cryopreservation - Synthetic Biomaterial Scaffolds- Graft Rejection – Immune Responses-Cell Migration-Controlled DrugDelivery- Micro technology Tools	8	2
3	SCAFFOLD FORMATION	Oxygen transport - Diffusion - Michalies-Menten kinetics - oxygen uptake rates -limits of diffusion - Principals of self assembly - Cell migration - 3D organization and angiogenesis - Skin tissue engineering –Introduction - scar vs. regeneration - split skin graft -apligraft. EngineeredDiseaseModels- Tissue Organization- Cell Isolation and Culture - ECM and Natural Scaffold Materials- Scaffold Fabrication and Tailoring	8	3
4	CARDIOVASCULAR TISSUE ENGINEERING	Blood vessels structure - vascular grafts - Liver tissue engineering – Bioartificial liver assist device - shear forces - oxygen transport - plasma effects – Liver tissue engineering - Self-assembled organoids - decelluarized whole livers – Stem cells - basic principle - embryonic stem cells - Induced pluripotentstem cells -Material Biocompatibility - Cell Mechanics - Vascularization- Stem Cell Therapies	8	4
5	PATTERNING OF BIOMIMETIC SUBSTRATES	Patterning of biomimetic substrates with AFM lithography primarily focusing on DPN-Nanotemplating polymer melts - Nanotechnology-based approaches in the treatment of injuries to tendons and ligaments- Progress in the use of electrospinning processing techniques for fabricating nanofiber scaffolds for neural applications -Nanotopography techniques for tissue-engineered scaffolds	8	5

Reference Books:

Ketul Popat"Nanotechnology in Tissue Engineering and Regenerative Medicine" CRC Press Taylor and Francis2011.

Cato T. Laurencin, Lakshmi S "Nanotechnology and Tissue Engineering: The Scaffold "CRC Press Taylor and Francis 2008.

e-Learning Source:

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	1				1	2	3	3	2	2	3
CO2	3	3	1	1	1				1	2	3	3	3	3	3
CO3	3	3	3	3	3	1	1	2	2	3	3	3	3	3	3
CO4	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	1	1	3	3	3	3	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	BE366	**Title of the Course**	BIOMEDICAL HAZARDS &SAFETY	**L**	**T**	**P**	**C**
Year	**3rd**	**Semester**	6th	**3**	**1**	**0**	**4**
Pre-Requisite	NONE	**Co-requisite**	NONE				
Course Objectives	To impart sufficient information on the various hazards and relevant precautionary and safety measures in healthcare system						

Course Outcomes	
CO1	Understand the legal framework of the Health and Safety at Work etc. Act 1974 and Regulations associated with it
CO2	Understand the employers', employees' and visitors' duties
CO3	Evaluate hazards and risks in order to carry out a risk assessment
CO4	Understand the legal requirement to report any accident or dangerous occurrence
CO5	Develop risk assessments for scientific laboratories that use chemicals or biological organisms or both

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS	Define Quality- Need for Standardization & Quality Management, TQM in Health care organization-Quality assurance methods ,QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipments **REGULATORY REQUIREMENT FOR HEALTH CARE** FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatory Codes	8	1
2	ELECTRICAL & FIRE SAFETY	Sources of shocks, macro & micro shocks -Hazards, monitoring and interrupting the Operation from leakage current- Elements of fire, causes of fire , Action to be taken in case of fire in a Hospital.	8	2
3	RADIATION SAFETY IN NUCLEAR MEDICINE AND RADIOTHERAPY	Design and description of NM department- Radiation protection in nuclear industry- Guidelines for radiation protection- Molecular medicine and radiation safety program- procedures for safe operation of radiation equipment- Radiation protection in external beam radiotherapy- Radiation protection in brachytherapy-Radioactive wastes.	8	3
4	LASER AND ULTRAVIOLET RADIATION SAFETY	Classification of UV radiation -Sources of UV- Biological effects of UV- Hazards associated with UV radiation- UV control measures - Safety management of UV Classifications of LASER and its radiation hazards- control measures-Emergencies and incident procedures.	8	4
5	ASSESSING QUALITY HEALTH CARE	Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals Sop's – Patient Orientation for Total Patient Satisfaction. 5S techniques	8	5

