



ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು
(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)
ಬುಲ್ ಟೆಂಪಲ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು - 560 019

B.M.S. COLLEGE OF ENGINEERING

(Autonomous college under VTU) BENGALURU-560 019

DEPARTMENT OF MEDICAL ELECTRONICS

Scheme & Syllabus

(Academic year: 2014-2018)



B.M.S. COLLEGE OF ENGINEERING, BENGALURU

(Autonomous College under VTU)

VISION	MISSION
Promoting Prosperity of mankind by augmenting human resource capital through Quality Technical Education & Training	Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society

DEPARTMENT OF MEDICAL ELECTRONICS

DEPARTMENT VISION	DEPARTMENT MISSION
To Promote quality education in Medical Electronics Engineering for health and well-being of humankind through teaching and research platforms.	<ul style="list-style-type: none">• To impart knowledge and skills necessary for professional development of graduates in Medical Electronics Engineering.• To provide continuous up gradation of technical education with strong academic progression.• To propagate creativity, responsibility, commitment and leadership qualities and exhibit professional ethics and values.

The PEOs of the program are:

PEO1: Graduates of Medical Electronics will build career in healthcare and allied fields.

PEO2: Graduates will adapt to the state of art technologies through lifelong learning, will effectively communicate and work a team.

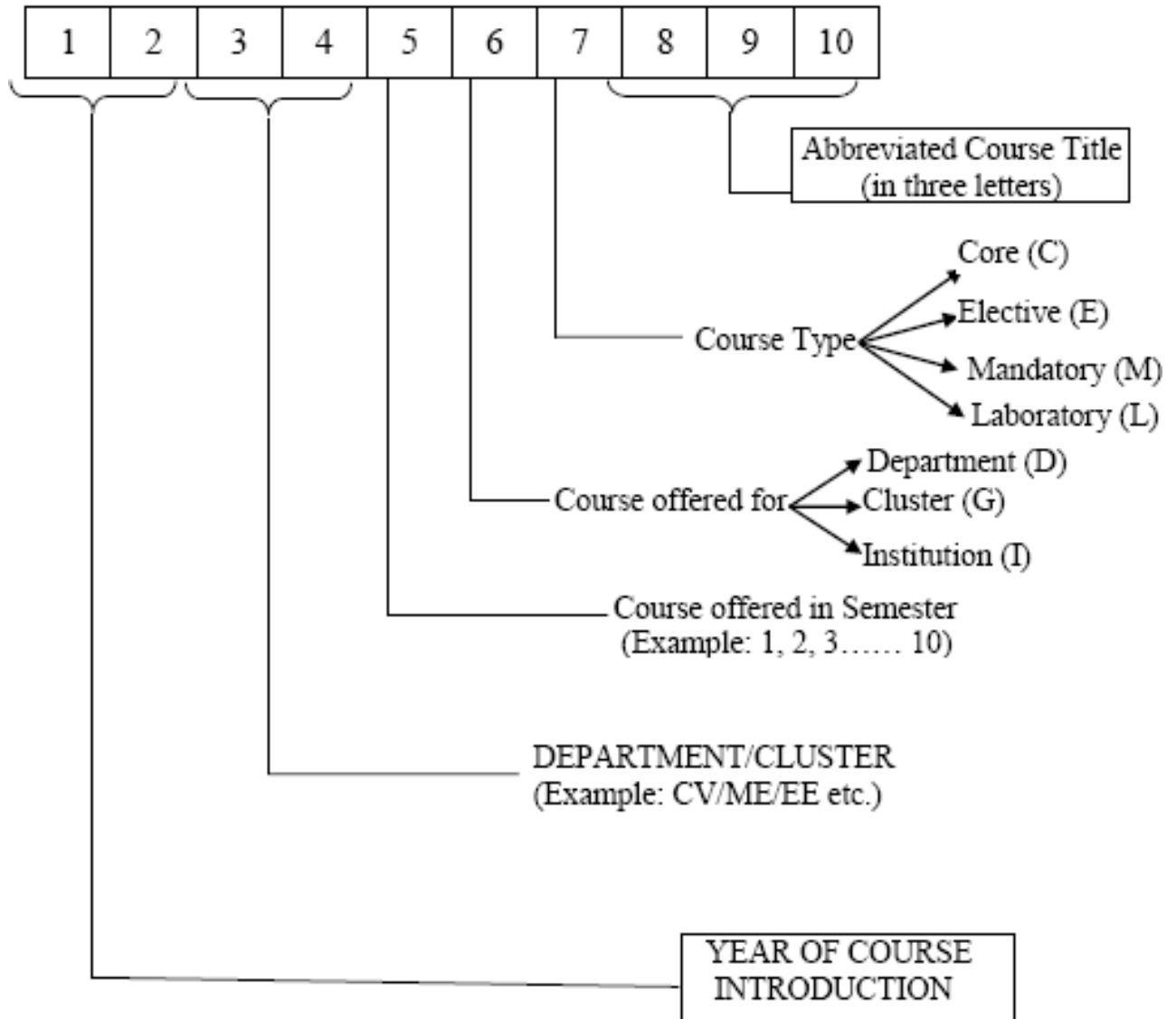
PEO3: Graduates will pursue higher studies and research.

Program Outcomes (POs)

Program outcomes (POs), are attributes acquired by the students at the time of graduation. The POs given in the table below, ensure that the POs are aligned to the Graduate Attributes (GAs) specified by National Board of Accreditation (NBA). These attributes are measured at the time of graduation and hence computed every year for outgoing batch. The POs are addressed and attained through the Course Outcomes (COs) of various courses of the curriculum.

PO1	An ability to apply knowledge of mathematics, science and engineering fundamentals for appropriate solutions to Medicaelectronics.
PO2	An ability to identify, analyze a problem, and formulate the computingrequirements appropriate to its solution.
PO3	An ability to design, implement and evaluate an electronic/computer-based system, process to meet desired needs in healthcare.
PO4	An ability to design experiments, as well as to analyze andInterpret Medical data.
PO5	An ability to use current techniques and modern tools necessary forcomputing practice leading to improvised health care.
PO6	An ability to understand health and safety issues through medicalelectronics concepts.
PO7	An ability to understand environmental considerations and sustainableengineering solutions in Medical Electronics.
PO8	An ability to understand professional ethics and legal issues related tohealthcare technologies.
PO9	An ability to function effectively as an individual and a member in diverseteam.
PO10	An ability to communicate effectively with a range of audiences.
PO11	An ability to understand management principles and apply these tomanage projects and finance.
PO12	An ability to engage in continuing professional development forlifelong learning.

NOMENCLATURE FOR THE COURSE CODE



SCHEME OF STUDY**III Semester**

Sl. No.	Course Code	Course Title	Credits				Total
			L	T	P	S	
1	15MA3GCADM	Advanced Engineering Mathematics	3	1	0	0	4
2	15ES3GCLCA	Linear Circuit Analysis	3	1	0	0	4
3	15ES3GCAMC	Analog Microelectronics	3	0	1	2	6
4	15ES3GCDEC	Digital Electronics	3	0	1	2	6
5	15ML3DCHAP	Introduction to Human Anatomy & Physiology	3	1	0	0	4
6	15ML3DCBSM	Biomedical Signals and Measurement	0	0	1	0	1
Total			15	3	3	4	25

IV Semester

Sl. No.	Course Code	Course Title	Credits				Total
			L	T	P	S	
1	15MA4GCDMP	Discrete Mathematics and Probability	3	1	0	0	4
2	15ES4GCAIC	Analog Integrated Circuits	3	0	1	2	6
3	15ES4GCMCS	Microcontrollers	3	0	1	2	6
4	15ES4GCCST	Control Systems	3	1	0	0	4
5	15ES4GCSAS	Signals & Systems	3	1	0	0	4
6	15ML4DCBES	Biomedical Ethics & Standards	0	0	1	0	1
Total			15	3	3	4	25

V Semester

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16ML5DCESD	Embedded Systems Design	3	0	0	0	3
2	16ML5DCBMI	Biomedical Instrumentation	3	0	1	2	6
3	16ML5DCBMR	Biomechanics and Rehabilitation	2	1	0	0	3
4	16ML5DCDSP	Digital Signal Processing	3	0	1	2	6
5	16ML5DCMDP	Medical Physics	2	1	0	0	3
6	16ML5DE1XX	Department Elective-I	3	1	0	0	4
		TOTAL	16	3	2	4	25

Department Elective: Group-I

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16ML5DE1PR	Pattern Recognition & Neural Networks	3	1	0	0	4
2	16ML5DE1OP	OOPs with C++ for Medical Applications	3	1	0	0	4
3	16ML5DE1BC	Brain Computer Interface	3	1	0	0	4

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VI Semester

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16ML6DCMIP	Medical Image Processing	3	0	1	2	6
2	16ML6DCBSP	Bio-Medical Signal Processing	2	0	1	0	3
3	16ML6DCBMA	Bio-Materials and Artificial Organs	2	1	0	0	3
4	16ML6DCMDD	Medical Device Development	3	0	1	2	6
5	16ML6DCMIM	Medical Imaging Modalities	3	1	0	0	4
6	16ML6GE1XX	Cluster Elective-I	3	0	0	0	3
		TOTAL	16	2	3	4	25

Cluster Elective: Group-I

Sl. No	Course Code	Course Title	Credits				Credits
			L	T	P	S	
1	16ML6GE1BM	Bio-MEMS	3	0	0	0	3
2	16ML6GE1MI	Medical Informatics	3	0	0	0	3

Medical Electronics

VII Semester

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16ML7DCMDT	Medical Device Testing on Sustainability	3	0	1	2	6
2	16ML7DCCDA	Clinical Data Analytics	3	0	1	2	6
3	16ML7IE1XX	Institutional / Open Elective-I	3	0	0	0	3
4	16ML7DCPCS	Project for Community Service	0	0	4	0	2
5	16ML7GE2XX	Cluster Elective-II	3	0	0	0	3
6	16ML7DE2XX	Department Elective-II	3	0	0	0	4
		TOTAL	15	0	6	4	25

Department Elective: Group-II

Sl. No	Course Code	Course Title	Credits				Credits
			L	T	P	S	
1	16ML7DE2VM	Biomedical Circuits with VLSI	3	0	0	0	3
2	16ML7DE2MH	Mobile Health	3	0	0	0	3
3	16ML7DE2NE	Image & Signal Processing for Networked E-health Applications	3	0	0	0	3

Cluster Elective: Group-II

Sl. No	Course Code	Course Title	Credits				Credits
			L	T	P	S	
1	16ML7GE2IP	Advanced Medical Image Processing	3	0	0	0	3
2	16ML7GE2LF	Lasers and Fibre Optics in Medicine	3	0	0	0	3

Institutional/ Open elective-I

Sl. No	Course Code	Course Title	Credits				Credits
			L	T	P	S	
1	16ML7IE1PR	Pattern Recognition and its applications	3	0	0	0	3

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VIII Semester

Sl. No.	Course Code	Course Title	Credits				
			L	T	P	S	Total
1	16HS8GCPMF	Project Management and Finance	2	0	0	1	3
2	16HS8GCIPL	Intellectual Property Rights and Cyber Law	2	0	0	1	3
1	16ML8DE3XX	Department Elective-III	3	0	0	0	3
4	16ML8IE2XX	Institutional/ Open elective-II	3	0	0	0	3
5	16ML8DCMPJ	Major Project	0	0	11	0	10
7	16ML8DCSMR	Seminar based on Internship / Industrial Training / Minor Project	0	0	2	0	2
		TOTAL	10	0	13	2	25

Department Elective: Group-III

Sl. No	Course Code	Course Title	Credits				Credits
			L	T	P	S	
1	16ML8DE3ML	Machine Learning	3	0	0	0	3
2	16ML8DE3BS	Biosensors	3	0	0	0	3
3	16ML8DE3SB	SoC for Biomedical applications	3	0	0	0	3

Institutional/ Open elective-II

Sl. No	Course Code	Course Title	Credits				Credits
			L	T	P	S	
1	16ML8IE1NN	Networks and its Applications	3	0	0	0	3

Course Articulation Matrix:

The Course instructor writes the course outcomes in the course design which will address the skills defined in the Program Outcomes. The COs of the courses in the curriculum and their mapping with Program Outcomes in terms of Levels is indicated in the Table next. The level of course mapping with POs considered are,

3-High correlation 2- Moderate correlation and 1- Low correlation.

The mapping strength of CO is mainly based on the percentage of marks in the Continuous Internal Evaluation (CIE) process as indicated below,

- a. ***Strongly correlation:*** - If assessment covers greater than 20% marks or if CO is related to Lab component or self-study component weightage given is high as students spend more time in implementation and the activity has more importance in TLP, then the weightage taken is 3.
- b. ***Moderately correlation:*** - If assessment covers greater than 10% marks and less than 20% marks or the activity defined under the particular CO has moderate contribution toward PO attainment then the weightage considered is 2
- c. ***Low level correlation:*** - If assessment covers less than 10% marks or the activity defined under the particular CO has low contribution toward PO attainment then the weightage taken is 1.

The factors like the depth to which the corresponding contents are covered and its importance are duly considered. The mapping strengths are accordingly considered when a CO is mapping to another PO also.

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	clampers, small signal amplifiers, oscillators, power amplifiers.																	
	CO5: Engage in self-study/independent study to formulate, design, implement, analyze and demonstrate an application using analog electronic components through an open ended experiment									2	2	2						
	CO6: Engage in self-study/independent study to formulate, design, implement, analyze and demonstrate an application using analog electronic components through an open-ended experiment									2	2	2		2				
Digital Electronics 15ES3GCDEC	CO1: Apply the knowledge of mathematics and engineering fundamentals to solve complex digital circuits.	3																
	CO2: Analyze digital circuits and arrive at suitable conclusions.		3															
	CO3: Design a digital circuit for given specifications			3														
	CO4: Design a digital circuit and Conduct experiments using modern tools.					3												
	CO5: Engage in self-study to formulate, design, implement, analyze and demonstrate an application of digital electronic circuits through an open-ended experiment					2									3			
Introduction To Human Anatomy And Physiology 15ML3DCHAP	CO1: Apply basic anatomical knowledge of the human being with particular detail in the musculoskeletal, nervous, endocrine, cardiovascular, and respiratory systems.	2													1			
	CO2: Identify systems physiology and health issues in relation to muscular, nervous, endocrine, and cardiovascular and respiratory systems		1															
	CO3: Listen and comprehend audio/video lectures related to					1					2							

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	maintenance measures for sustainability.																		
	CO4: Apply the concepts learnt to device testing and maintenance of specific medical device in a group, record and present it.								2	2	2	2	3	3					
Clinical Data Analytics 16ML7DCCDA	CO1.Ability to apply knowledge of mathematics, science and Engineering to develop the solution using bio statistical concepts.	3																	
	CO2.Ability to analyse a problem and formulate appropriate solution for bio statistical concepts application.		3																
	CO3.An ability to design and perform statistical test and interpret results			3															
	CO4: Ability to implement and demonstrate statistical analysis using modern tool usage.				3	3													
	CO5. Implement the concepts practically in group perform an open ended experiment/min project and document the same.									3		3	3	3	3	3	3		
Project for Community service 16ML7DCPCS	CO1: Ability to apply knowledge to identify, gather information and analyse to formulate the unmet need and problem definition for project through survey			3											3				
	CO2: Ability to use appropriate tool/tools to implement and demonstrate the project.				3	3										3			
	CO3: Ability to design and develop sustainable solution/system for the biomedical applications			3					3									3	
	CO4: Ability to make effective presentation of the work abiding professional ethics as an individual and a team member.				3					3	3								
	CO5: Ability to develop systems with scope for enhancement and continue life-long learning.														3				

8th Semester															
Project Management and Finance 16ML8DCPMF	CO1: Apply the Knowledge of project management principles and to implement project management methodologies required for successful project completion	3								1	2	2			
	CO2: Develop Ethical principles in project planning and execution as a team and documentation in project implementation.												2		
	CO3: Identify and Apply finance aspects for project implantation in time.											3		1	
	CO4: Use modern tools to simulate their respective projects and case studies and investigate the behaviour under various operating conditions.												1		
Intellectual Property Rights And Cyber Law 16HS8GCIPL	CO1: understand and commit to professional ethics and responsibilities to obtain Intellectual property Rights like Patents, Copyright & Trademarks								3						
	CO2: Understand the impact of Patents, Copyright & Trademarks and demonstrate the knowledge of Cyber Law for the societal and environmental context.						3								
	CO3: Ability to use IPRs and Cyber Law to access societal, health, safety & Cultural issues					3									
	CO4: Ability to work in multiple teams to effectively communicate IP & Cyber Law.								3	2					
Major Project 16ML8DCMPJ	CO1 Apply the knowledge of science and medical electronics engineering to provide solutions for human-health related problems	3											3	3	3
	CO2: Analyze and identify biomedical engineering		3										3	3	3

	problems based on literature survey and need analysis.																		
	CO3: Develop solutions for relevant biomedical engineering problems with appropriate consideration of public health, safety and society.			3											3	3	3		
	CO4: Design experimental techniques/ simulation models and interpret the data conclusively			3											3	3	3		
	CO5: Use modern tools and resources in developing health-care solutions needing their applications				3										3	3	3		
	CO6: Apply reasoning based on the contextual knowledge of the design problem statement and assess societal, health and safety issues					3													
	CO7: Demonstrate the knowledge of a sustainable solution in the context of society						3												
	CO8: Apply biomedical ethics and responsibilities while working on project work							3											
	CO9: Function both individually and in diverse teams requiring multidisciplinary approaches								3										
	CO10: Comprehend, prepare effective reports and make clear presentations to an engineering community									3									
	CO11: Demonstrate the knowledge of project management and financial requirements of a project work										3								
	CO12: Exhibit self-reliance and life-long learning skills to align to the new trends											3							
Internship based Seminar 16ML8DCSMR	CO1: Ability to apply the concept of engineering knowledge for design development and analysis of			3	3										3				

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	complex problems using modern tools and technologies																
	CO2: Ability to function individually and member in a team to find a suitable engineering solution.							3						2			
	CO3: Ability to demonstrate the knowledge and understanding of engineering and management principles									3	3					2	
	CO4: Ability to communicate on complex engineering activities and its solutions.			3	3				3				1				

Program Articulation Matrix

Course Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O 1	PS O 2	PS O 3
15ES3GCLCA	3	2	---	---	---	---	---	---	2	2	---	---	2	---	---
15ES3GCAMC	3	2	2	---	2	---	---	---	2	2	2	---	2	2	---
15ES3GCDEC	3	3	3	---	2	---	---	---	---	---	---	---	3	---	---
15ES3GCHAP	2	1	---	---	1	---	---	---	---	2	---	---	1	---	---
15ES4GCAIC	2	1	3	3	---	---	1	---	2	---	---	---	3	---	---
15ES4GCMCS	3	3	3		3	---	---	---	3	---	---	---	2	2	2
15ES4GCCST	3	3	---	2	2	1	---	---	2	2	---	2	2	---	---
15ML4DCBES	---	---	---	---	---	2	---	3	---	---	---	---	---	---	---
15ES4GCSAS	2	3	3	2		---	---	---	2	2	2	---	---	---	3
16ML5DCESD	2	2	---		2	---	---	---	2	2	--	1	---	---	1
16ML5DCBMI	1	---	---	2	2	2	---	---	2	2	2	---	2	2	2
16ML5DCBMR	2	2	1	---	---	1	2	2	2	---	---	---	---	1	---
16ML5DCDSP	3	3	3	3	---	---	---	---	2	2	2	---	---	---	3
16ML5DCMDP	3	3	---	---	---	3	---	---	2	2	2	2	3	2	---
16ML6DCMIP	3	3	3	3	3	---	---	---	3	---	---	---	---	3	3
16ML6DCBSP	3	3	2	3	3	---	---	---	3	2	2	2	---	2	2
16ML6DCBMA	3	---	---	---	---	2	---	2	---	---	---	---	---	---	2
16ML6DCMDD	3	2	---	3	3	3	3	3	3	3	3	3	3	3	---
16ML6DCMIM	3	3	3	---	---	2	2	2	2	2	---	---	3	2	2
16ML7DCMDT	---	2	3	---	2	---	---	2	2	2	3	3	3	3	---
16ML7DCCDA	3	3	3	3	3	---	---	---	3	---	3	3	3	3	3
16ML7DCPCS	---	---	3	3	3	3	---	3	3	3	3	3	3	3	3
16HS8GCPMF	3	---	---	---	---	---	---	1	2	2	3	1	1	2	1
16HS8GCIPL	---	---	---	---	---	---	---	3	---	---	---	---	3	---	---
16ML8DCMPJ	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
16ML8DCSMR	---	---	3	3	---	---	---	---	3	3	3	3	3	2	2

III SEMESTER SYLLABUS

Course Title	ADVANCED ENGINEERING MATHEMATICS (Common to EC, TE, EE, IT, ML)				
Course Code	15MA3GCADM	Credits	4	L-T-P-S	3:1:0:0
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)		
Prerequisites: Trigonometric formulas, methods of differentiation, methods of integration, partial derivatives, matrices, Fourier Series, Fourier Transforms					
UNIT-I					9 hours
MATRICES: Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of system of linear equations and solution. Solution of a system of non-homogenous linear algebraic equations: Gauss elimination method, LU decomposition method, Gauss-Seidel method. Eigen values and eigenvectors of matrices. Reduction of a matrix to diagonal form. (7L+2T) Suggested Reading: Inverse of a matrix using Gauss-Jordan method. Largest Eigen value and corresponding eigenvector using Rayleigh power method.					
UNIT-II					10hours
NUMERICAL METHODS: Solution of algebraic and transcendental equations: Newton-Raphson method. Finite Differences and interpolation: Forward differences, backward differences. Newton-Gregory forward interpolation formula, Newton-Gregory backward interpolation formula, Lagrange's interpolation formula, Lagrange's inverse interpolation. Numerical integration: Simpson's 1/3 rd , 3/8 th rule, Weddle's rule. Numerical solution of ordinary differential equations: Euler's modified method, Runge-Kutta method of fourth order. (8L+2T) Suggested Reading: Milne's method to solve ordinary differential equations. Solution of simultaneous differential equations by Runge-Kutta fourth order method.					
UNIT-III					10hours
PARTIAL DIFFERENTIAL EQUATIONS: Formation of Partial differential equations-elimination of arbitrary constants, elimination of arbitrary functions. Equations of first order- Solution of the linear equation $P p + Q q = R$ (Lagrange's partial differential equation).					

Applications: One-dimensional heat equation and wave equation (without proof), Transmission line-telegraph equations, various possible solutions of these by the method of separation of variables.

(7L+3T)

Suggested Reading: Direct integration method, method of separation of variables, D'Alembert's solution of wave equation.

UNIT-IV

9 hours

COMPLEX ANALYSIS 1:

Function of a complex variable, limits, continuity and differentiability of a complex valued function. Analytic functions, properties of analytic functions, Cauchy-Riemann equations in Cartesian and polar form, construction of analytic functions by Milne-Thomson method.

Conformal mapping-Transformations $w = z^2$ and $w = z + \frac{a}{z}$ ($z \neq 0$). Bilinear transformations.

Suggested Reading: Standard transformations $w = c + z, w = cz, w = 1/z$, properties of bilinear transformations.

UNIT-V

9 hours

COMPLEX ANALYSIS 2:

Complex integration: Line integral, Problems on line integral, Cauchy's theorem, Cauchy's integral formula.

Complex series: Taylor's series, Maclaurin's series and Laurent's series (without proof).

Zeros, Poles and Residues: Residue theorem (without proof). Evaluation of real definite integrals using residues.

(7L+3T)

Suggested Reading: Power series, radius of convergence. Removable and essential singularities, improper real integrals with singular points on real axis.

Applications: Use of harmonic function to a heat transfer problem. Analyzing AC circuits, Current in a field-effect transistor.

Mathematics Lab

- Solution of system of algebraic equations using Gauss Seidel method.
- LU decomposition of matrices.
- Eigen values and eigenvectors of matrices.

- Largest Eigen value, smallest Eigen value and corresponding eigenvectors of a matrix.
- Solution of algebraic and transcendental equations using Newton- Raphson method.
- Numerical integration.
- Numerical solution of ordinary differential equations

Text books:

- | | |
|-----------|--|
| 1. | Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers. |
| 2. | Advanced Engineering Mathematics, 5th edition, 2011, by Dennis G.Zill and Cullen, Jones and Bartlett India Pvt. Ltd. |

Reference books:

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|-----------|--|
| 1. | Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc. Graw Hill. |
| 2. | Advanced Engineering Mathematics, Erwin Kreyszig, 10 th edition Vol.1 and Vol.2, 2014, Wiley-India. |
| 3. | Numerical Methods for Scientific and Engineering Computation. M.K. Jain, S.R.K Iyengar, R.K. Jain, 6 th edition, 2010, New Age International (P) Limited Publishers |

E Books:

- | | |
|-----------|---|
| 1. | Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001
http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y . |
| 2. | Advanced Engineering Mathematics, P. V. O’Neil, 5 th Indian reprint, 2009, Cengage learning India Pvt. Ltd. |
| 3. | http://ocw.mit.edu/courses/mathematics/ (online course material) |

Moocs:

- | | |
|-----------|---|
| 1. | http://nptel.ac.in/courses.php?disciplineId=111 |
| 2. | https://www.khanacademy.org/ |
| 3. | https://www.class-central.com/subject/math (MOOCS) (4)E-learning: www.vtu.ac.in |
| 4. | E-learning: www.vtu.ac.in |

Course outcomes
At the end of the course ,the student will have the ability to
CO-1: Obtain numerical solution a system of algebraic equations, algebraic and transcendental equations and ordinary differential equations.
CO-2: Formulate boundary value problems involving one dimensional heat and wave equation
CO-3: Solve partial differential equations with appropriate boundary conditions using the method of separation of variables
CO-4: Construct analytic functions and simple conformal mappings.
CO-5: Evaluate real and complex integrals using the calculus of residues.

Course Title	LINEAR CIRCUIT ANALYSIS				
Course Code	15ES3GCLCA	Credits	4	L-T-P-S	3-1-0-0
CIE	100 Marks(50% weightage)	SEE	100 Marks (50% weightage)		
Prerequisites: Basic Electrical Engineering, Engineering Mathematics- I & II					
UNIT-1					5+2 hours
Basic Concepts: Practical sources, Source transformations, Network reduction using Star Delta transformation, Loop and node analysis with linearly dependent and independent sources for DC and AC networks, Concepts of supernode and supermesh.					
UNIT-2					8+3hours
Network Topology: Graph of a network, Concept of tree and co-tree, incidence matrix, tie-set, tie-set & cut- set schedules, Formulation of equilibrium equations, Principle of duality. Resonant Circuits: Series and parallel resonance, frequency response of series and Parallel circuits, Q factor, Bandwidth					
UNIT-3					7+3 hours
Network Theorems: Superposition, Reciprocity, Milliman's, Thevenin's and Norton's theorems; Maximum Power transfer theorem					
UNIT-4					10+3 hours

Transient behavior and initial conditions:

Behavior of circuit elements under switching condition and their representation, evaluation of initial and final conditions in RL,RC and RLC circuits

Laplace Transformation & Applications:

Review of Laplace transforms, Waveform Synthesis, initial and final value theorems, step, ramp and impulse responses, convolution theorem, solution of simple R-L, R-C, R-L-C networks for AC and DC excitations using Laplace transforms.

UNIT-5

6+1 hours

Two port network parameters and State Variable analysis:

Definition of z, y, h and transmission parameters, modeling with these parameters, relationship between parameters sets. Writing state equations and solution using Laplace transforms.

Text books:

1.	“Network Analysis”, M.E. Van Valkenburg, PHI/Pearson Education, 3rdEdition. Reprint 2002.
2.	“Networks and systems”, Roy Choudhury, 2 nd edition, 2006 re-print, New Age International Publications
3.	Theory and Problems of Electric Circuits, Schaum`s Series, 2 nd Edition McGraw Hill

Reference books:

1.	th “Engineering Circuit Analysis”, Hayt, Kemmerly and Durbin, TMH 6 2002
2.	“Network analysis and Synthesis”, Franklin F. Kuo, Wiley Edition
3.	“Analysis of Linear Systems”, David K. Cheng, Narosa Publishing House, 11 th reprint, 2002
4.	“Circuits”, Bruce Carlson, Thomson Learning, 2000. Reprint 2002

E Books:

1.	Nptel.ac.in/courses/108105065- Networks signals and systems by Prof T.K. Basu, IIT Kharagpur
2.	Nptel.ac.in/courses/108102042- Circuit Theory by Prof Dutta Roy S.C, IIT Delhi
3.	www.electrodiction.com/circuit-theory

Moocs:	
1.	http://elearning.vtu.ac.in/06ES34.html
2.	https://www.coursera.org/course/circuits
Course outcomes At the end of the course ,the student will have the ability to	
CO-1: Formulate equations based on physical laws and analyze the steady state behavior of complex electric networks	
CO-2: Apply the knowledge of mathematics and graph theory to the solution of complex electrical networks	
CO-3: Apply mathematical and analytical techniques to analyze transient behavior of networks	
CO-4: Analyze networks based on two port networks and state variables	

Course Title	ANALOG MICROELECTRONICS				
Course Code	15ES3GCAMC	Credits	6	L-T-P-S	3-0-1-2
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)		
Prerequisites: Elements of Electronics Engineering					
UNIT-1					7 hours
<p>Diodes: Introduction. Limiting and clamping circuits - Limiter circuits, The Clamped capacitor or DC restorer.</p> <p>Bipolar Junction Transistor (BJTs): Introduction, Single stage BJT amplifiers - The basic structure , characterizing BJT Amplifiers, The common emitter amplifier Frequency Response of the CE amplifier-The 3 frequency bands, The high frequency response. The low frequency response.</p>					
UNIT-2					8 hours

<p>MOSFETS: Introduction ,Device structure and physical operation - Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small V_{GS}, Operation as V_{GS} is increased, Derivation of the i_D-V_{DS} relationship, The P- Channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the sub threshold region . Current voltage Characteristics – Circuit symbol, i_D-V_{DS} characteristics, characteristics of the P-Channel MOSFET MOSFET Circuits at DC. The MOSFET as an amplifier and as a switch - Large - signal operation , Graphical derivation of the transfer characteristic, operation as a switch, operation as a linear amplifier. Biasing in MOS amplifier circuits - Biasing by fixing V_{GS}, Biasing by fixing V_G and connecting a resistor in the source , Biasing using a drain to gate feedback resistor, biasing using a current source.</p>		
UNIT-3		7 hours
<p>Small - signal operation and models of MOSFETs - The DC bias point, the signal current in the drain terminal ,the voltage gain, separating dc analysis and the signal analysis, small signal equivalent circuit models, the transconductance g_m, the T equivalent circuit model. Single stage MOS amplifiers - The basic structure, characterizing amplifiers, The CS amplifier, The CS amplifier with a source resistance. IC Biasing - Current sources, current mirror and current steering circuits - The basic MOSFET current source, MOS current steering circuits Current mirror circuit with improved performance - The Wilson current mirror</p>		
UNIT-4		7 hours
<p>Feedback:- Introduction ,the general feedback structure, Some properties of negative feedback - Gain density, bandwidth extension, noise reduction, reduction in nonlinear distortion, The four basic feedback topologies - Voltage amplifiers, current amplifiers, transconductance amplifiers , practical feedback circuits for current series and voltage series feedback</p>		
UNIT-5		7 hours
<p>Power Amplifiers: Introduction, The classification of output stages. Class A output stage - transfer characteristic, signal waveforms, power dissipation, power conversion efficiency, transformer coupled power amplifiers, class B transformer coupled amplifier Class B output stage - Circuit operation , transfer characteristic, power conversion efficiency, power dissipation, reducing crossover distortion, single supply operation Class AB output stage - Circuit operation, output resistance Power BJTs – Junction temperature, thermal resistance, power dissipation versus temperature, transistor case and heat sink</p>		

This course shall include an assessment based on the **QEEE Phase IV** on 'Fundamentals of Small Signal Analysis' taught by Prof. Shanthi Pavan, IIT Madras.

SI No	Laboratory Experiment List Title of Experiments
1	Diode and Transistor as a switch.
2	Zener diode characteristics and Zener as regulator.
3	Diode clipping circuits- Single/Double ended.
4	Diode clamping Circuits - positive clamping/negative clamping.
5	BJT as RC coupled amplifier.
6	BJT as RC phase shift oscillator.
7	Crystal Oscillator.
8	Power Amplifier.
9	Open ended experiments.

Text books:

- | | |
|----|---|
| 1. | Microelectronic Circuits-Theory and applications by Adel S. Sedra and Kenneth C.Smith, Fifth Edition , (Oxford International Student Edition) |
| 2. | Electronic Devices and Circuit Theory - Robert L.Boylestad and Louis Nashelsky (Pearson Education) |

Reference books:

- | | |
|----|---|
| 1. | Electronic Devices and Circuits- Millman and Halkias, TMH |
|----|---|

E Books:

- | | |
|----|---|
| 1. | www.pyroelectro.com/edu/analog |
| 2. | http://freevidelectures.com/Course/3020/Circuits-for-Analog-System-Design |

Moocs:

- | | |
|----|---|
| 1. | https://www.mooc-list.com/course/electronic-systems-and-digital-electronics-uninettuno?static=true |
| 2. | http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-spring-2009/ |
| 3. | Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware Reviews and Ratings |

Course outcomes

At the end of the course ,the student will have the ability to

CO-1: Define, understand and explain the structure, V-I characteristics, working and applications of analog electronic devices like diodes, Bipolar Junction Transistors (BJTs) and MOSFETs

CO-2: Apply the knowledge of KVL and KCL to obtain voltage /current/waveform at different points in analog electronic circuits such as diode clippers, clampers, amplifiers using BJTs and MOSFETs, current sources, current mirrors, power amplifiers, feedback amplifiers

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<p>CO-3: Analyze analog electronic circuits such as diode clippers, clampers, amplifiers using BJTs and MOSFETs, current sources, current mirrors, power amplifiers, feedback amplifiers etc. to obtain voltage /current/waveform at different points for given specifications</p>
<p>CO-4: Design analog electronic circuits such as diode clippers, clampers, amplifiers using BJTs and MOSFETs, current sources, current mirrors, power amplifiers, feedback amplifiers for given specifications.</p>
<p>CO-5: Conduct experiments using analog electronic components and electronic instruments to function as switch, regulator, clippers, clampers, small signal amplifiers, oscillators, power amplifiers</p>
<p>CO-6: Engage in self-study/independent study to formulate, design, implement, analyze and demonstrate an application using analog electronic components through an open ended experiment</p>
<p>CO-7: Engage in self-study/independent study to submit a seminar report and make an effective presentation on topics related to the course (e-waste management, www.deity.gov.in, Comparative study of components, preparing the specifications of components, verifying the data sheets, applications of analog electronics)</p>

Course Title	DIGITAL ELECTRONICS				
Course Code	15ES3GCDEC	Credits	6	L-T-P-S	3-0-1-2
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)		
Prerequisites:					
Elements of Electronics Engineering					
UNIT-1					8 hours
<p>Introduction: Review of Boolean algebra, logic gates.</p> <p>Simplification of Boolean functions : Three Variable K – Maps, Four Variable K – Maps, The Tabulation Method, Determination of Prime Implicants, Selection of prime implicants.</p> <p>Combinational Logic Circuits: Introduction, Carry Look Ahead Adder, Parallel Adder, Decimal Adder Code conversion, , Magnitude Comparator, Decoders, Multiplexers, Read Only memories (ROM), Programmable Logic Arrays(PLAs).</p>					
UNIT-2					7 hours
Flip-Flops:					
The Basic Flip-flop circuit, Clocked Flip-flops, Triggering of Flip-flops: Master Slave Flip-Flops, Edge Triggered Flip Flops, Characteristic Equations.					