Reference Books:

Khandpur R.S., Hand book of Biomedical instrumentation ,TMH

Carr& Brown , Introduction to Biomedical Equipment, PHI

e-Learning Source:

PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1		2		3	1	3	3	3	2	1	2
CO2	3	3	3	1	3	2	1	2	1	2	3	3	1		1
CO3	3	3	3	3	2	2	1	2	1	2	3	3	2	1	3
CO4	3	3	3	2	1	2	1	2	1	2	3	3	2	1	3
CO5	1	1	3	1		2		3	1	3	3	3	2		2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	EC355	**Title of the Course**	Biomedical Laser Instruments	**L**	**T**	**P**	**C**
Year	III	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	PY101	**Co-requisite**					
Course Objectives	To understand the concept of laser and associated terminologies To understand the working of the optical fiber with its type, losses and application in clinical laser instruments To learn the different parameter of laser which help the treatment of human organ under test To understand the working of different type of diagnosis by the laser instruments To understand the different type of endoscopic instruments To understand the working of laser instruments for Clinical applications						

Course Outcomes	
CO1	For a given laser instrument, the student can able to change the intensity (needed for the clinical purpose) of the output laser beam through the change in the physical parameters of the instruments
CO2	For the given optical fiber system, student can able to understand the concept of optical fiber use in medical instruments
CO3	For the given medical laser instrument, student can able to understand the effects of lasers on human body and quality control mechanism of medical laser instruments
CO4	For the given laser assisted diagnosis instrument, student can able to learn the use of the instrument on the human organ including the issues with the instruments with the negative effects of laser on human body
CO5	For the given endoscopic imaging systems, the student able to learn working of different of different type of endoscopy use for different human organs

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Laser Tissue Interaction**	Principle and fundamentals of laser, Laser radiation and its characteristics, Biological tissue composition, Light penetration and reflectance, Laser medicine domains, Alterations of bio tissue properties during hyperthermal and ablation reactions, photodynamic therapy	8	CO-1
2	**Types of Laser Used In Medicine**	Classification of laser, laser construction and working principle of solid state laser, Atomic laser, Molecular laser, Liquid dye laser, Semiconductor laser, Solid state dye laser	8	CO-2
3	**Laser Applications-I**	Applications of laser radiation in ophthalmology, Laser treatment for eye tissues and diseases, Lasers in dermatology- handling of pain, Dermatological disorders, Lasers in cardiovascular diagnostics, Lasers in cardiovascular therapy	8	CO-3
4	**Laser Applications-II**	Lasers in urology, Lasers in gynecology, Lasers in laparoscopy, Lasers in laryngeal surgery, Lasers in otology, Lasers in neurology	8	CO-4
5	**Laser In Orthopedic Surgery, Dentistry and Laser Safety**	Mechanism of bone and cartilage reparation, Lasers in ortho paedic surgery, Laser techniques used in spinal surgery, Lasers in dentistry- lasers in endodontic procedures, Caries detection and treatment by laser radiation, Types of laser hazards, laser safety, laser use risk management.	8	CO-5

Reference Books:

Markolf H. -Fundamentals and 3rd edition, 2014.

Waynant, Ronald W. Lasers in medicine. CRC press, 2011.

e-Learning Source:

https://nptel.ac.in/courses/104104085

https://onlinecourses.nptel.ac.in/noc21_ee87/preview

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	2	2	2	2	1					3	3	
CO2	3	3	2	2	2	2	2	2					2	3	
CO3	3	3	3	2	2	3	3	3					3	3	
CO4	3	3	3	2	2	3	3	3					3	3	
CO5	3	3	3	3	2	2	3	3					3	3	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-21							
Course Code	EC 356	**Title of the Course**	Diagnostic Imaging Systems	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	**3**	**1**	**0**	**4**
Pre-Requisite	Physics(PY -101)	**Co-requisite**					
Course Objectives	1. To understand the concept of X-Ray imaging. 2. To understand the concept of Mamography and its instruments. 3. To understand the concept of Nuclear Medicine 4. To understand the concept of Ultrasound 5. Study of special application of Computed Tomography like Quantitative CT, phase selective imaging of heart etc.						