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UNIT-3		8 hours
Sequential Logic Circuits: Shift Registers, Ripple Counters, Design of Synchronous Counters		
UNIT-4		8 hours
Sequential systems: Analysis of Clocked Sequential circuits, State Reduction and Assignment, Design Procedure, Design with State Equations		
UNIT-5		8 hours
Logic Families: Characteristic of Digital ICs, Transistor – Transistor Logic, Complementary MOS (CMOS) Logic, Comparison of TTL and CMOS families		
This course shall include assessments based on the QEEE Phase IV lecture on 'Nitty Gritty of logic Gates to Processor Design' by Prof. Ashok Jhunjunwala, IIT Madras (based on the topics Logic Gates to Execution Unit Design, ALU design)		
Laboratory Experiment List		
Sl.No	Title of the Experiments	
1	Applications of IC 7483 (Adders, Subtractors and Comparators)	
2	Multiplexers (using Gates and IC) and their applications	
3	Decoders/DeMultiplexers (using Gates and IC) and their applications	
4	BCD to Decimal decoder using 7-segment display	
5	Verification of MSJK Flip-flop (using Gates and IC 7476)	
6	Asynchronous counters (using ICs 7476,7490,7493)	
7	Synchronous Counters (using ICs 7476, 74190/74192)	
8	Shift registers and their applications (using ICs 7476, 7495)	
Text books:		
1	Digital Logic and Computer Design- M. Morris Mano, Prentice Hall – Pearson Education	
2	Fundamental of Logic Design- Charles Roth Jr., Thomas Learning	
Reference books:		
1	Digital Principles and Design- Donald Givone, Tata McGraw Hill	
2	Digital Logic Applications and principles- John Yarbrough, Pearson Education	
E Books:		

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1.	http://www.free-engineering-books.com/2014/11/digital-fundamentals-by-thomas-l-floyd.html
2.	https://books.google.co.in/books/about/Fundamentals_of_Digital_Circuits.html?id=BOVkrLiLUcEC
Moocs:	
1.	http://freevideolectures.com/blog/2010/11/130-nptel-iit-online-courses/
2.	http://freevideolectures.com/Course/2319/Digital-Systems-Design#
3.	www. Pyroelectrom.com/edu
4.	Nptel.ac.in/courses/117106086
5.	http://nptel.ac.in/courses/117105080
6.	Digital Circuits and Systems YouTube - S. Srinivasan, IIT Madras
7.	Digital Integrated Circuits YouTube – Amitava Dasgupta, IIT Madras
Course outcomes	
At the end of the course ,the student will have the ability to	
CO1: Apply the knowledge of mathematics and engineering fundamentals to solve complex digital circuits.	
CO2: Analyze digital circuits and arrive at suitable conclusions.	
CO3: Design a digital circuit for given specifications	
CO4: Design a digital circuit and Conduct experiments using modern tools.	
CO5: Engage in self-study to formulate, design, implement, analyze and demonstrate an application of digital electronic circuits through an open-ended experiment	

Course Title	INTRODUCTION TO HUMAN ANATOMY AND PHYSIOLOGY				
Course Code	15ML3DCHAP	Credits	4	L-T-P-S	3-1-0-0
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% weightage)		
Prerequisites:		NIL			
UNIT-1				Lecture (6Hrs) and Tutorial (4 Hrs)	
<p>Cell, tissue and nervous system :- Basic definitions: Homeostasis and feedback systems, Body cavities, Chemistry of life processes, Organization of the cell, Introduction to cell systems. Types of tissues: epithelial, connective, muscular, and nervous tissues. Types of membranes: mucous, serous, and synovial membranes. Tissue repair and ageing. Histology: Action potentials, Synaptic transmission: Central nervous system and Autonomic nervous system.</p> <p><u>Tutorial (3 hours):</u> Basic navigation of anatomy and physiology, Body plan & its organization, Cell biology, cell histology and Nervous System through software tool.</p>					

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UNIT-2		Lecture (6Hrs) and Tutorial (2 Hrs)
<p>Cardiovascular system :- Formed elements of blood, Plasma, Haemopoiesis, clotting, Blood groups, Structure of blood vessels, Naming of major blood vessels, Structure of the heart, Structure of the cardiovascular system, Conduction system of the heart, the cardiac cycle, Cardiac mechanics, Effects of exercise.</p> <p><u>Tutorial (2 hours):</u> Focus on the blood and blood vessels, cardiovascular system and human heart through software tool.</p>		
UNIT-3		Lecture (6 Hrs) and Tutorial (2 Hr)
<p>Digestive system:- Introduction, organs of digestive system- mouth, tongue, teeth, salivary glands, pharynx, oesophagus, stomach, gastric juice. Functions of stomach- small intestine: structure, chemical digestion. Large intestine: structure, functions. Rectum and anal canal. Pancreas & Liver.</p> <p><u>Tutorial (1 hour):</u> Focus on the digestive system through software tool.</p>		
UNIT-4		Lecture (8 Hrs) and Tutorial (4 Hrs)
<p>Respiratory system:- Structure of the respiratory system, Mechanics of ventilation; Gas exchange, Control of respiration; Effects of exercise. Hormone action: Hypothalamus and pituitary gland-Thyroid, Parathyroid. Organs of the urinary system: detailed renal anatomy, renal function.</p> <p><u>Tutorial (4 hours):</u> Focus on the respiratory System, endocrine System and urinary System through software tool.</p>		
UNIT-5		Lecture (8 Hrs) and Tutorial (2 Hrs)
<p>Skeletal and Muscular systems:- Structure of bone, Homeostasis of bone, Skull, Vertebral column, Thorax, Pectoral Girdle, Upper limb, Pelvic girdle, Lower limb. Skeletal muscle: Contraction and relaxation, Metabolism: Control of tension and Exercise, Cardiac muscle, Smooth muscle.</p> <p><u>Tutorial (2 hour):</u> Focus on skeletal system and Muscular System through software tool.</p>		
This course will include lecture from QEEE followed by a suitable QUIZ		
Text books:		
1	Introduction to the Human Body, The Essentials of Anatomy and Physiology, 9th Edition, Tortora G.J. and Derrickson B., Wiley, USA, 2011, ISBN 0470598921.	
2	Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, 9th Edition, Churchill Livingstone Publications.	
Reference books:		

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1	Concise Medical Physiology- by Sujit K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd.
2	Human Physiology: From Cells to Systems - by Lauralee Sherwood, 6th Edition, Brooks Cole Publication.
E-books:	
1	Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, 9th Edition, Churchill Livingstone Publications.
2	Essentials of Medical Physiology - by K. Sembulingam and Prema Sembulingam, 3rd Edition, Jaypee Publications.
On line course link:	
1.	https://www.kcl.ac.uk/medicine/research/divisions/imaging/departments/biomedengineering/BEngDegree/Study/Introduction-to-Anatomy-and-Physiology.aspx
2.	https://www.primalpictures.com/anatomy-physiology.aspx
Course outcomes	
At the end of the course ,the student will have the ability to	
CO1: Apply basic anatomical knowledge of the human being with particular detail in the musculoskeletal, nervous, endocrine, cardiovascular, and respiratory systems.	
CO2: Identify systems physiology and health issues in relation to muscular, nervous, endocrine, and cardiovascular and respiratory systems	
CO3: Listen and comprehend audio/video lectures related to the course using modern tools and assimilate this knowledge to aid the development of engineering systems.	

Course Title	BIOMEDICAL SIGNALS AND MEASUREMENTS				
Course Code	15ML3DCBSM	Credits	01	L-T-P-S	0-0-1-0
CIE	100 Marks (50%weightage)	SEE	100 Marks (50% weightage)		
Experiments					
1.	To simulate Electrocardiogram Waveform <ul style="list-style-type: none"> <input type="checkbox"/> To understand normal ECG waveform <ul style="list-style-type: none"> <input type="checkbox"/> To understand noise associated with ECG measurement i.e. line Frequency and baseline wandering <input type="checkbox"/> To understand various abnormalities associated with ECG pattern 				
2.	To simulate Electroencephalogram Signal <ul style="list-style-type: none"> <input type="checkbox"/> To understand normal EEG pattern. <input type="checkbox"/> To understand various abnormalities associated with EEG. <input type="checkbox"/> To assist in studying sleep patterns. <input type="checkbox"/> To assist in diagnosing mental disorders 				

3.	To simulate Electromyogram Signal <ul style="list-style-type: none"> <input type="checkbox"/> To understand EMG waveform. <ul style="list-style-type: none"> <input type="checkbox"/> To understand noise associated with EMG measurement. <input type="checkbox"/> To understand how EMG signal is generated from the muscle.
4.	To simulate Motor Nerve Conduction Velocity <ul style="list-style-type: none"> <input type="checkbox"/> To simulate the process of measurement of motor conduction velocity (MCV). <input type="checkbox"/> To understand the relationship between MCV and various abnormalities associated with muscles. <input type="checkbox"/> To understand the application of MCV.
5.	To simulate ECG Pulse missing detector <ul style="list-style-type: none"> <input type="checkbox"/> To understand various wave complexes involved in ECG analysis <input type="checkbox"/> To understand the scheme for measurement of heart rate from ECG <input type="checkbox"/> To understand the significance of missing QRS wave and its detection.
6.	To simulate 12 Lead ECG Signals <ul style="list-style-type: none"> <input type="checkbox"/> To understand normal 12 lead ECG waveform. <input type="checkbox"/> To understand various lead selection and their types. <input type="checkbox"/> To understand various lead color code for ECG.

Note: The above experiments to be performed from the url <http://coep.vlab.co.in/?sub=25>

Course outcomes At the end of the course ,the student will have the ability to
CO1: Understand the basics of the biomedical signals
CO2: Understand the concept about ECG,EMG and EEG
CO3: Ability to Simulate the biomedical signals using software tool and analyze the same

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## IV SEMESTER SYLLABUS

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| <b>Course Title</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <b>DISCRETE MATHEMATICS AND PROBABILITY</b><br>(Common to ECE/EEE/IT/ML/TCE) |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>15MA4GCDMP</b>                                                            | <b>Credits</b> | <b>4</b>                         | <b>L-T-P-S</b> | <b>3-1-0-0</b>  |
| <b>CIE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>100 Marks (50% weightage)</b>                                             | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Prerequisites:</b><br>Basic concepts of set theory, relations and functions, Matrices, Basic concepts of probability, addition theorem, conditional probability, Bayes' theorem, discrete random variable, Binomial distribution                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                              |                |                                  |                |                 |
| <b>UNIT-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                              |                |                                  |                | <b>12 hours</b> |
| <b>SET THEORY AND RELATIONS :</b><br>Introduction to sets and subsets, operations on sets, laws of set theory. Duality, Principle of duality for the equality of sets. Countable and uncountable sets. Addition Principle. Introduction to Relations. Definition, Types of functions, operations on relations, matrix representation of relations, composition of relations, properties of relations, equivalence relations, partial orders, Hasse diagram. Posets- extremal elements on posets. <b>(9L+3T)</b><br><br>Suggested Reading: Some particular functions- Floor and ceiling functions, Projection, Unary and Binary operations. |                                                                              |                |                                  |                |                 |
| <b>UNIT-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                              |                |                                  |                | <b>10 hours</b> |
| <b>ALGEBRAIC STRUCTURES:</b> Groups, properties of groups. Some particular groups - The Klein 4-group, additive group of integers modulo $n$ , multiplicative group of integers mod $p$ , permutation groups. Subgroups, Cyclic groups, Coset decomposition of a group, homomorphism, isomorphism. <b>(7L+3T)</b><br><br>Suggested Reading: Lagrange's theorem and its consequences.                                                                                                                                                                                                                                                       |                                                                              |                |                                  |                |                 |
| <b>UNIT-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                              |                |                                  |                | <b>9 hours</b>  |
| <b>GRAPH THEORY :</b><br>Basic concepts: Types of graphs, order and size of a graph, in-degree and out-degree, connected and disconnected graphs, Eulerian graph, Hamiltonian graphs, subgraphs, dual graphs, isomorphic graphs. Matrix representation of graphs: adjacency matrix, incidence matrix. Trees: spanning tree, breadth first search. Minimal spanning tree: Kruskal's algorithm, Prim's algorithm, shortest path-Dijkstra's algorithm. <b>(7L+2T)</b><br><br>Suggested Reading: Konigsberg bridge problem, Utility problem.                                                                                                   |                                                                              |                |                                  |                |                 |

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| <b>UNIT-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                  | <b>8 hours</b> |
| <p><b>PROBABILITY:</b><br/>           Theoretical distributions: Poisson distribution, Normal distribution: Error function, Central limit theorem. Two dimensional random variables: Discrete random variable, Mathematical expectation, Covariance and Correlation. <span style="float: right;"><b>(6L+2T)</b></span></p> <p>Suggested Reading: Exponential distribution, Uniform distribution. Continuous two dimensional random variables.</p> |                                                                                                                  |                |
| <b>UNIT-5</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                  | <b>9 hours</b> |
| <p><b>MARKOV CHAIN AND QUEUING THEORY :</b><br/>           Markov Chain, Probability vectors, stochastic matrices, fixed point vector, regular stochastic matrices. Higher transition probabilities, stationary distribution of regular Markov chains. Queuing models: Concept of Queue, M/M/1 queuing systems. <span style="float: right;"><b>(7L+2T)</b></span></p> <p>Suggested Reading: Power supply model, Economic cost profit model.</p>   |                                                                                                                  |                |
| <b><u>Mathematics Lab</u></b>                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                  |                |
| <ul style="list-style-type: none"> <li>• Probability distributions</li> <li>• Minimal spanning tree- Kruskal's algorithm, Prim's algorithm.</li> <li>• Shortest Path- Dijkstra's algorithm</li> </ul>                                                                                                                                                                                                                                             |                                                                                                                  |                |
| <b>Text books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                  |                |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                | Discrete Mathematical Structures, Dr. DSC, 4 <sup>th</sup> edition, 2011-12, Prism Engineering Education Series. |                |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                | Higher Engineering Mathematics, B.S. Grewal, 43 <sup>rd</sup> edition, 2013, Khanna Publishers.                  |                |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                | Discrete Mathematics, Seymour Lipschutz. M. Lipson, 2005, Tata McGraw Hill.                                      |                |
| <b>Reference books:</b>                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                  |                |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                | Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc. Graw Hill.                                           |                |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                | Discrete Mathematics, J K Sharma, 3 <sup>rd</sup> edition, 2013, Macmillan India Ltd.                            |                |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                | Queuing Theory and Telecommunications, Networks and applications, Giovanni Giambene, 2005, Springer              |                |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                | Data Networks, Dimitri Bertsekas, Robert Gallager, 2 <sup>nd</sup> edition, 1992, Prentice India                 |                |

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| 5.                                                                                                                                                                                                       | Schaum's Outline of Probability and Statistics, John J Schiller, Murray R Speigel, 4th edition, 2013, Schaum's Outlines                                                                                                                           |
| <b>E Books:</b>                                                                                                                                                                                          |                                                                                                                                                                                                                                                   |
| 1.                                                                                                                                                                                                       | Discrete Mathematics for Computer Science, Gary Haggard, John Schlipf, Sue Whitesides, Thomson Brooks/Cole, 2006                                                                                                                                  |
| 2.                                                                                                                                                                                                       | (1) <a href="http://www.khanacademy.org/math/probability/random-variablestopic/random_variables_prob_dist/v/random-variables">http://www.khanacademy.org/math/probability/random-variablestopic/random_variables_prob_dist/v/random-variables</a> |
| 3.                                                                                                                                                                                                       | <a href="http://ocw.mit.edu/courses/mathematics/">http://ocw.mit.edu/courses/mathematics/</a> (online course material)                                                                                                                            |
| <b>Moocs:</b>                                                                                                                                                                                            |                                                                                                                                                                                                                                                   |
| 1.                                                                                                                                                                                                       | <a href="http://www.nptelvideos.in/2012/11/discrete-mathematical-structures.html">www.nptelvideos.in/2012/11/discrete-mathematical-structures.html</a>                                                                                            |
| 2.                                                                                                                                                                                                       | <a href="http://www.cs.berkeley.edu/~daw/teaching/cs70-s05">www.cs.berkeley.edu/~daw/teaching/cs70-s05</a>                                                                                                                                        |
| 3.                                                                                                                                                                                                       | <a href="https://www.khanacademy.org/">https://www.khanacademy.org/</a>                                                                                                                                                                           |
| <b>Course outcomes</b>                                                                                                                                                                                   |                                                                                                                                                                                                                                                   |
| At the end of the course ,the student will have the ability to                                                                                                                                           |                                                                                                                                                                                                                                                   |
| <b>CO-1:</b> Understand the notation of set theory, relations and functions.                                                                                                                             |                                                                                                                                                                                                                                                   |
| <b>CO-2:</b> Construct a Hasse diagram for partial orderings, Use many terms associated with graphs and prove whether two graphs are isomorphic.                                                         |                                                                                                                                                                                                                                                   |
| <b>CO-3:</b> Obtain the probability of an event using discrete and continuous distributions, including the n-step transition probability.                                                                |                                                                                                                                                                                                                                                   |
| <b>CO-4:</b> Analyse and classify simple states (recurrent/transient)                                                                                                                                    |                                                                                                                                                                                                                                                   |
| <b>CO-5:</b> Understand, derive and apply the properties of the M/M/m queuing model (properties like stationary probability, average waiting and system time, expected number of customers in the queue) |                                                                                                                                                                                                                                                   |

# Medical Electronics

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| <b>Course Title</b> | <b>ANALOG INTEGRATED CIRCUITS</b>    |                |                                  |                |                |
| <b>Course Code</b>  | <b>15ES4GCAIC</b>                    | <b>Credits</b> | <b>6</b>                         | <b>L-T-P-S</b> | <b>3-0-1-2</b> |
| <b>CIE</b>          | <b>100 Marks<br/>(50% weightage)</b> | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                |

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| <b>Prerequisites:</b> Elements of Electronics Engineering, Analog Microelectronics                                                                                                                                                                                                                                                                                                                                                                |                |
| <b>UNIT-1</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>8 hours</b> |
| <p><b>Operational Amplifier Characteristics:</b><br/>           Introduction, DC Characteristics, AC Characteristics, Analysis of data sheets of an OP-AMP<br/> <b>Operational Amplifier Applications:</b><br/>           Review of basic Opamp applications, Instrumental Amplifier, V to I, and I to V converter, Op-amp circuits using Diodes - Half wave rectifier, Full wave rectifier, Sample and hold circuit, Multiplier and Divider.</p> |                |
| <b>UNIT-2</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>7 hours</b> |
| <p><b>Comparators and Waveform Generators:</b><br/>           Introduction, comparator, Regenerative comparator (Schmitt Trigger), Square wave generator (Astable Multivibrator), Monostable Multivibrator, Triangular wave generator. (RC and Wein bridge oscillators only).</p>                                                                                                                                                                 |                |
| <b>UNIT-3</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>7 hours</b> |
| <p><b>Voltage Regulators:</b><br/>           Introduction, Series op-amp regulator, IC Voltage regulators, 723 General purpose Regulator, Switching Regulator.<br/> <b>Active Filters:</b><br/>           Introduction, RC Active Filters, First order low pass filter, second order active filter, Higher order low pass filter, High pass active filter, All pass filter-phase shift lead and lag circuit</p>                                   |                |
| <b>UNIT-4</b>                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>7 hours</b> |
| <p><b>Timers :</b><br/>           Introduction to 555 timer, Description of Functional diagram, monostable operation, astable operation.<br/> <b>Phase locked loops :</b> Introduction, Basic principles, phase detector/comparator, voltage controlled oscillator (VCO)</p>                                                                                                                                                                      |                |

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| <b>UNIT-5</b>                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                     | <b>7 hours</b> |
| <p><b>D-A and A-D Converters:</b><br/>         Introduction, Basic DAC Techniques- Weighted Resistor DAC, R-2R Ladder DAC.<br/>         A-D Converters: Direct type ADCs- The parallel Comparator (Flash) A/D converter, Successive Approximation Converter, DAC/ADC Specification, Sigma – delta ADC</p> |                                                                                                                                                                                     |                |
| 1                                                                                                                                                                                                                                                                                                         | Inverting and non- inverting amplifier, voltage follower                                                                                                                            |                |
| 2                                                                                                                                                                                                                                                                                                         | Inverting and non- inverting summing Amplifier                                                                                                                                      |                |
| 3                                                                                                                                                                                                                                                                                                         | Differentiator and integrator                                                                                                                                                       |                |
| 4                                                                                                                                                                                                                                                                                                         | Precision half wave and full wave rectifier                                                                                                                                         |                |
| 5                                                                                                                                                                                                                                                                                                         | Zero crossing detector and Schmitt trigger                                                                                                                                          |                |
| 6                                                                                                                                                                                                                                                                                                         | Weinbridge Oscillator                                                                                                                                                               |                |
| 7                                                                                                                                                                                                                                                                                                         | First order active low pass filter                                                                                                                                                  |                |
| 8                                                                                                                                                                                                                                                                                                         | First order active high pass filter                                                                                                                                                 |                |
| 9                                                                                                                                                                                                                                                                                                         | 555 as astable multivibrator                                                                                                                                                        |                |
| 10                                                                                                                                                                                                                                                                                                        | 555 as monostable multivibrator                                                                                                                                                     |                |
| 11                                                                                                                                                                                                                                                                                                        | IC 723 as low voltage and high voltage regulators                                                                                                                                   |                |
| 12                                                                                                                                                                                                                                                                                                        | D to A convertor                                                                                                                                                                    |                |
| 13                                                                                                                                                                                                                                                                                                        | A to D convertor                                                                                                                                                                    |                |
| <p><b>Text books:</b></p>                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                     |                |
| 1.                                                                                                                                                                                                                                                                                                        | Linear Integrated Circuits- D. Roy Choudhury & Shail B. Jain (New age Publication)                                                                                                  |                |
| 2.                                                                                                                                                                                                                                                                                                        | Op-Amps and Linear Integrated Circuits- Ramakanth A.Gayakwad,4th edition , PHI                                                                                                      |                |
| <p><b>Reference books:</b></p>                                                                                                                                                                                                                                                                            |                                                                                                                                                                                     |                |
| 1.                                                                                                                                                                                                                                                                                                        | Linear Integrated Circuits- S. Salivahanan & V.S. Kanchana Bhaaskaran (Tata McGraw-Hill Publication)                                                                                |                |
| 2.                                                                                                                                                                                                                                                                                                        | Opamps and Linear ICs-David A.Bell (Prentice-Hall Publications)                                                                                                                     |                |
| <p><b>E Books:</b></p>                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                     |                |
| 1.                                                                                                                                                                                                                                                                                                        | <a href="http://freevidelectures.com/Course/2321/Electronics-for-Analog-Signal-Processing-I">http://freevidelectures.com/Course/2321/Electronics-for-Analog-Signal-Processing-I</a> |                |
| 2.                                                                                                                                                                                                                                                                                                        | <a href="http://freevidelectures.com/Course/2322/Electronics-for-Analog-Signal-Processing-I">http://freevidelectures.com/Course/2322/Electronics-for-Analog-Signal-Processing-I</a> |                |

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| <b>Moocs:</b>                                                                                                                                           |                                                                                                                                                                                                         |
| 1.                                                                                                                                                      | <a href="http://ocw.tudelft.nl/courses/microelectronics/analog-integrated-circuit-design/course-home/">http://ocw.tudelft.nl/courses/microelectronics/analog-integrated-circuit-design/course-home/</a> |
| 2.                                                                                                                                                      | <a href="#">Introductory Analog Electronics Laboratory (Spring 2007) by MIT Open Courseware   Reviews and Ratings</a>                                                                                   |
| 3.                                                                                                                                                      | <a href="http://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/">http://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/</a>                                     |
| <b>Course outcomes</b>                                                                                                                                  |                                                                                                                                                                                                         |
| At the end of the course ,the student will have the ability to                                                                                          |                                                                                                                                                                                                         |
| CO1: Apply the knowledge of electronic engineering fundamentals to solve problems requiring solutions based on analog integrated circuits               |                                                                                                                                                                                                         |
| CO2: Analyse and interpret DC and AC limitations of Operational Amplifiers                                                                              |                                                                                                                                                                                                         |
| CO3: Build and analyze responses of analog integrated circuits in the areas of power sourcing, signal conditioning and analog communication             |                                                                                                                                                                                                         |
| CO4: Design and implement sub-circuits of analog / mixed-signal systems to meet the desired specifications for linear and non-linear applications       |                                                                                                                                                                                                         |
| CO5: Reason and select analog integrated circuit configurations for optimum performance to achieve sustainability                                       |                                                                                                                                                                                                         |
| CO6: Work both independently and in team to implement, document and present open- ended experiments and projects built using analog integrated circuits |                                                                                                                                                                                                         |

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| <b>Course Title</b>                                                                                                                                                                                                                                    | <b>MICROCONTROLLERS</b>          |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                                                                                     | <b>15ES4GCMCS</b>                | <b>Credits</b> | <b>6</b>                         | <b>L-T-P-S</b> | <b>3-0-1-2</b>  |
| <b>CIE</b>                                                                                                                                                                                                                                             | <b>100 Marks (50% weightage)</b> | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Prerequisites:</b> Elements of Electronics Engineering Digital Electronics                                                                                                                                                                          |                                  |                |                                  |                |                 |
| <b>UNIT-1</b>                                                                                                                                                                                                                                          |                                  |                |                                  |                | <b>07 hours</b> |
| <b>INTRODUCTION TO MICROCOMPUTER AND MICROCONTROLLER:</b>                                                                                                                                                                                              |                                  |                |                                  |                |                 |
| Introduction to Microprocessors, Internal organization of computer- Bus Structures, Harvard & Von-Neumann CPU architecture, <b>The 8051 Architecture:</b> Introduction, 8051 Microcontroller Hardware, Input / Output Pins, External Memory Interface. |                                  |                |                                  |                |                 |

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| <b>UNIT-2</b>                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                           | <b>8 hours</b> |
| <p><b>MICROCONTROLLER PROGRAMMING:</b><br/>           Instruction set architecture-RISC &amp; CISC CPU Architectures, Pipelining, Execution of an instruction, Addressing Modes and Instruction set. Example Demonstration using 8051 instruction set, Data transfer instructions, Arithmetic instructions, Logical instructions, Branching and Subroutines, Example programs.</p> |                                                                                                                                                           |                |
| <b>UNIT-3</b>                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                           | <b>8 hours</b> |
| <p><b>CONCEPTS OF EMBEDDED ‘C’ PROGRAMMING:</b><br/>           Data types, examples in 8051 C, program structures, logical operations, Memory and I/O access, Programming peripherals (Examples: Timer / Counter), Programming serial communication (serial data input/output) - example programs using 8051</p>                                                                   |                                                                                                                                                           |                |
| <b>UNIT-4</b>                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                           | <b>7 hours</b> |
| <p><b>INTERRUPTS AND INTERRUPT PROGRAMMING:</b><br/>           Concept of Interrupts Interrupts in 8051. Programming Timer Interrupts, Programming External Hardware Interrupts, Programming Serial Communication Interrupts</p>                                                                                                                                                   |                                                                                                                                                           |                |
| <b>UNIT-5</b>                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                           | <b>6 hours</b> |
| <p><b>INTERFACING AND APPLICATIONS:</b> Interfacing 8051 to LCD, DAC, ADC Stepper motor interfacing. Applications of microcontrollers.</p>                                                                                                                                                                                                                                         |                                                                                                                                                           |                |
| <p><b>LABORATORY EXPERIMENTS:</b><br/>           Part A: Data Transfer, Logical-Byte/Bit manipulations, Jump and Subroutine Calls using Assembly language, counters and delay generation using timers, Embedded C programs<br/>           Part B: Interfacing: LCD Display, Stepper motor control, logical interface, 7 segment interface, DAC and keyboard.</p>                   |                                                                                                                                                           |                |
| <b>Text books:</b>                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                           |                |
| 1.                                                                                                                                                                                                                                                                                                                                                                                 | “The 8051 Microcontroller Architecture, Programming & Applications”, Kenneth J. Ayala 2e, Thomson Learning 2005                                           |                |
| 2.                                                                                                                                                                                                                                                                                                                                                                                 | “The 8051 Microcontroller and Embedded Systems – using assembly and C”, Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D. McKinlay; PHI, 2006 |                |

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| <b>Reference books:</b>                                                                                                                                                                                   |                                                                                                                                                                                                                                                                            |
| 1.                                                                                                                                                                                                        | 'Computer Organization and Architecture', Carl Hamacher, McGrawHill, 5th Edition                                                                                                                                                                                           |
| 2.                                                                                                                                                                                                        | <a href="http://cnx.org/contents/dadb4fd5-8390-4323-a056-f6381587e89a@1/Microcontroller%288051%29-Lab">http://cnx.org/contents/dadb4fd5-8390-4323-a056-f6381587e89a@1/Microcontroller%288051%29-Lab</a>                                                                    |
| <b>E Books:</b>                                                                                                                                                                                           |                                                                                                                                                                                                                                                                            |
| 1.                                                                                                                                                                                                        | <a href="http://nptel.ac.in/courses/Webcourse-contents/IIT.../microcontrollers">nptel.ac.in/courses/Webcourse-contents/IIT.../microcontrollers</a>                                                                                                                         |
| 2.                                                                                                                                                                                                        | <a href="http://freevideolectures.com/Course/3018/Microprocessors-and-Microcontrollers">http://freevideolectures.com/Course/3018/Microprocessors-and-Microcontrollers</a>                                                                                                  |
| <b>Moocs:</b>                                                                                                                                                                                             |                                                                                                                                                                                                                                                                            |
| 1.                                                                                                                                                                                                        | <b>Embedded Systems - Shape The World</b> - <a href="https://www.edx.org/course/embedded-systems-shape-world-utaustinx-ut-6-02x">https://www.edx.org/course/embedded-systems-shape-world-utaustinx-ut-6-02x</a>                                                            |
| 2.                                                                                                                                                                                                        | <b>Electronic Interfaces: Bridging the Physical and Digital Worlds-</b><br><a href="https://www.edx.org/course/electronic-interfaces-bridging-physical-uc-berkeleyx-ee401x-0">https://www.edx.org/course/electronic-interfaces-bridging-physical-uc-berkeleyx-ee401x-0</a> |
| <b>Course outcomes :</b> At the end of the course ,the student will have the ability to                                                                                                                   |                                                                                                                                                                                                                                                                            |
| CO1: Understand the concepts of 8051 microcontroller architecture, assembly and embedded C programming                                                                                                    |                                                                                                                                                                                                                                                                            |
| CO2: apply the learnt concepts of 8051 microcontroller to solve the problems using assembly and embedded C programming.                                                                                   |                                                                                                                                                                                                                                                                            |
| CO3: Identify the IDE to conduct experiments                                                                                                                                                              |                                                                                                                                                                                                                                                                            |
| CO4: Debug/analyze the code in assembly and embedded C                                                                                                                                                    |                                                                                                                                                                                                                                                                            |
| CO5: Engage in independent study/ self-study as an individual and as a team- member to design, formulate and implement an open ended experiment on applications of microntrollers for medical electronics |                                                                                                                                                                                                                                                                            |

# Medical Electronics

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| <b>Course Title</b>                                                                                                                                                                                                                                                                      | <b>CONTROLSYSTEMS</b>                                                           |                |                                  |                |                  |
| <b>Course Code</b>                                                                                                                                                                                                                                                                       | <b>15ES4GCCST</b>                                                               | <b>Credits</b> | <b>4</b>                         | <b>L-T-P-S</b> | <b>3-1-0-0</b>   |
| <b>CIE</b>                                                                                                                                                                                                                                                                               | <b>100 Marks<br/>(50% weightage)</b>                                            | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                  |
| <b>Prerequisites:</b> Linear Circuit Analysis, Engineering Mathematics I & II, Advanced Mathematics                                                                                                                                                                                      |                                                                                 |                |                                  |                |                  |
| <b>UNIT-1</b>                                                                                                                                                                                                                                                                            |                                                                                 |                |                                  |                | <b>9+3 hours</b> |
| <b>Introduction:</b><br>Examples of Control Systems, open loop vs Closed loop Systems, Mathematical Modeling of Linear Systems: Transfer functions, Mechanical Systems, Analogous Systems, Block diagram, Signal Flow graph, Compensators: Lag, Lead(obtaining transfer functions only). |                                                                                 |                |                                  |                |                  |
| <b>UNIT-2</b>                                                                                                                                                                                                                                                                            |                                                                                 |                |                                  |                | <b>6+3 hours</b> |
| <b>Controllers &amp; Time response analysis:</b><br>Step response of first order, second order systems, response specification, steady state error and error constants. Example of effect of P-I controllers on the time response                                                        |                                                                                 |                |                                  |                |                  |
| <b>UNIT-3</b>                                                                                                                                                                                                                                                                            |                                                                                 |                |                                  |                | <b>9+2 hours</b> |
| <b>Stability Analysis:</b><br>Concept of stability, RH criterion, applications of RH criterion with limitations, Nyquist plot, Polar plots, Stability Analysis using Nyquist criterion                                                                                                   |                                                                                 |                |                                  |                |                  |
| <b>UNIT-4</b>                                                                                                                                                                                                                                                                            |                                                                                 |                |                                  |                | <b>6+2 hours</b> |
| <b>Root locus technique:</b><br>Introduction to root locus concepts, Construction rules, Analysis of stability by root locus plot                                                                                                                                                        |                                                                                 |                |                                  |                |                  |
| <b>UNIT-5</b>                                                                                                                                                                                                                                                                            |                                                                                 |                |                                  |                | <b>6+2 hours</b> |
| <b>Frequency response Analysis:</b><br>Bode plots, Relative stability, Frequency domain specification.                                                                                                                                                                                   |                                                                                 |                |                                  |                |                  |
| <b>Text books:</b>                                                                                                                                                                                                                                                                       |                                                                                 |                |                                  |                |                  |
| <b>1.</b>                                                                                                                                                                                                                                                                                | Control Engineering by Nagrath & Gopal, New Age International Publishers        |                |                                  |                |                  |
| <b>2.</b>                                                                                                                                                                                                                                                                                | Engineering control systems - Norman S. Nise, John WILEY & sons , fifth Edition |                |                                  |                |                  |
| <b>Reference books:</b>                                                                                                                                                                                                                                                                  |                                                                                 |                |                                  |                |                  |
| <b>1.</b>                                                                                                                                                                                                                                                                                | Modern control Engineering- Ogata, Prentice Hall                                |                |                                  |                |                  |
| <b>2.</b>                                                                                                                                                                                                                                                                                | Automatic Control Systems - B.C Kuo, John Wileyand Sons                         |                |                                  |                |                  |

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| <b>E Books:</b>                                                                                                                  |                                                                                                                                                                                                                                                                               |
| 1.                                                                                                                               | <a href="http://en.wikibooks.org/wiki/Control_Systems">http://en.wikibooks.org/wiki/Control_Systems</a>                                                                                                                                                                       |
| 2.                                                                                                                               | <a href="http://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/#practical-examples-of-open-loop-control-system">http://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/#practical-examples-of-open-loop-control-system</a> |
| 3.                                                                                                                               | <a href="http://www.facstaff.bucknell.edu/mastascu/eControlHTML/CourseIndex.html">http://www.facstaff.bucknell.edu/mastascu/eControlHTML/CourseIndex.html</a>                                                                                                                 |
| <b>Moocs:</b>                                                                                                                    |                                                                                                                                                                                                                                                                               |
| 1.                                                                                                                               | <a href="http://www.nptel.com/IITK">www.nptel.com/IITK</a>                                                                                                                                                                                                                    |
| 2.                                                                                                                               | <a href="https://www.edx.org/course/">https://www.edx.org/course/</a>                                                                                                                                                                                                         |
| 3.                                                                                                                               | <a href="http://nptel.ac.in/courses/108103007/1">http://nptel.ac.in/courses/108103007/1</a>                                                                                                                                                                                   |
| <b>Course outcomes</b>                                                                                                           |                                                                                                                                                                                                                                                                               |
| At the end of the course ,the student will have the ability to                                                                   |                                                                                                                                                                                                                                                                               |
| <b>CO-1:</b> Obtain mathematical models of open loop and closed loop physical systems                                            |                                                                                                                                                                                                                                                                               |
| <b>CO-2:</b> Apply mathematical techniques to perform time response analysis of a control system                                 |                                                                                                                                                                                                                                                                               |
| <b>CO-3:</b> Carry out stability analysis using different mathematical techniques                                                |                                                                                                                                                                                                                                                                               |
| <b>CO4:</b> Formulate, design, implement, analyse and demonstrate, document and present an application systems using modern tool |                                                                                                                                                                                                                                                                               |