Course Outcomes	
CO1	To study the principal of X-Ray and CT.
CO2	To study the concept of Nuclear Medicine.
CO3	To study the concept and functionality of Ultrasound.
CO4	To study the concept and instruments of MRI.
CO5	To study the special application of Other Imaging Techniques.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	X-Ray and CT	Production of X-rays, X-ray tubes and generators, Screen film and digital radiography, mammography,CT system design, Hounsfield unit, modes of acquisition	8	1
2	Nuclear Medicine	Radioisotopes, radionuclide production, types of detectors, scintillators, gamma camera, Emission tomography –positron emission tomography (PET) and Single photon emission computer tomography	8	2
3	Ultrasound	Characteristics of sound, interactions of ultrasound with matter, Ultrasound transducers, ultrasound beam properties, image data acquisition, Modes of image display and storage, Doppler ultrasound, intravascular ultrasound	8	3
4	MRI	Basic concepts of MR physics, spin polarization, Resonance, relaxation, spin echoes, gradient echoes, Spatial encoding using magnetic field gradients, k-space and image reconstruction, MRI scanner hardware, functional MRI, MR spectroscopy	8	4
5	Other Imaging Techniques	Spectroscopy techniques: light source, optical fibers, monochromator,filters and polarizers, Real time spectroscopy techniques, fractional flow reserve measurement techniques, Magnetoencephalography, optical coherence tomography	8	5

Reference Books:

1.Jerrold T. Bushberg, John M. Boone, “The essential physics of medical imaging”, Lippincott Williams & Wilkins, 3rd edition, 2011.

2. Rongguang Liang, “Biomedical optical imaging technologies: Design and applications”, Springer Science & Business Media, 1st edition, 2012.

3. M. A. Flower (Editor), “Webb's Physics of medical imaging, Second Edition”, CRC Press, Taylor & Francis Group, ISBN: 978-0-7503-0573-0, 2nd edition, 2016.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	1							1	1	
CO2	2	3	3	2	1	1							1		1
CO3	3	3	3	2	1	1									
CO4	3	3	2	2	1								1	1	
CO5	3	3	2	2											

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session:							
Course Code	**EC359**	**Title of the Course**	X-Ray Imaging and Computed Tomography	**L**	**T**	**P**	**C**
Year	**3**	**Semester**	6	3	1	0	4
Pre-Requisite	Integrated Circuit	**Co-requisite**	NA				
Course Objectives	• To understand the concept of X-Ray imaging. • To understand the concept of Mamography and its instruments. • To understand the concept of Fluoroscopy and its imaging. • To understand the concept and instruments of Advanced CT. • To study of special application of Computed Tomography like Quantitative CT, phase selective imaging of heart etc						

Course Outcomes	
CO1	To study the principal of radiography and its types.
CO2	To study the concept of Mammography and details of instruments of Mammography .
CO3	To study the concept and functionality of Fluoroscopy and its imaging chain components
CO4	To study the concept and instruments of Advanced Computed Tomography
CO5	To study the special application of Computed Tomography.

Unit No.	Title of the Unit	Content of Unit	Contact Hrs.	Mapped CO
1	X-Ray	Projection radiography, Screen film radiography, Computed radiography, digital radiography, Dual energy radiography, X-ray contrast agents.	8	1
2	Mammography	Mammography: X-ray tube, beam filtration, X-ray generator and photo timer system, compression, scattered radiation and magnification, Digital mammography, color X-ray imaging	8	2
3	Specialized X-Ray Techniques	Fluoroscopy: Imaging chain components, detector systems, Modes of operation and automatic exposure control, Digital subtraction angiography, Single photon counting x-ray detectors in medical imaging, Image quality and artifacts	8	3
4	Advanced CT	Slip ring technology, Helical CT-instrumentation, Multislice CT, detector configuration, multislice helical configuration, Cone beam CT, isotropic imaging, Dual source and dual energy	8	4
5	Special Applications	Quantitative CT, phase selective imaging of heart, 3D reconstruction: technical aspects, rendering techniques, Features of dedicated breast CT scanner, Quality control of CT scanners, future of CT	8	5

Reference Books:

1. Jerrold T. Bushberg, John M. Boone, Lippincott Williams & Wilkins, "The Essential Physics of Medical Imaging", Lippincott Williams and Wilkins, 3rdedition, 2011.

2. "Willi A. Kalender, 'Computed Tomography: Fundamentals, System Technology, Image Quality, Applications', John Wiley & Sons, 3rdedition, 2011..

3. Euclid Seeram, "Computed Tomography: Physical Principles, Clinical Applications, and Quality Control",Elsevier Health Sciences, 4thedition,2015.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**	**1**	**2**	**2**	**2**	**1**	**1**					**3**	**3**	
CO2	**3**	**3**	**2**	**2**	**2**	**1**	**2**	**2**					**2**	**3**	
CO3	**3**	**3**	**1**	**2**	**2**	**1**	**1**	**1**					**3**	**3**	
CO4	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**					**3**	**3**	
CO5	**3**	**3**	**1**	**1**	**2**	**2**	**1**	**1**					**3**	**3**	

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	**BE368**	**Title of the Course**	**BIOPHYSICS & BIOCHEMISTRY**	**L**	**T**	**P**	**C**
Year	**3**	**Semester**	6	**3**	**1**	**0**	**4**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	The course aims to provide an advanced understanding of the core principles and topics of Biophysics & Biochemistry and their experimental basis, and to enable students to acquire a specialized knowledge and understanding of selected aspects by means of a branch lectureseries						

Course Outcomes	
CO1	The students will get broad and deep understanding of the ways that life functions are explained in terms of the principles of chemistry and physics
CO2	The ability to utilize computational tools as appropriate to the biochemistry, biophysics, and molecular biology disciplines, including research, data analysis, and communication.
CO3	The students will get knowledge necessary for students, according to their career goals, to attain acceptance into advanced degree programs.
CO4	The students will be exposed to familiarity with the complexity of issues facing professionals in the biochemistry, biophysics, and molecular biology disciplines, including scientific and moral ethics, cultural diversity, and environmental concerns.
CO5	The students will be exposed to familiarity with the types of contributions that this course can provide to society, including improvements in the human condition, and economic stimulation at the local, national, and international levels.

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Biological Principles**	Composition and properties of cell membrane, membrane transport, body fluid, electrolytes, filtration, diffusion, osmosis, electrophoresis, plasmapheresis, radioimmunoassay, Photochemical reaction, laws of photochemistry, fluorescence, phosphorescence.	8	1
2	**Electrical stimulus and biophysical activity**	Patient safety, electrical shock and hazards, leakage current, Electrical activity of heart (ECG), Electrical activity of brain(EEG), Electroretinogram (ERG), Electro-occologram (EOG), Electromyogram(EMG).	8	2
3	**Radioactivity**	Ionizing radiation, U-V & IR radiations, Production of radioisotopes, Radioactive decay, Half-life period.	8	3
4	**Macromolecules**	Classification & functions of carbohydrates, glycolysis, TCA cycle, ATP synthesis. Classification & functions of proteins, architecture of protein, Classification of amino acid, oxidative and non oxidative deamination, transamination. Classification & functions of lipids, biosynthesis of long chain fatty acid, oxidation and degradation of fattyacid.	8	4
5	**Enzymes and Nucleic acid**	Chemical nature &broad classification of enzymes, M-M kinetics, Isozymes and Allosteric enzymes. Structure of DNA, DNA Replication, Transcription, Translation.	8	5

Reference Books:

Text book of medical physiology -Guyton

The biomedical hand book 3 -Joseph D

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	3	1		2		3	1	3	3	3	2	1	2
CO2	3	3	3	1	3	2	1	2	1	2	3	3	1		1
CO3	3	3	3	3	2	2	1	2	1	2	3	3	2	1	3
CO4	3	3	3	2	1	2	1	2	1	2	3	3	2	1	3
CO5	1	1	3	1		2		3	1	3	3	3	2		2

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	EC357	**Title of the Course**	_Electro Diagnosis Lab	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	0	0	4	2
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Students will learn and understand the working of the instruments related to the diagnosis process of the human body organs						

Course Outcomes	
CO1	Summarize the measurable features of the sensory nerve action potential, compound muscle action potential, F-response, H-reflex, and repetitive stimulation
CO2	Compare the clinical and electrodiagnostic features of common polyneuropathies, mononeuropathies, radiculopathies, plexopathies, and myopathies.
CO3	Ability to analyze and interpret physical assessment and diagnosis and set appropriate short and long term goals.
CO4	Ability to choose, demonstrate intervention safely and document the progression appropriately
CO5	Understand the function of elementary digital circuits under real and simulated environment.

Experiment No	**Title of the Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-1	To simulate the defibrillator and understand energy levels generated by defibrillator through Online Virtual Lab.	4	CO-1
2	Exp-2	To simulate Haemodialysis Machine and calculate the dialysis flow rate through Virtual Lab	4	CO-1
3	Exp-3	To simulate Biopotential Amplifier and calculate the output voltage through Virtual Lab	4	CO-2
4	Exp-4	To simulate Pacemaker and understand various energy levels generated by pacemaker through Virtual. Lab	4	CO-2
5	Exp-5	To simulate Electrocardiogram Waveform using online virtual lab	4	CO-3
6	Exp-6	To study EMG using surface Electrodes.	4	CO-4
7	Exp-7	To study EOG using surface Electrodes.	4	CO-5

Reference Books:

Dillingham, Timothy, Michael Andary, and Daniel Dumitru. "Electrodiagnostic medicine." Braddom's Physical Medicine and Rehabilitation. Elsevier, 2021. 115-152.

e-Learning Source:

https://bmi-iitr.vlabs.ac.in/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**	**2**	**1**	**1**	**1**		**1**	**1**			**1**	**2**	**3**	**1**
CO2	**3**	**3**	**3**	**2**	**1**	**1**			**1**			**1**	**2**	**3**	**1**
CO3	**3**	**3**	**3**	**2**	**1**	**1**			**1**				**2**	**3**	**1**
CO4	**3**	**3**	**3**	**2**	**1**				**2**				**2**	**3**	**1**
CO5	**3**	**3**	**2**	**2**					**1**				**2**	**3**	**1**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	EC358	**Title of the Course**	Biosensors & Transducers Laboratory	**L**	**T**	**P**	**C**
Year	**III**	**Semester**	VI	0	0	4	2
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	Students will learn and understand the basics of sensors and able to use the sensors in biomedical devices.						

Course Outcomes	
CO1	Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, position and light
CO2	Choose proper sensor comparing different standards and guidelines to make sensitive measurements of physical parameters like pressure, flow, acceleration, etc
CO3	Predict correctly the expected performance of various sensors
CO4	Locate different type of sensors used in real life applications and paraphrase their importance
CO5	Set up testing strategies to evaluate performance characteristics of different types of sensors and transducers and develop professional skills in acquiring and applying the knowledge outside the classroom through design of a real-life instrumentation system

Experiment No	**Title of the Experiment**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	Exp-1	Characterize the temperature sensor (Thermocouple).	4	CO-1
2	Exp-2	Characterize the temperature sensor (RTD)	4	CO-1
3	Exp-3	characterize the strain gauge sensor	4	CO-2
4	Exp-4	Simulate the performance of Biosensor	4	CO-2
5	Exp-5	Simulate the performance of chemical sensor (PH)	4	CO-3
6	Exp-6	Study of Temperature sensor characteristic using Arduino	4	CO-4
7	Exp-7	To study the light dependent resistors (LDR).	4	CO-5
8	Exp-8	To study the Temperature measurement using LM35.	4	CO-5