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| <b>Course Title</b>                                                                                                                                                                                                                                                             | <b>SIGNALS AND SYSTEMS</b>       |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                                                                                                              | <b>15ES4GCSAS</b>                | <b>Credits</b> | <b>4</b>                         | <b>L-T-P-S</b> | <b>3-1-0-0</b>  |
| <b>CIE</b>                                                                                                                                                                                                                                                                      | <b>100 Marks (50% weightage)</b> | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Prerequisites:</b> Linear Circuit Analysis, Engineering Mathematics I & II, Advanced Mathematics                                                                                                                                                                             |                                  |                |                                  |                |                 |
| <b>UNIT-1</b>                                                                                                                                                                                                                                                                   |                                  |                |                                  |                | <b>10 hours</b> |
| <b>INTRODUCTION:</b> Definitions of a signal and a system, classification of signals, basic operations on signals, elementary signals, Systems viewed as Interconnections of operations, properties of systems.                                                                 |                                  |                |                                  |                |                 |
| <b>UNIT-2</b>                                                                                                                                                                                                                                                                   |                                  |                |                                  |                | <b>10 hours</b> |
| <b>TIME-DOMAIN REPRESENTATIONS FOR LTI SYSTEMS:</b> Convolution, impulse response representation, Convolution Sum and Convolution Integral, Properties of impulse response representation, Differential and difference equation Representations, Block diagram representations. |                                  |                |                                  |                |                 |

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| <b>UNIT-3</b>                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                           | <b>8 hours</b>  |
| <p><b>FOURIER SERIES:</b> Introduction, Discrete time and continuous time Fourier series (derivation of trigonometric Fourier series representation are excluded), Properties of Fourier series (No proof), Applications of Fourier series. Sampling Theorem and Reconstruction</p>  |                                                                                                                                                                                                                                                                                           |                 |
| <b>UNIT-4</b>                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                           | <b>10 hours</b> |
| <p><b>FOURIER TRANSFORM:</b> Discrete and continuous Fourier transforms &amp; their properties (With proof). Fourier transform representation of periodic signals, Applications of Fourier transform, Frequency response of LTI systems. Laplace Transform and its Applications.</p> |                                                                                                                                                                                                                                                                                           |                 |
| <b>UNIT-5</b>                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                           | <b>10 hours</b> |
| <p><b>Z-TRANSFORMS:</b> Introduction, Z – transform, properties of ROC &amp; Z – transforms Inverse Z–transforms, unilateral Z- Transform, analysis of LTI Systems and application to solve Difference equations.</p>                                                                |                                                                                                                                                                                                                                                                                           |                 |
| <b>Text books:</b>                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                           |                 |
| 1.                                                                                                                                                                                                                                                                                   | Simon Haykin and Barry Van Veen “Signals and Systems”, John Wiley & Sons, 2001.Reprint 2002                                                                                                                                                                                               |                 |
| 2.                                                                                                                                                                                                                                                                                   | Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, “Signals and Systems” Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002                                                                                                                                           |                 |
| <b>Reference books:</b>                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                           |                 |
| 1.                                                                                                                                                                                                                                                                                   | H. P Hsu, R. Ranjan, “Signals and Systems”, Scham’s outlines, TMH, 2006                                                                                                                                                                                                                   |                 |
| 2.                                                                                                                                                                                                                                                                                   | B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2005                                                                                                                                                                                                                  |                 |
| 3.                                                                                                                                                                                                                                                                                   | Ganesh Rao and SatishTunga, “Signals and Systems”, Sanguine Technical Publishers, 2004                                                                                                                                                                                                    |                 |
| <b>E Books:</b>                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                           |                 |
| 1.                                                                                                                                                                                                                                                                                   | NPTEL lecture Video on Signals and Systems by Prof. S.C.Dutta Roy,<br><a href="http://www.satishkashyap.com/2012/04/iit-video-lectures-on-signals-and.html">http://www.satishkashyap.com/2012/04/iit-video-lectures-on-signals-and.html</a>                                               |                 |
| 2.                                                                                                                                                                                                                                                                                   | NPTEL lecture Video on Signals and Systems by Prof. T.K. Basu, IIT Kharagpur.<br><a href="http://www.nptel.ac.in/courses/108105065/">http://www.nptel.ac.in/courses/108105065/</a>                                                                                                        |                 |
| 3.                                                                                                                                                                                                                                                                                   | NPTEL on line Course Modules–IIT Bombay –Signals and Systems<br><a href="http://www.cdeep.iitb.ac.in/nptel/Electrical%20&amp;%20Comm%20Engg/Signals%20and%20System/TOC-M1.html">http://www.cdeep.iitb.ac.in/nptel/Electrical%20&amp;%20Comm%20Engg/Signals%20and%20System/TOC-M1.html</a> |                 |

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| <b>Moocs:</b>                                                                                                                                                                                                           |                                                                                                                                                               |
| <b>1.</b>                                                                                                                                                                                                               | <a href="https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-0">https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-0</a> |
| <b>2.</b>                                                                                                                                                                                                               | <a href="https://www.edx.org/course/signals-systems-part-2-iitbombayx-ee210-2x-0">https://www.edx.org/course/signals-systems-part-2-iitbombayx-ee210-2x-0</a> |
| <b>Course outcomes :</b> At the end of the course ,the student will have the ability to                                                                                                                                 |                                                                                                                                                               |
| CO1: Define, understand, and explain various types of signals systems, their time and frequency domain representation and their realization.                                                                            |                                                                                                                                                               |
| CO2: Classify signals and systems, obtain the output for LTI systems using the time domain and the frequency domain representation, obtain the frequency domain representation of LTI systems using various transforms. |                                                                                                                                                               |
| CO3: Analyse the given specifications for systems for causality, stability, linearity, time invariance physical reliability.                                                                                            |                                                                                                                                                               |
| CO4: Design LTI systems for the given response specifications in an efficient                                                                                                                                           |                                                                                                                                                               |
| CO5: Make and effective oral presentation or report writing on contribution of signal processing in various engineering aspects.                                                                                        |                                                                                                                                                               |

|                     |                                        |                |                                  |                |                |
|---------------------|----------------------------------------|----------------|----------------------------------|----------------|----------------|
| <b>Course Title</b> | <b>BIOMEDICAL ETHICS AND STANDARDS</b> |                |                                  |                |                |
| <b>Course Code</b>  | <b>15ML4DCBES</b>                      | <b>Credits</b> | <b>01</b>                        | <b>L-T-P-S</b> | <b>0-0-1-0</b> |
| <b>CIE</b>          | <b>100 Marks (50% weightage)</b>       | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                |

|                                                                                                                      |                                                             |
|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|
| <b>Experiments</b>                                                                                                   |                                                             |
| <b>1.</b>                                                                                                            | Introduction to commonly manufactured medical devices       |
| <b>2.</b>                                                                                                            | Identify the relationships between devices                  |
| <b>3.</b>                                                                                                            | Device the system description and system diagram            |
| <b>4.</b>                                                                                                            | Common standards followed for medical devices               |
| <b>5.</b>                                                                                                            | Ethical issues pertaining to development of Medical devices |
| <b>Course outcomes</b><br>At the end of the course ,the student will have the ability to                             |                                                             |
| <b>CO1:</b> Understand the ethical properties, laws, history etc to do the right thing in Medical device development |                                                             |
| <b>CO2:</b> Able to act ethically after having known the skills needed                                               |                                                             |

**CO3:** Able to synthesize principles of medical device regulatory requirements, investigational device exemptions & regulatory submissions

**CO4:** Assess quality system standards, procedures and practices

## MANDATORY MATHEMATICS COURSES FOR LATERAL ENTRY STUDENTS

|                     |                                     |                |   |                |         |
|---------------------|-------------------------------------|----------------|---|----------------|---------|
| <b>Course Title</b> | <b>MATHEMATICS-I</b> (All branches) |                |   |                |         |
| <b>Course Code</b>  | 15MA3IMMAT                          | <b>Credits</b> | 0 | <b>L-T-P-S</b> | 0:0:0:0 |
| <b>CIE</b>          | 100 marks (100% weightage)          |                |   |                |         |

**Pre-requisites:** - Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration

|               |  |                  |
|---------------|--|------------------|
| <b>UNIT I</b> |  | <b>[9 hours]</b> |
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**DIFFERENTIAL AND INTEGRAL CALCULUS:**

List of standard derivatives including hyperbolic functions, rules of differentiation. Differentiation of product of two functions using Leibnitz rule (direct problems). Taylor's and Maclaurin's series expansion for functions of single variable. List of standard integrals, integration by parts. Definite integrals – problems. **(7L+2T)**

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| <b>UNIT II</b> |  | <b>[10 hours]</b> |
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**POLAR COORDINATES AND PARTIAL DERIVATIVES :**

Polar curves: Polar coordinates, angle between radius vector and tangent, angle between two polar curves. Partial differentiation. Total differentiation-Composite and Implicit functions. Taylor's and Maclaurin's series expansion for functions of two variables. Jacobians and their properties (without proof) – Problems. **(7L+3T)**

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| <b>UNIT III</b> |  | <b>[08 hours]</b> |
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**FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS :**

Introduction to first order differential equations. Linear equation and its solution. Bernoulli's equation and its solution. Exact differential equation and its solution. Orthogonal Trajectories. **(6L+2T)**

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| <b>UNIT IV</b> |  | <b>[9 hours]</b> |
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**SECOND AND HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS:**

Ordinary differential equations with constant coefficients: Homogeneous differential equations, non-homogeneous differential equations – Particular integral for functions of the type  $f(x) = e^{ax}$ ,  $\sin(ax)$ ,  $\cos(ax)$ ,  $x^n$ ,  $e^{ax}\sin(bx)$ ,  $e^{ax}\cos(bx)$ . Method of variation of parameters. Cauchy's and Legendre differential equations.

**(7L+2T)**

**UNIT V**

**[8 hours]**

**VECTOR CALCULUS AND ORTHOGONAL CURVILINEAR COORDINATES (OCC):**

Recapitulation of scalars, vectors and operation on scalars and vectors. Scalar and vector point functions. Del operator, gradient-directional derivative, divergence, curl and Laplacian operator. Vector identities (without proof). Cylindrical and Spherical polar coordinate systems. Expressing a vector point function in cylindrical and spherical systems. Expressions for gradient, divergence, curl and Laplacian in OCC. **(6L+2T)**

**Text Books:**

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10<sup>th</sup> edition, 2014, Wiley- India.
2. Higher Engineering Mathematics, B.V. Ramana, 7<sup>th</sup> reprint, 2009, Tata Mc. Graw Hill.

**Reference Books:**

1. Higher Engineering Mathematics, B.S. Grewal, 43<sup>rd</sup> edition, 2014, Khanna Publishers
2. Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd.

**E Books:**

1. Engineering Mathematics, [K. A. Stroud](#), [Dexter J. Booth](#), Industrial Press, 2001 [http://books.google.co.in/books/about/Engineering\\_Mathematics.html?id=FZnCL-xB8dEC&redir\\_esc=y](http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZnCL-xB8dEC&redir_esc=y).
2. Advanced Engineering Mathematics, P. V. O'Neil, 5<sup>th</sup> Indian reprint, 2009, Cengage learning India Pvt. Ltd.
3. <http://ocw.mit.edu/courses/mathematics/> (online course material)

**Moocs:**

1. [https:// www.khanacademy.org/Math](https://www.khanacademy.org/Math)

|                                                                                                                          |                                                                                                              |
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| 2.                                                                                                                       | <a href="https://www.class-central.com/subject/math">https:// www.class-central.com/subject/math</a> (MOOCS) |
| 3.                                                                                                                       | E-learning: <a href="http://www.vtu.ac.in">www.vtu.ac.in</a>                                                 |
| <b>Course Outcomes</b>                                                                                                   |                                                                                                              |
| At the end of the course, the student will have the ability to                                                           |                                                                                                              |
| <b>CO-1:</b> Understand the basic concepts of differentiation and integration.                                           |                                                                                                              |
| <b>CO-2:</b> Apply the concepts of polar curves and multivariate calculus.                                               |                                                                                                              |
| <b>CO-3:</b> Apply analytical techniques to compute solutions of first and higher order ordinary differential equations. |                                                                                                              |
| <b>CO-4:</b> Apply techniques of vector calculus to engineering problems.                                                |                                                                                                              |
| <b>CO-5:</b> Comprehend the generalization of vector calculus in curvilinear coordinate system.                          |                                                                                                              |

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|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|----------------|----------|-------------------|----------------|
| <b>Course Title</b>                                                                                                                                                      | <b>MATHEMATICS-II</b><br>(All Branches) |                |          |                   |                |
| <b>Course Code</b>                                                                                                                                                       | <b>15MA4IMMAT</b>                       | <b>Credits</b> | <b>0</b> | <b>L-T-P-S</b>    | <b>0:0:0:0</b> |
| <b>CIE</b>                                                                                                                                                               | 100 marks (100% weightage)              |                |          |                   |                |
| <b>Pre-requisites :-</b> Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.                                     |                                         |                |          |                   |                |
| <b>UNIT I</b>                                                                                                                                                            |                                         |                |          | <b>[8 hours]</b>  |                |
| <b>LAPLACE TRANSFORMS:</b> Laplace transforms of standard functions. Properties and problems. Laplace Transform of Periodic functions with plotting. Unit step function. |                                         |                |          | <b>(6L+2T)</b>    |                |
| <b>UNIT II</b>                                                                                                                                                           |                                         |                |          | <b>[9 hours]</b>  |                |
| <b>INVERSE LAPLACE TRANSFORMS:</b> Inverse Laplace transforms of standard functions. Properties and problems. Solution of ODE- Initial and Boundary value Problems.      |                                         |                |          | <b>(7L+2T)</b>    |                |
| <b>UNIT III</b>                                                                                                                                                          |                                         |                |          | <b>[11 hours]</b> |                |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|--|------------------|
| <b>DOUBLE INTEGRAL:</b>                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| Evaluation of double integral. Change of order of integration. Change of variables to polar coordinates. Application: Area. <span style="float: right;"><b>(8L+3T)</b></span>                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>UNIT IV</b>                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  | <b>[8 hours]</b> |
| <b>TRIPLE INTEGRALS AND IMPROPER INTEGRALS:</b>                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| Evaluation of triple integral. Application: Volume. Gamma and Beta functions-definition<br>Relation between Gamma and Beta functions. Properties and Problems. <span style="float: right;"><b>(6L+2T)</b></span> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>UNIT V</b>                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  | <b>[8 hours]</b> |
| <b>VECTOR INTEGRATION:</b>                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| Line integral. Green's theorem. Stokes' theorem. Gauss divergence theorem. <span style="float: right;"><b>(6L+2T)</b></span>                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>Text Books:</b>                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>1.</b>                                                                                                                                                                                                        | Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbook series, Vol. 1 and Vol. 2, 10 <sup>th</sup> edition, 2014, Wiley- India.                                                                                                                                                                                                                                                                                                                                                                                               |  |  |                  |
| <b>2.</b>                                                                                                                                                                                                        | Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zill and Cullen, Jones and Bartlett India Pvt. Ltd                                                                                                                                                                                                                                                                                                                                                                                                                            |  |  |                  |
| <b>Reference Books:</b>                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>1.</b>                                                                                                                                                                                                        | Higher Engineering Mathematics, B.S. Grewal, 43 <sup>rd</sup> edition, 2014, Khanna Publishers.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>2.</b>                                                                                                                                                                                                        | Higher Engineering Mathematics, B.V. Ramana, 7 <sup>th</sup> reprint, 2009, Tata Mc. Graw Hill.                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>E Books:</b>                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>1.</b>                                                                                                                                                                                                        | (1) Engineering Mathematics, <a href="http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&amp;redir_esc=y">K. A. Stroud</a> , <a href="http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&amp;redir_esc=y">Dexter J. Booth</a> , Industrial Press, 2001<br><a href="http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&amp;redir_esc=y">http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&amp;redir_esc=y</a> . |  |  |                  |
| <b>2.</b>                                                                                                                                                                                                        | Advanced Engineering Mathematics, P. V. O'Neil, 5 <sup>th</sup> Indian reprint, 2009, Cengage learning India Pvt. Ltd.                                                                                                                                                                                                                                                                                                                                                                                                                          |  |  |                  |
| <b>3.</b>                                                                                                                                                                                                        | <a href="http://ocw.mit.edu/courses/mathematics/">http://ocw.mit.edu/courses/mathematics/</a> (online course material)                                                                                                                                                                                                                                                                                                                                                                                                                          |  |  |                  |
| <b>Moocs:</b>                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |  |                  |
| <b>1.</b>                                                                                                                                                                                                        | <a href="https://www.khanacademy.org/Math">https:// www.khanacademy.org/Math</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  |  |                  |

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| 2.                                                                                | <a href="https://www.class-central.com/subject/math">https:// www.class-central.com/subject/math</a> (MOOCS) |
| 3.                                                                                | E-learning: <a href="http://www.vtu.ac.in">www.vtu.ac.in</a>                                                 |
| <b>Course Outcomes</b>                                                            |                                                                                                              |
| At the end of the course, the student will have the ability to                    |                                                                                                              |
| <b>CO-1:</b> Use Laplace transforms to solve differential equations.              |                                                                                                              |
| <b>CO-2:</b> Apply double integrals to compute areas.                             |                                                                                                              |
| <b>CO-3:</b> Learn to use triple integrals in computing volumes.                  |                                                                                                              |
| <b>CO-4:</b> Use Gamma and Beta functions to evaluate integrals.                  |                                                                                                              |
| <b>CO-5:</b> Understand the use of integral calculus in scalar and vector fields. |                                                                                                              |

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V SEMESTER SYLLABUS

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|---|---|----------------|----------------------------------|-----------------|
| Course Title | EMBEDDED SYSTEMS DESIGN & MEDICAL APPLICATIONS | | | |
| Course Code | 16ML5DCESD | Credits | 03 | L-T-P-S |
| | | | | 3:0:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | |
| Course Outcomes | | | | |
| At the end of the course, the student will have the ability to | | | | |
| CO1: understand the fundamental concepts of embedded system design. | | | | |
| CO2: Ability to design metric, identify and develop hardware and software model requirements for embedded system design. | | | | |
| CO3: Ability to understand communication protocols, develop schemes to interface external devices and design program models by applying knowledge of multitasking principles in embedded system design | | | | |
| CO4: study understand and give presentation on LPC 1768 architecture to use it for embedded programming | | | | |
| CO5: Ability to select and use appropriate IDE to conduct experiments on ARM cortex M3 embedded controller. | | | | |
| Prerequisites:- Digital and programming fundamentals | | | | |
| UNIT-I | | | | 7 hours |
| Introduction: Processor Embedded into a system, Embedded Hardware units and Devices in a system, Embedded Software in a system, Examples of embedded systems, embedded system-on-chip (Soc) and use of VLSI Circuit design technology, complex systems design and processors, design process in embedded systems, formalization of system design, classification of embedded systems, skills required for an embedded system designer. | | | | |
| UNIT-II | | | | 08 hours |
| Devices and communication buses for devices network: IO types and examples, serial communication devices, parallel device ports, timer and counting devices, watchdog timer, Real time clock, networked embedded systems, serial bus communication protocols. | | | | |
| UNIT-III | | | | 09 hours |
| Device drivers and interrupts service mechanism: Programmed-I/O busy-wait Approach without interrupt service mechanism, ISR concept, interrupt sources, interrupt servicing mechanism, multiple interrupts, context and the periods for the context switching, interrupt latency and deadline, device driver programming. | | | | |

Medical Electronics

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| UNIT-IV | | 08 hours |
| <p>Program modelling concepts, IPC and Synchronization: Program models, DFG models, state machine programming models for event-controlled program flow, modelling of multiprocessor systems. Multiple processes/Threads, Semaphores, Shared data, IPC, Functions of Mail box, Pipes and Sockets.</p> | | |
| UNIT-V | | 9 hours |
| <p>Real-time operating systems: OS services, process management, timer functions, memory management, interrupt routines in RTOS environment and handling of interrupt source calls, real-time operating systems, basic design using an RTOS, RTOS task scheduling models, interrupt latency and response of the tasks as performance metrics.</p> | | |
| Text books: | | |
| 1. | Raj Kamal, Embedded systems, TMH. | |
| Reference books | | |
| 1. | Shibu K.V, embedded system design, TMH | |
| 2. | Jack Ganssle Embedded Systems, Newness | |

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| Course Title | BIOMEDICAL INSTRUMENTATION | | | | |
| Course Code | 16ML5DCBMI | Credits | 06 | L-T-P-S | 3:0:1:2 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |
| Course Outcomes | | | | | |
| CO1: Apply knowledge of mathematics science and engineering fundamentals in designing, analyzing and/or working of biomedical circuits and instruments. | | | | | |
| CO2: Understand the health, safety, Environmental, legal and ethical issues while designing/working of a biomedical circuits and instruments. | | | | | |
| CO3: Work, document and present as an individual and as a team-member to design, formulate and implement experiments using modern equipment's & tools. | | | | | |
| CO4: Present in a group and document the findings or suggestions for the problems in the current techniques, modern tools and computing practice to improve technology in health care instruments through hospital visits for lifelong learning. | | | | | |
| UNIT-I | | | | | 8 hours |
| <p>Physiological Transducers: Classification of transducers, performance characteristics of transducers. Pressure transducers, transducers for body temperature measurement, photoelectric transducers, optical fiber sensor, biosensor and smart sensor. Biomedical recorders and biofeedback instruments.</p> <p>Patient Monitoring Systems: System concepts, cardiac monitor, bedside patient monitoring system, central monitors, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiratory rate, catheterization laboratory instrumentation.</p> | | | | | |

Medical Electronics

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| UNIT-II | | 08 hours |
| <p>Oximeters: Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter. Blood Flow Meters: Electromagnetic blood flow meters-different types, Ultrasonic blood flow meters, NMR blood flow meters and Laser Doppler blood flow meters.</p> <p>Cardiac output measurements: Indicator dilution method, Dye dilution method, Thermal dilution techniques, Measurement of continuous cardiac output derived from the aortic pressure waveform, Impedance technique.</p> <p>Pulmonary Function Analyzer: Pulmonary function measurement, Spirometry, Pneumotachometer, Measurement of volume by Nitrogen washout technique</p> | | |
| UNIT-III | | 08 hours |
| <p>Blood Gas Analyzers: Acid-base balance, blood pH measurement, measurement of blood pCO₂, intra-arterial blood gas monitoring, complete blood gas analyzer.</p> <p>Audiometer and Hearing Aids: Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, audiometer system, Bekesy evoked response audiometer system, calibration of audiometer and hearing aids.</p> | | |
| UNIT-IV | | 08 hours |
| <p>Cardiac Pacemakers and Defibrillators: Need for cardiac pacemaker, External Pacemaker, Implantable pacemaker, Types of Implantable pacemakers and recent developments. Programmable pacemaker, Rate-responsive pacemakers, pacing system Analysers, Need for Defibrillator, Dc defibrillators, Implantable Defibrillators, Defibrillator analysers.</p> | | |
| UNIT-V | | 7 hours |
| <p>Instruments of Surgery: Principles of surgical diathermy, surgical diathermy Machine, Safety aspects in electro- surgical units, surgical diathermy Analyzer.</p> <p>Automated drug delivery Systems: Infusion pumps, components of drug infusion systems and implantable infusion systems.</p> <p>Patient Safety: Electric shock hazards, Leakage currents, safety codes and analyzer. Ethical issues in the design of Biomedical Instruments.</p> | | |
| Text books: | | |
| 1. | Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2 nd Edition, Tata McGraw Hill,2003 | |
| 2. | J. G. Webster, Biomedical Instrumentation, John Wiley and Sons, Hoboken, NJ, 2004. | |
| Reference books | | |
| 1. | Leslie Cromwell, Fred J. Weibell, Eric A. Pfeiffer, Biomedical Instrumentation and Measurements, PHI | |
| 2. | Biomedical Instrumentation by Dr.M. Arumugam-Second Edition- 1994 | |
| E-Books | | |
| 3. | http://www.ebook3000.com/Introduction-to-Biomedical-Instrumentation--The-Technology-of- Patient-Care_51854.html | |

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| 4. | Barbara Christe, Introduction to Biomedical Instrumentation: The Technology of Patient Care, Cambridge University Press/2009/ISBN: 0521515122 |
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|--|--|----------------|----------------------------------|----------------|-----------------|
| Course Title | BIOMECHANICS AND REHABILITATION | | | | |
| Course Code | 16ML5DCBMR | Credits | 03 | L-T-P-S | 2:1:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |
| Course Outcomes | | | | | |
| CO1: Ability to apply knowledge of mathematics science and engineering to understand the fundamentals of moving systems and familiarity with human anatomy to competently analyze the movement of the human body. | | | | | |
| CO2: Ability to analyze the dynamics of human movement flow properties of blood and comprehend the biomechanical principles that relate to movement and communication disabilities. | | | | | |
| CO3: Ability to discuss, develop and apply the principles of biomechanics to a range of rehabilitation strategies and problem solving. | | | | | |
| UNIT-I | | | | | 05 hours |
| Introduction to Biomechanics –What Is Biomechanics, Mechanics In Physiology. Definition of Stress, Strain And Strain Rate, The Non viscous Fluid, Newtonian Viscous Fluid, The Hookean Elastic Solid, Viscoelasticity, Response Of A Viscoelastic Body To Harmonic Excitation, Use Of Viscoelastic Models ,Methods Of Testing . | | | | | |
| The Flow Properties of Blood -Blood rheology, the constitutive equation of blood based on viscometric Data and casson’s equation, Laminar flow of blood in tube, blood with viscosity described by casson’s equation. | | | | | |
| UNIT-II | | | | | 05 hours |
| Bioviscoelastic fluids: Introduction, small deformation experiments, mucus from the respiratory tract, saliva, cervical mucus and semen, synovial fluid, flow properties of synovial fluid, | | | | | |
| Bioviscoelastic solids: Introduction, some elastic materials-actin, elastin, resilin and abduction, fibers, collagen, Quasi-linear viscoelasticity of soft tissues, the concept of pseudo-elasticity. | | | | | |
| UNIT-III | | | | | 05 hours |
| Introduction to Rehabilitation and Rehabilitation Team: What is Rehabilitation? Epidemiology of Rehabilitation, Health, Levels of pevention, Preventive Rehabilitation, Diagnosis of Disability, Functional, Diagnosis, Importance of Physiatry in Functional Diagnosis, Impairment Disability Handicap, Primary and Secondary disabilities, Effects of Prolonged inactivity and Bed rest on body system. | | | | | |
| Rehabilitation Team: classification of members, The role of members, The Role of Physiatrist, Occupational therapist, Recreation therapist, Prosthetist- Orthotist, speech pathologist, Rehabilitation nurse, social worker, Corrective Therapist, Psychologist, Music therapist, Dance therapist and Biomedical Engineer. | | | | | |

Medical Electronics

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| UNIT-IV | | 05 hours |
| Therapeutic Exercise Technique: Co-ordination exercises, Freckles exercises, Gait analyses- pathological Gaits, gait Training, Relaxation Exercises- Methods for training Relaxation, strengthening exercises-strength training, Types of contraction, Mobilization exercises, Endurance Exercises. | | |
| UNIT-V | | 7 hours |
| Principles in management of communication:
Impairment –introduction to communication, Aphasia, Types of Aphasia, Treatment of aphasic patient, Augmentative communication-general form of communication, types of visual aids, hearing aids, Types of conventional hearing aid, writing aids. | | |
| TEXT BOOKS: | | |
| 1. Biomechanics- Mechanical Properties of Living tissues -Y.C.Fung -Second Edition- SpringerVerlag. | | |
| 2. Text book of Rehabilitation- S Sunder- 3 rd Edition-Jaypee Brothers Medical Publishers (P) Ltd. New Delhi | | |
| REFERENCE BOOKS: | | |
| 1 | Biomechanics principles and applications by Schneck and Bronzino, CRC Press, 2003 | |
| 2 | Physical Rehabilitation by Suman B O’ Sullivan, Thomas J Schmitz. 5 th Edition | |

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|---------------------|----------------------------------|----------------|----------------------------------|----------------|----------------|
| Course Title | DIGITAL SIGNAL PROCESSING | | | | |
| Course Code | 16ML5DCDSP | Credits | 06 | L-T-P-S | 3:0:1:2 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |

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| Course Outcomes | | |
| CO1. To apply knowledge of Mathematics and Engineering to understand Sampling and Reconstruction of signals from the given samples. | | |
| CO2. An ability to identify and analyze a problem and formulate the computing requirements to determine the spectrum of the given signals. | | |
| CO3. An ability to implement the processes of FFT to reduce the computational complexity and to increase the speed and to attenuate noise. | | |
| CO4. An ability to understand and formulate algorithms using the Multirate signal processing for sampling rate conversion in speech signal analysis and transmission. | | |
| CO5. An ability to use current techniques and modern tools to improve the Medical data analysis | | |
| UNIT-I | | 09 hours |
| Introduction to DSP, Sampling and reconstruction of a discrete time signal in the frequency domain. Definition of Discrete Fourier Transform (DFT). Useful properties of DFT : linearity, circular shift, Multiplication by a complex exponential sequence, Properties of even and odd parts of $x[n]$, Multiplication, Parseval’s relation, Circular convolution in the time domain ,use of tabular arrays and circular arrays | | |
| UNIT-II | | 08 hours |

Medical Electronics

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| Use of DFT in linear filtering, linear convolution of two finite duration sequences, overlap add and save methods. Relation between DFT and other transforms. Direct computation of DFT. Necessity for efficient computation of DFT. Radix 2 Fast Fourier Transform (FFT) algorithm for DFT computation. Decimation in time algorithm, decimation in frequency algorithms. Radix 2 FFT algorithm for computation of Inverse Discrete Fourier Transform. (IDFT) | |
| UNIT-III | 08 hours |
| Introduction to realization of digital systems, block diagrams representation, Realization of Infinite Impulse Response (IIR) systems: direct form, parallel form, cascade form. Introduction to IIR filters, Impulse invariant & Bilinear Transformations, Design of analog Butterworth and Chebyshev filters, Design of Digital Butterworth and Chebyshev filters. | |
| UNIT-IV | 08 hours |
| Realization of Finite Impulse Response (FIR) systems : Direct Form, Linear Phase Form. Introduction to FIR filters, Frequency response of ideal digital low pass filter, high pass filter, Frequency sampling technique of designing FIR filters, Windowing design of FIR filters using Rectangular, Kaiser and Hamming window. | |
| UNIT-V | 6 hours |
| Introduction to Multirate Digital Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling conversion by a Rational factor I/D, Filter Design and implementation for sampling rate conversion. Direct form FIR Filter structure, Polyphase filter structures, Time Variant filter structures. Signal Averaging: Basics of signal averaging, Typical Signal Averager, Signal averaging as a Digital Filter. | |
| TEXT BOOKS: | |
| 1. | Digital Signal Processing, A computer based approach, Sanjit K Mitra, Tata McGrawHill, Third Edition |
| 2. | Digital Signal Processing, Principles, Algorithms and Applications, John G. Proakis, Dimitris K Manolakis, Pearson education/PHI, (4th Edition) |
| | |
| REFERENCE BOOKS: | |
| 1. Fundamentals of Digital Signal Processing, Lonnie Ludeman, John Wiley & Sons; Wiley International 1st Edition, 1988. | |
| 2. Discrete-Time Signal Processing, Alan V. Oppenheim, Ronald W. Schaffer, John R. Buck, Prentice-Hall Signal Processing Series, 2nd Edition, 1999 | |
| 3. Understanding Digital Signal Processing, Richard G. Lyons Prentice Hall, March 25, 2nd Edition 2004 | |
| 4. Digital Signal Processing: Fundamentals and Applications, Li Tan, Academic Press, 1st edition 2007 | |
| 5. Schaum's Outline of Digital Signal Processing, Monson Hayes, McGraw- Hill, 1st edition, 1998 | |
| 6. Biomedical Digital Signal Processing, Wills Tompkins, PHI | |
| 7. NPTEL VIDEO LECTURES | |

Medical Electronics

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| Course Title | MEDICAL PHYSICS | | | | |
| Course Code | 16ML5DCMDP | Credits | 03 | L-T-P-S | 2:1:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |

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| Course Outcomes | | |
| CO1: Apply the knowledge of mathematics, science and engineering to understand the concepts of Human Physiology | | |
| CO2: Identify and analyze a problem related to physics in heat, energy, work, power, pressure, sound and light applied to human body | | |
| CO3: Understand the health and safety issues through physics concepts applied to human body | | |
| CO4: Function and engage in communicating the recent trends in medical Physics. | | |
| UNIT-I | | 05 hours |
| Metabolism: Energy, Heat, Work, and Power of the Body: | | |
| Conservation of Energy and Heat flow, Energy content of body fuel, Metabolic rates, loss of Body Heat, Body temperature. | | |
| UNIT-II | | 06 hours |
| Fluids Pressure, Fluid Flow in the Body, and Motion in Fluids: | | |
| Characteristics Pressures in the Body, Basic physics of pressure and flow of fluids, Pressure and flow in the body, Motion of Humans in Fluids. | | |
| UNIT-III | | 06 hours |
| Cardiovascular system: Physics of cardiovascular system: Properties of Blood, Blood Pressure and flow in vessels—measuring flow in blood vessels, Modeling flow in Blood Vessels, Pressure Drops in arteries and resistive Vessels, Blood flow rates and speeds, consequences of clogged Arteries, work done by heart and the metabolic needs of the heart . | | |
| Modeling the Circulatory System and the Heart: Model of the Heart, Model of the overall flow of the circulatory System, the arterial Pulse, Windkessel Model, Modeling the malfunctioning Heart. | | |
| UNIT-IV | | 06 Hrs |
| Sound, Speech and Hearing: The physics of sound waves: Absorption of sound, Resonant cavities. Speech production: types of sounds, systems in speech production(exclude voice- filtering theory), parameters of the human voice, the energies of speaking, Hearing(exclude the immittance of the human ear), other vibrations of the body | | |
| Laser applications in Medicine: Nd-Yag Laser, CO ₂ Laser, Pulsed Ruby Laser | | |

Medical Electronics

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| UNIT-V | 6 hours |
| <p>Focusing and imaging with lenses: image formation, scientific basis for imaging, moving lenses. Imaging and detection by the eye: the eye as a compound lenses, accommodation, field of vision and binocular vision, adjustments of light levels, limitation to visual acuity, imperfect human vision, correction of the visions, Types of visual impairment, connections to visual perceptions.</p> | |
| TEXT BOOKS: | |
| 1. | Herman I.P., Physics of the Human Body, Springer Publications, 2007 |
| 2. | Dr.R.N.Roy “Medical biophysics”, Books and Allied(P) Ltd. 1st Edition,2001, Reprint 2010 |
| REFERENCE BOOKS | |
| 1. | Paul Davidovits “Physics in Biology and Medicine “ , Academic Press, 3 rd Edition, 2007 |
| 2. | B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose “MEDICAL PHYSICS AND BIOMEDICAL ENGINEERING”, Medical Science Series© IOP Publishing Ltd 1999 |