Reference Books:

Sinclair, Ian. *Sensors and transducers*. Elsevier, 2000.

e-Learning Source:

https://bmi-iitr.vlabs.ac.in/

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**	**2**	**1**	**1**	**1**		**1**	**1**			**1**	**3**	**2**	**3**
CO2	**3**	**3**	**3**	**2**	**1**	**1**			**1**			**1**	**3**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**1**	**1**			**1**				**3**	**1**	**3**
CO4	**3**	**3**	**3**	**2**	**1**				**2**				**3**	**1**	**3**
CO5	**3**	**3**	**2**	**2**					**1**				**3**	**1**	**3**

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**

Integral University, Lucknow

Effective from Session: 2020-2021							
Course Code	**BE367**	**Title of the Course**	**TISSUE ENGINEERING LAB**	**L**	**T**	**P**	**C**
Year	**3**	**Semester**	6	**0**	**0**	**4**	**2**
Pre-Requisite	None	**Co-requisite**	None				
Course Objectives	This course will train students in advanced cellular and tissue engineering methods that apply physical, mechanical and chemical manipulation of materials in order to direct cell and tissue function. Students will learn the techniques and equipment of bench research including cell culture, immunofluorescent imaging, soft lithography, variable stiffness substrates, application/measurement of forces and other methods						

Course Outcomes	
CO1	Use of conventional microscopy for the understanding of tissue structure
CO2	Understand microscopic organization of Tissues into Organs and system
CO3	Tissue observation and image capture
CO4	Histology as a diagnostic tool

Unit No.	**Title of the Unit**	**Content of Unit**	**Contact Hrs.**	**Mapped CO**
1	**Module 1**	Scaffold Formation and Characterization; Preparation of 2D Collagen Films; Preparation of 3D Scaffolds; Preparation of Silk Fibroin scaffold by Salt Leaching Method; Preparation of Silk Fibroin scaffold by Phase Separation Method; Preparation of Silk Fibroin scaffold by Electrospinning; Design of 3D scaffold by rapid proto typing technique.; Characterization of biopolymers and scaffold; Mechanical Strength; Contact angle measurement; Pore size & Porosity;	8	1
2	**Module 2**	Cells and Cell Culture; Introduction to Cell Culture lab and aseptic skill; Use of Biosafety cabinet, CO2 incubators, Microscopes, Sterile Conditions; Preparation of Cell Culture Media and other supplements & Additives; Isolation and Culturing of MNCs from Peripheral blood; Cell counting & cell morphology	8	2
3	**Module 3**	Bioreactors and Integration; Introduction to type of bioreactors & their operation; (Spinner Flask, Rotating vessel, Perfused Column and Perfused Chamber); MNC seeding on 2D films and 3D scaffolds; MNC seeding on 2D & 3D polymer scaffolds by static method; MNC seeding on 2D & 3D polymer scaffolds by dynamic method; Culture and cell growth study inbioreactor;	8	3
4	**Module 4**	Cell Survival & Function; Live/Dead Fluorescence Assay; MTT Viability Test; Cell Viability Test by Trypan Blue staining method	8	4

Reference Books:

Ketul Popat "Nanotechnology in Tissue Engineering and Regenerative Medicine" CRC Press Taylor and Francis2011.

Cato T. Laurencin, Lakshmi S "Nanotechnology and Tissue Engineering: The Scaffold "CRC Press Taylor and Francis 2008.

e-Learning Source:

	Course Articulation Matrix: (Mapping of COs with POs and PSOs)														
PO-PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	2	3	3	3	3	3	2	2	3
CO2	3	3	3	3	3	3	2	3	3	3	2	3	2	2	3
CO3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	3	2	3	3	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Name & Sign of Program Coordinator	**Sign & Seal of HoD**