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| Course Title | PATTERN RECOGNITION & NEURAL NETWORKS | | | | |
| Course Code | 16ML5DE1PR | Credits | 04 | L-T-P-S | 3:1:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |
| Course Outcomes | | | | | |
| CO1: Ability to describe why a particular model is appropriate in a given situations, formulate the model and use it appropriately. | | | | | |
| CO2: Ability to analytically demonstrate how different models and different algorithms are related to one another. | | | | | |
| CO3: Ability to implement a set of practical methods and program solutions to some given real world machine learning problems. | | | | | |
| CO4: Ability to justify why a given model is appropriate for the situation and develop an algorithm from a given model | | | | | |
| CO5: Ability to design and compare machine learning methods, and discuss how different methods relate to one another and will be able to develop new and appropriate machine learning methods appropriate for particular problems. | | | | | |
| UNIT-I | | | | | 08 hours |
| Introduction: Applications of pattern recognition, statistical decision theory, image processing and analysis, the internet, pointers to literature. Probability: Introduction, Probability of events, random variables, joint distribution & densities, moments of random variables, estimation of parameters from samples, minimizing risk estimators. | | | | | |
| UNIT-II | | | | | 08 hours |
| Statistical decision making: Introduction, Bayes theorem, multiple feature, conditionally independent feature, decision foundries, unequal costs of error, estimation of error rates the living one out technique characteristics curves estimating the composition of populations. | | | | | |

Medical Electronics

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| UNIT-III | | 08 hours |
| Nonparametric decision making: introduction, histogram, kernel & window estimators, nearest neighbour classification techniques, adaptive decision boundaries, adaptive. Clustering: Introduction, hierarchical clustering and partitional clustering. | | |
| UNIT-IV | | 07 hours |
| Basic concepts of neurocomputing, Basic terminology related to an artificial neuron, The Perceptron, Linear Networks. | | |
| UNIT-V | | 6 hours |
| Multi-Layer Feedforward Neural Networks, Self-Organising systems & Feature Maps, Recurrent networks. | | |
| TEXT BOOKS: | | |
| 1. | Pattern recognition & image analysis (chapter 1 to Chapter 6) Earl Gose, Richard JohnsonBaugh & Steve Jost, PHI. | |
| 2. | Pattern Recognition Statistical structural & neural approaches, Robert J Schalkof, JohnWiley, 1992. | |
| REFERENCE BOOKS | | |
| 1. | Richard O. Duda, Peter E. Hart, and David G.Stork: Pattern Classification, 2nd Edition,Wiley-Interscience, 2001. | |
| 2. | K. Jain, R. Bolle, S. Pankanti: Biometrics: Personal Identification in Networked Society, Kluwer Academic, 1999. | |

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|---------------------|---|----------------|----------------------------------|----------------|----------------|
| Course Title | OOPS with C++ for Medical Applications | | | | |
| Course Code | 16ML5DE1OP | Credits | 04 | L-T-P-S | 3:1:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |

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| Course Outcomes | | |
| CO1: Able to differentiate between structure oriented programming and object oriented programming and use object oriented programming language like C++ and associated libraries to develop object oriented programs for handling Medical data | | |
| CO2: Ability to identify, analyze and apply the concepts of classes, Objects and other advanced OOPs concepts like inheritance, data abstraction, encapsulation, operator overloading, functions, polymorphism, exception handling for Medical data management | | |
| CO3: An ability to formulate, design, implement, analyze, demonstrate, document and present the concepts as application to healthcare implemented in groups or individual. | | |
| UNIT-I | | 07 hours |
| OOPS paradigm-Programming language, Object-Oriented Programming, Object-Oriented Languages, Basic concept of oops-Objects, Classes, Encapsulation, Data Abstraction, Inheritance, Polymorphism, Dynamic Binding, Message Passing, Brief History of C++, Applications of OOPS concepts in Medicine. | | |
| Data types & Variables- Structure of a C++ program, Comments, Variables, Identifiers, Data types. Declaration of variables, Initialization of variables, Scope of variables, Constants, Operators and Control Structures -Types of Operators. Priority of Operators. | | |

Medical Electronics

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| UNIT-II | | 08 hours |
| Structures and Unions, User defined data types.
Functions - Returning values from functions. Reference arguments. Overloaded function. Inline function. Default arguments. Returning by reference, Constructors and Destructors, Applications of functions in Medicine | | |
| UNIT-III | | 07 hours |
| Arrays- Initializing arrays, Strings, Pointers. Pointers and arrays, Dynamic Memory. Classes and Objects- Introduction to class, Class Definition, Classes and Objects, Access specifiers – Private, Public and Protected. Member functions of the class, Object as data types constructor. Object as function arguments. The default copy constructor, returning object from function. Structures and classes. Classes objects and memory static class | | |
| UNIT-IV | | 07 hours |
| Function Overloading- Precautions to be taken while overloading functions. Static Class Members, Static Member Functions, Friend Functions
Operator Overloading- Introduction to Operator Overloading, Operator Overloading fundamentals, implementing the operator functions.
Inheritance - Reusability, Inheritance concept-single inheritance. Using the derived class, Constructor and destructor in derived class, Object initialization and conversion, Types of Inheritance, Nested classes, Virtual base class, Applications of Inheritance in Medicine. | | |
| UNIT-V | | 6 hours |
| Pointers - Addresses and pointers. The address of operator and pointer and arrays. Memory management- New and Delete, pointers to objects, debugging pointers.
Virtual Function - friend function, Static function, Assignment and copy initialization, this pointer, dynamic type information
Streams and Files - Streams classes, Stream Errors, Disk File I/O with streams, file pointers, error handling in file I/O with member function, overloading the extraction and insertion operators, memory as a stream object, command line arguments, and printer output.
Templates and Exceptions - Function templates, Class templates Exceptions
The Standard Template Library - Introduction algorithms, sequence containers, iterators, specialized iterators, associative containers, strong user-defined object, function objects. Applications in Medicine. | | |
| TEXT BOOKS: | | |
| 1. | Object oriented programming in TURBO C++, Robert Lafore, Galgotia Publications.2002 | |
| 2. | Object Oriented Programming with C++, E Balaguruswamy, Third edition, TMH 2006 | / |
| REFERENCE BOOKS | | |
| 1 | The complete reference C – by Herbert shieldt Tata McGraw Hill Publication. | |
| 2 | C++ Primer (5th Edition) by S. B. Lippman, J. Lajoie, B. E. Moo | |
| E-BOOKS | | |
| 1. | http://www.ddegjust.ac.in/studymaterial/mca-3/ms-17.pdf | |
| 2. | https://bookstore.github.io/cse/secondyear/Balaguruswamy%20Object%20Oriented%20Programming%20With%20C++%20Fourth%20Edition.pdf | |

Medical Electronics

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| Course Title | Brain Computer Interface | | | | |
| Course Code | 16ML5DE1BC | Credits | 03 | L-T-P-S | 3:0:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |

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| Course Outcomes | | |
| CO1. Ability to apply the knowledge of mathematics science and engineering fundamentals to understand the Brain Organization, Anatomy, and Function. | | |
| CO2. Ability to analyze and process the brain signals for artifact reduction. | | |
| CO3. Ability to understand types of BCI, principles and its applications which are present state of art in the Neurosciences domain. | | |
| UNIT-I | | 07 hours |
| <p>Basic Neurosciences: Basic Neuroscience: Neurons, Action Potentials or Spikes, Dendrites and Axons, Synapses, Spike Generation, Adapting the Connections: Synaptic Plasticity – (LTP, LTD, STDP, Short-Term Facilitation and Depression), Brain Organization, Anatomy, and Function.</p> <p>Recording and Stimulating the Brain: Recording Signals from the Brain: Invasive Techniques & Noninvasive Techniques. Stimulating the Brain - Invasive Techniques & non-Techniques. Simultaneous Recording and Stimulation: Multi-electrode Arrays, Neurochip.</p> | | |
| UNIT-II | | 08 hours |
| <p>Signal Processing for BCI's: Spike Sorting, Frequency Domain Analysis: Fourier analysis, Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT), Spectral Features, Wavelet Analysis. Time Domain Analysis: Hjorth Parameters , Fractal Dimension , Autoregressive (AR) Modeling, Bayesian Filtering, Kalman Filtering, Particle Filtering), Spatial Filtering : (Bipolar, Laplacian, and Common Average Referencing ,Principal Component Analysis (PCA) ,IndependentComponent Analysis (ICA) , Common Spatial Patterns (CSP)</p> <p>Artifact Reduction Techniques: Thresholding, Band-Stop and Notch Filtering, Linear Modeling, Principal Component Analysis (PCA), Independent Component Analysis (ICA).</p> | | |
| UNIT-III | | 07 hours |
| <p>Building a BCI: Major Types of BCIs: Brain Responses Useful for Building BCIs: Conditioned Responses, Population Activity, Imagined Motor and Cognitive Activity, Stimulus-Evoked Activity.</p> <p>Invasive BCIs: Two Major Paradigms in Invasive Brain-Computer Interfacing: BCIs Based on Operant Conditioning, BCIs Based on Population Decoding.</p> | | |
| UNIT-IV | | 09 hours |
| <p>Invasive BCIs in Humans: Cursor and Robotic Control Using a Multielectrode Array Implant, Cognitive BCIs in Humans, Long-Term Use of Invasive BCIs, Long-Term BCI Use and Formation of a Stable Cortical Representation, Long-Term Use of a Human BCI Implant</p> <p>Semi-Invasive BCIs: Electrographic (ECoG) BCIs -ECoG BCIs in Human, BCIs Based on Peripheral Nerve Signals Nerve-Based BCIs, Targeted Muscle Innervation (TMR).</p> | | |
| UNIT-V | | 6 hours |
| <p>Medical Applications: Sensory Restoration, Motor Restoration, Cognitive Restoration, Rehabilitation, Restoring Communication with Menus, Cursors, and Spellers, Brain-Controlled Wheelchairs,</p> <p>Nonmedical Applications: Web Browsing and Navigating Virtual Worlds, Robotic Avatars, High Throughput Image Search Lie Detection and Applications in Law , Monitoring Alertness, Estimating Cognitive Load, Education and Learning, Security, Identification, and Authentication, Physical</p> | | |

Amplification with Exoskeletons, Mnemonic and Cognitive Amplification , Applications in Space, Gaming and Entertainment, Brain-Controlled Art.

Ethics of Brain-Computer Interfacing: Medical, Health, and Safety Issues, Balancing Risks versus Benefits, Informed Consent, Abuse of BCI Technology, BCI Security and Privacy, Legal Issues, Moral and Social-Justice Issues.

TEXT BOOKS:

| | |
|----|---|
| 1. | Brain-Computer Interfacing: An Introduction (1 st Edition) by Rajesh P. N. Rao |
| 2. | Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction (The Frontiers Collection) Hardcover-(13DEC-2010) by Bernhard Graimann (Editor), Brendan Z.Allison (Editor), Gert P furtscheller (Editor) |

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## VI SEMESTER SYLLABUS

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| <b>Course Title</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>MEDICAL IMAGE PROCESSING</b>                                                                          |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <b>16ML6DCMIP</b>                                                                                        | <b>Credits</b> | <b>06</b>                        | <b>L-T-P-S</b> | <b>3:0:1:2</b>  |
| <b>CIE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>100 Marks (50% weightage)</b>                                                                         | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                          |                |                                  |                |                 |
| CO1: The ability to understand concepts of digital image representation, processing, compression and objectives of biomedical image analysis and CAD.                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                          |                |                                  |                |                 |
| CO2: The ability to apply algorithms in digital image processing for medical image enhancement restoration segmentation and image compression                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                          |                |                                  |                |                 |
| CO3: The ability to conduct experiments for medical image analysis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                          |                |                                  |                |                 |
| CO4: Develop Graphical user interface based mathematical models to understand image enhancement and segmentation algorithms                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                          |                |                                  |                |                 |
| CO5: Engage in self-study as an individual and a team-member to design and implement an open ended experiment for medical image segmentation                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                          |                |                                  |                |                 |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                          |                |                                  |                | <b>07 hours</b> |
| Fundamentals: Introduction, Fundamental steps in DIP, Components of DIP system, A simple image formation model, Image sampling and quantization, Basic relationship between pixels, Color image processing fundamentals related with all color Models, Types of Medical Images, Objectives of Biomedical Image Analysis, Computer aided Diagnosis, Image Quality and Information Content                                                                                                                                                                 |                                                                                                          |                |                                  |                |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                          |                |                                  |                | <b>05 hours</b> |
| Image Enhancement in Spatial Domain: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Gray level slicing, Bit plane slicing, Histogram processing–Histogram equalization, Histogram matching (specification), Local enhancement, Arithmetic/Logic operations – Image subtraction, Image averaging, Basics of spatial filtering, Smoothing spatial filters – Smoothing linear filters, order statistics filters Sharpening spatial filters – Foundation, The Laplacian, The Gradient. |                                                                                                          |                |                                  |                |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                          |                |                                  |                | <b>05 hours</b> |
| Image Enhancement in Frequency Domain: Background, Basic properties of the frequency domain, Basic filtering in the frequency domain, Basic filters and their properties, Smoothing frequency domain filters – Ideal low pass filters, Butterworth lowpass filters, Gaussian lowpassfilters, Sharpening frequency domain filters – Ideal high pass filters, Butterworth highpassfilters, Gaussian highpass filters, Homomorphic filtering.                                                                                                               |                                                                                                          |                |                                  |                |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                          |                |                                  |                | <b>05 hours</b> |
| Removal of Artifacts: Characterization of Artifacts, Image degradation/restoration model, Examples of noise PDFs, Structured noise Physiological interference, Other types of noise and artifact, Restoration using spatial filtering – Mean filters, Geometric mean filters, Harmonic mean filters, Median filter, Max & min filters, Midpoint filter.                                                                                                                                                                                                  |                                                                                                          |                |                                  |                |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                          |                |                                  |                | <b>05 hours</b> |
| Detection of Regions of Interest: Thresholding and Binarization, Optimal thresholding Detection of Isolated Points and Lines, Edge Detection, The Laplacian of Gaussian, , Region Growing, Splitting and merging of regions Image Compression: Fundamentals, Variable length coding, LZW coding, Bit plane coding, Run length coding, Lossless predictive coding, Lossy predictive coding, Image compression standards – Basic, JPEG.                                                                                                                    |                                                                                                          |                |                                  |                |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                          |                |                                  |                |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, Third Edition. Pearson Education Inc. |                |                                  |                |                 |

# Medical Electronics

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|-------------------------------|------------------------------------------------------------------------------------------------------------------|
| 2.                            | Biomedical Image Analysis by Rangaraj M Rangayan by CRC Press 2004                                               |
| <b>REFERENCE BOOKS</b>        |                                                                                                                  |
| 1                             | Image Processing, Analysis and Machine Vision by Milan Sonka, Vaclav Hlavac & Roger Boyle, Second Edition        |
| 2                             | Akay M , Biomedical Signal Processing, Academic: Press 1994                                                      |
| <b>Online Course/E-Books:</b> |                                                                                                                  |
| 1.                            | <a href="http://www.dcc.uchile.cl/~jsaavedr/libros/dip_gw.pdf">www.dcc.uchile.cl/~jsaavedr/libros/dip_gw.pdf</a> |
| 2                             | <a href="http://iclass.iuea.ac.ug">iclass.iuea.ac.ug</a>                                                         |

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| <b>Course Title</b> | <b>BIO-MEDICAL SIGNAL PROCESSING</b> |                |                                  |                |                |
| <b>Course Code</b>  | <b>16ML6DCBSP</b>                    | <b>Credits</b> | <b>03</b>                        | <b>L-T-P-S</b> | <b>2:0:1:0</b> |
| <b>CIE</b>          | <b>100 Marks (50% weightage)</b>     | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                |

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| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |  |                 |
| CO1. Apply knowledge of mathematics, science and engineering to develop solutions using biomedical signal processing concepts                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  |                 |
| CO2. Analyze a problem and formulate appropriate solution for biomedical signal processing concepts and applications                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |                 |
| CO3. Design experiments in biomedical signal and analyze computer based process to meet desired needs in healthcare.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |  |                 |
| CO4. Work, document and present as an individual and as a team-member to design formulate and implement experiments using modern tools.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |  |                 |
| CO5. Implement the concepts practically in groups, perform an open ended experiment/mini-project. Present and document the same.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |  |                 |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |  | <b>06 hours</b> |
| <b>Adaptive filters:</b> Principle of an adaptive filter, the steepest descent algorithm, adaptive noise canceller, cancellation of 50 Hz and power line interference in electrocardiography, applications of adaptive filters. Canceling Donor heart Adaptive filters, high frequency noise in ECG, motion artifact in ECG, maternal interference in Fetal ECG, canceling of maternal ECG in fetal ECG, muscle contraction interference in VAG, interference in Heart-transplant electrocardiography, cancellation of ECG signal from the electrical activity of the chest muscles, cancellation of high frequency noise in Electro-surgery. |  |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  | <b>05 hours</b> |
| <b>Data Compression Techniques:</b> Lossy and Lossless data reduction Algorithms. ECG data compression using Turning point, AZTEC, FAN coding techniques.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |  |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |  | <b>05 hours</b> |
| <b>Cardiological Signal Processing:</b> ECG Parameters and their estimations: ECG QRS Detection techniques, estimation of R-R interval, estimation of ST segment inclination, Rhythm analysis, arrhythmia analysis monitoring, long term continuous ECG recording                                                                                                                                                                                                                                                                                                                                                                             |  |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |  | <b>05 hours</b> |
| <b>Neurological signal processing:</b> Introduction, Linear prediction theory, The Autoregressive (AR) method, Recursive estimation of AR parameters, Spectral error measure, Adaptive segmentation, EEG Transient detection and elimination in epileptic patients and its overall performance.                                                                                                                                                                                                                                                                                                                                               |  |                 |

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| <b>UNIT-V</b>                                                                                                                                                                                                         | <b>05 hours</b>                                                                                                                                                 |
| <b>Sleep EEG:</b> Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, Event history analysis for modeling sleep. |                                                                                                                                                                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                    |                                                                                                                                                                 |
| 1.                                                                                                                                                                                                                    | D.C.Reddy, Biomedical Signal Processing- principles and techniques, Tata McGraw-Hill 2005,                                                                      |
| 2.                                                                                                                                                                                                                    | Rangaraj M. Rangayyan – Biomedical Signal Analysis. IEEE Press, 2001.                                                                                           |
| <b>REFERENCE BOOKS</b>                                                                                                                                                                                                |                                                                                                                                                                 |
| 1                                                                                                                                                                                                                     | Biomedical Digital Signal Processing, Willis J.Tompkins, PHI,                                                                                                   |
| 2                                                                                                                                                                                                                     | Akay M , Biomedical Signal Processing, Academic: Press 1994                                                                                                     |
| <b>Online Course/E-Books:</b>                                                                                                                                                                                         |                                                                                                                                                                 |
| 1.                                                                                                                                                                                                                    | <a href="http://ocw.mit.edu">ocw.mit.edu</a> › Courses › Health Sciences and Technology MIT Open Course War <a href="http://ocw.mit.edu">http://ocw.mit.edu</a> |
| 2.                                                                                                                                                                                                                    | <a href="http://www.vub.ac.be/en/study/fiches/30340/biomedical-signals-and-images">www.vub.ac.be/en/study/fiches/30340/biomedical-signals-and-images</a>        |
| 3.                                                                                                                                                                                                                    | <a href="http://www.crcpress.com">www.crcpress.com</a> › Biomedical Science › Biomedical Imaging                                                                |
| 4.                                                                                                                                                                                                                    | <a href="http://hindawi.com/journals/special%20issues/129194.pdf">hindawi.com/journals/special issues/129194.pdf</a>                                            |

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|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|----------------|----------------------------------|----------------|-----------------|
| <b>Course Title</b>                                                                                                                                                                                                    | <b>BIO-MATERIALS AND ARTIFICIAL ORGANS</b> |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                                                     | <b>16ML6DCBMA</b>                          | <b>Credits</b> | <b>03</b>                        | <b>L-T-P-S</b> | <b>2:1:0:0</b>  |
| <b>CIE</b>                                                                                                                                                                                                             | <b>100 Marks (50% weightage)</b>           | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Course Outcomes</b>                                                                                                                                                                                                 |                                            |                |                                  |                |                 |
| CO1. Apply knowledge of mathematics, science and engineering to understand the Features of biomaterials and the biocompatibility phenomena.                                                                            |                                            |                |                                  |                |                 |
| CO2. Understand the function and relationship between the structure and functionality of chosen artificial organ                                                                                                       |                                            |                |                                  |                |                 |
| CO3. Identify application of membrane materials in artificial organs and implants design.                                                                                                                              |                                            |                |                                  |                |                 |
| CO4. Analyze technical, ethical, economic, environmental and legal problems in the design of Artificial organs.                                                                                                        |                                            |                |                                  |                |                 |
| <b>UNIT-I</b>                                                                                                                                                                                                          |                                            |                |                                  |                | <b>05 hours</b> |
| <b>STRUCTURE OF BIO-MATERIALS AND BIO-COMPATIBILITY:</b> Definition and classification of bio-materials, mechanical properties, visco-elasticity, wound healing process, bodyresponse to implants, blood compatibility |                                            |                |                                  |                |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                         |                                            |                |                                  |                | <b>06 hours</b> |
| <b>IMPLANT MATERIALS</b> Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons, medical applications       |                                            |                |                                  |                |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                        |                                            |                |                                  |                | <b>05 hours</b> |
| <b>POLYMERIC IMPLANT MATERIALS</b> Polymerization, polyamides, Acrylic polymers,rubbers, high strength thermoplastics, medical applications. Bio polymers: Collagen and Elastin                                        |                                            |                |                                  |                |                 |

# Medical Electronics

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| <b>UNIT-IV</b>                                                                                                                                                                                                                                                          |                                                                                                                 | <b>05 hours</b> |
| <b>ARTIFICIAL ORGANS</b> Artificial Heart, Prosthetic Cardiac Valves, Artificial lung (oxygenator), Artificial Kidney (Dialyser membrane), Dental Implants – Artificial limb & hand. Ethical, Environmental and Safety issues in the implantation of artificial organs. |                                                                                                                 |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                           |                                                                                                                 | <b>05 hours</b> |
| <b>Sleep EEG:</b> Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, Event history analysis for modeling sleep.                                                   |                                                                                                                 |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                      |                                                                                                                 |                 |
| 1.                                                                                                                                                                                                                                                                      | Sujata V. Bhatt, Biomaterials Second Edition, Narosa Publishing House, 2005.                                    |                 |
| 2.                                                                                                                                                                                                                                                                      | Joon B. Park, Joseph D. Bronzino, Biomaterials - Principles and Applications – CRC Press, 2003                  |                 |
| <b>REFERENCE BOOKS:</b>                                                                                                                                                                                                                                                 |                                                                                                                 |                 |
| 3.                                                                                                                                                                                                                                                                      | Park J.B., “Biomaterials Science and Engineering”, Plenum Press, 1984.                                          |                 |
| 4.                                                                                                                                                                                                                                                                      | Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGraw-Hill, 2003                            |                 |
| 5.                                                                                                                                                                                                                                                                      | John Enderle, Joseph D. Bronzino, Susan M. Blanchard, “Introduction to Biomedical Engineering”, Elsevier, 2005. |                 |

|                                                                                                                                                                                                                                                                                                                    |                                   |                |                                  |                |                 |
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| <b>Course Title</b>                                                                                                                                                                                                                                                                                                | <b>MEDICAL DEVICE DEVELOPMENT</b> |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                 | <b>16ML6DCMDD</b>                 | <b>Credits</b> | <b>06</b>                        | <b>L-T-P-S</b> | <b>3:0:1:2</b>  |
| <b>CIE</b>                                                                                                                                                                                                                                                                                                         | <b>100 Marks (50% weightage)</b>  | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                             |                                   |                |                                  |                |                 |
| CO1. Identify and analyse unmet clinical need and its requirements to solve it.                                                                                                                                                                                                                                    |                                   |                |                                  |                |                 |
| CO2. Search, analyse and document clinical practice, engineering science and relevant literature in order to determine the need for further research and development in a chosen clinical area.                                                                                                                    |                                   |                |                                  |                |                 |
| CO3. Develop a sustainable business plan, including market overview, regulation strategies for health & safety of individuals and intellectual property (IP) strategies.                                                                                                                                           |                                   |                |                                  |                |                 |
| CO4. Understand medical device design engineering and manufacturing process by avoiding common quality pitfalls in turn learning project management.                                                                                                                                                               |                                   |                |                                  |                |                 |
| CO5. Present the findings of the research in a team to peer audience.                                                                                                                                                                                                                                              |                                   |                |                                  |                |                 |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                      |                                   |                |                                  |                | <b>10 hours</b> |
| <b>Med Tech Invention:</b> Needs finding through Observation and Problem Identification. Need Statement Development. Need Screening & Selection through Stakeholder Analysis, Market Analysis & Needs Filtering. Concept Generation, Screening and selection.                                                      |                                   |                |                                  |                |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                     |                                   |                |                                  |                | <b>08 hours</b> |
| <b>Product Requirements:</b> Define MedTech Device. Classification of Device. Role of Requirements in MedTech Product Development. Market Requirements, Customer Requirements, Clinical Workflow. Design Input. ISO 13485. Intended use, Functional / performance requirements, safety, usability requirements etc |                                   |                |                                  |                |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                    |                                   |                |                                  |                | <b>08 hours</b> |
| <b>Product Requirements:</b> Define MedTech Device. Classification of Device. Role of Requirements in MedTech Product Development. Market Requirements, Customer Requirements, Clinical Workflow. Design Input. ISO 13485. Intended use, Functional / performance requirements, safety, usability requirements etc |                                   |                |                                  |                |                 |

# Medical Electronics

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| <b>UNIT-IV</b>                                                                                                                                            | <b>07 hours</b>                                                                                                                                                                                                                                         |
| <b>Validation:</b> System Validation. Usability Validation. Safety Validation. Clinical Validation, Regulatory Submission                                 |                                                                                                                                                                                                                                                         |
| <b>UNIT-V</b>                                                                                                                                             | <b>05 hours</b>                                                                                                                                                                                                                                         |
| <b>Program Management:</b> Program Planning, Stage Gate Process, Milestones. Budgeting, Development Strategy, Risk identification and Mitigation process. |                                                                                                                                                                                                                                                         |
| <b>TEXT BOOKS:</b>                                                                                                                                        |                                                                                                                                                                                                                                                         |
| 1.                                                                                                                                                        | “ <b>Biodesign: The Process of Innovating Medical Technologies</b> ”, by Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel published by <b>Cambridge University Press: 2<sup>nd</sup> edition</b> |
| <b>REFERENCE BOOKS:</b>                                                                                                                                   |                                                                                                                                                                                                                                                         |
| 1.                                                                                                                                                        | “ <b>Inventing medical devices: A perspective from India</b> ”, by Dr Jagdish Chaturvedi, CreateSpace Independent Publishing Platform; 1 <sup>st</sup> edition, 2015.                                                                                   |
| 2.                                                                                                                                                        | “ <b>The Medical Device R&amp;D Handbook</b> ”, by Theodore R. Kucklick, Second Edition, CRC Press, 2012                                                                                                                                                |

|                     |                                   |                |                                  |                |                |
|---------------------|-----------------------------------|----------------|----------------------------------|----------------|----------------|
| <b>Course Title</b> | <b>MEDICAL IMAGING MODALITIES</b> |                |                                  |                |                |
| <b>Course Code</b>  | <b>16ML6DCMIM</b>                 | <b>Credits</b> | <b>04</b>                        | <b>L-T-P-S</b> | <b>3:1:0:0</b> |
| <b>CIE</b>          | <b>100 Marks (50% weightage)</b>  | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                |

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| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |
| CO1: Apply the knowledge of mathematics, science and engineering fundamentals to the solutions of complex problems using principles of medical imaging.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                 |
| CO2: Identify, formulate and analyse a problem in medical imaging applications to arrive at substantiated conclusions using Engineering sciences.                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                 |
| CO3: Select and apply appropriate techniques, resources through virtual flat form IT tools including modelling to complex engineering activities with an understanding of the limitations in the medical imaging modalities.                                                                                                                                                                                                                                                                                                                                                                                                 |                 |
| CO4: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the medical image modalities through hospital visit.                                                                                                                                                                                                                                                                                                                                                                                                |                 |
| CO5: Apply the ethical principles and understand the impact of the professional engineering solutions in societal, and environmental contexts, through the need for sustainable development to health care domain.                                                                                                                                                                                                                                                                                                                                                                                                           |                 |
| CO6: Communicate and write reports in IEEE paper format effectively with the engineering community of health care domain as a member and as an individual in teams.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                 |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>09 hours</b> |
| <b>Fundamentals of X-ray</b> – Electromagnetic radiation, Interactions between X-rays and matter, Intensity of X-ray beam, Attenuation, Generation and Detection of X-rays – X-ray generation, X-ray generators, Biological effects of ionizing radiation, Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography, Image subtraction Computed Tomography: Conventional tomography, Computed tomography – Projection function, Algorithms for image reconstruction, CT number, Image artifacts, Spiral CT. Recent developments, Digital radiography, Digital subtraction angiography (DSA) |                 |

# Medical Electronics

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| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                        | <b>07 hours</b> |
| <p><b>Fundamentals of acoustic propagation</b> - Stress strain relationship, Characteristic impedance, Intensity, Reflection and refraction, Attenuation, absorption &amp; scattering, Doppler effect, Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers.</p> <p><b>Ultrasonic diagnostic Methods:</b> Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Constant depth mode (C-mode), Doppler methods, Biological effects of ultrasound.</p>   |                                                                                                        |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                        | <b>09 hours</b> |
| <p><b>Introduction, Fundamentals of Radioactivity</b> – Nuclear particles, Nuclear activity and half-life, Units of measuring nuclear activity, Specific activity, Interaction of nuclear particles and matter, Attenuation of Gamma radiation, Radionuclides, Generation &amp; Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, diagnostic methods using radiation detector probes – Thyroid function test, Renal function test, Blood volume measurement, SPECT,PET.</p> |                                                                                                        |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                        | <b>07 hours</b> |
| <p><b>Fundamentals of nuclear magnetic resonance-</b> Angular momentum, magnetic dipole moment, magnetization, Larmor frequency, Rotating frame of reference and RF magnetic field, Free induction decay (FID), Fourier spectrum of the NMR signal, Spin density, Relaxation times, Pulsesequences.</p>                                                                                                                                                                                                                      |                                                                                                        |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                        | <b>05 hours</b> |
| <p>Introduction, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. Imaging Methods- Introduction, Characteristics of MRI images- Spatial resolution, image contrast. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields, Imaging safety, introduction to Functional MRI.</p>                                                                                                                                                                             |                                                                                                        |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                        |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Principles of Medical Imaging by Kirk Shung, Michael B. Smith and Benjamin Tsui, Academic Press, 1992. |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Handbook of Biomedical Instrumentation – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003.         |                 |
| <b>REFERENCE BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                        |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Fundamentals of Medical Imaging by Paul Suetens, Cambridge University Press, 2002.                     |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Medical imaging signals and systems M. Links. Upper Saddle River, NJ: Pearson Prentice Hall,2006.      |                 |

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|----------------|-----------------------------------|----------------|----------------|
| <b>Course Title</b>                                                                                                                                             | <b>BIO-MEMS</b>                  |                |                                   |                |                |
| <b>Course Code</b>                                                                                                                                              | <b>16ML6GE1BM</b>                | <b>Credits</b> | <b>03</b>                         | <b>L-T-P-S</b> | <b>3:0:0:0</b> |
| <b>CIE</b>                                                                                                                                                      | <b>100 Marks (50% weightage)</b> | <b>SEE</b>     | <b>100 Marks (50% weightage)/</b> |                |                |
| <b>Course Outcomes</b>                                                                                                                                          |                                  |                |                                   |                |                |
| CO1: Ability to apply knowledge of mathematics, science and engineering to understand the working principle of MEMS and sensors, Microfluidic Systems, Bio-mems |                                  |                |                                   |                |                |
| CO2: Ability to identify, analyse and formulate the computing requirement using MOEMS technology, Micro fabrication techniques.                                 |                                  |                |                                   |                |                |
| CO3: An ability to understand the environmental impact & safety issues of biomems with reference to medical standards and ethics.                               |                                  |                |                                   |                |                |
| CO4: Ability to function, engage in implementing, communicating the concepts and principles learnt in course using soft tool.                                   |                                  |                |                                   |                |                |

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| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                           | <b>07 hours</b> |
| <p><b>MEMS and Microsystems:</b> Working principle of Microsystems, materials for MEMS and Microsystems, micromachining, System modelling and properties of materials.</p> <p><b>Micro sensors and Actuators:</b> Mechanical sensors and actuators – beam and cantilever, Piezoelectric materials, thermal sensors and actuators- micro machined thermocouple probe, Peltier effect heat pumps, thermal flow sensors</p> |                                                                                                                                           |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                           | <b>09 hours</b> |
| <p><b>Micro Opto Electro Mechanical Systems:</b> Fundamental principle of MOEMS technology, light modulators, beam splitter, microlens, digital micromirror devices, light detectors, optical switch.</p> <p><b>Microfluidic Systems:</b> Microscale fluid, expression for liquid flow in a channel, fluid actuation methods, electrophoresis, microfluid dispenser, microneedle, micropumps continuous flow system.</p> |                                                                                                                                           |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                           | <b>07 hours</b> |
| <p><b>Scaling laws in miniaturization:</b> Introduction to scaling, scaling in geometry, scaling in rigid body dynamics.</p> <p><b>Microfabrication techniques:</b> Introduction, photolithography, electron beam lithography, and soft lithography, chemical vapour deposition, Impurity doping, Etching, micromachining.</p>                                                                                           |                                                                                                                                           |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                           | <b>09 hours</b> |
| <p><b>Introduction to Bio-MEMS:</b> what are biosensors? , the driving force behind biomedical applications, biocompatibility, reliability considerations, regulatory considerations, Emerging BioMEMs Technology: minimally invasive surgery, point care clinical diagnosis, pressure and flow measurement in cardiovascular system, diabetes, endoscopy, neurosciences, oncology, ophthalmology.</p>                   |                                                                                                                                           |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                           | <b>07hours</b>  |
| <p><b>Chemical and biomedical micro systems:</b><br/>Introduction, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. Imaging Methods- Introduction, Characteristics of MRI images- Spatial resolution, image contrast. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields, Imaging safety, introduction to Functional MRI.</p>                       |                                                                                                                                           |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                           |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                       | Nitaigour Premchand Mahalik, “ MEMS”, Tata McGraw Hill Publishing Company, New Delhi, 2007                                                |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                       | Steven S. Saliterman, “Fundamentals of BioMEMS and Medical Microdevices”, WileyInterscience.                                              |                 |
| <b>REFERENCE BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                           |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                       | Tai-Ran-Hsu, “MEMS and Microsystems design and manufacture” Tata McGraw Hill Publishing Company, NewDelhi, 2002                           |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                       | Vijay K Varadan, K J Vinoy, S Gopakrishnan, “ Smart material systems and MEMS design and development methodologies”, WILEY, India, 2006 — |                 |

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|---------------------|----------------------------------|----------------|----------------------------------|-----------------------------------|
| <b>Course Title</b> | <b>MEDICAL INFORMATICS</b>       |                |                                  |                                   |
| <b>Course Code</b>  | <b>16ML6GE1MI</b>                | <b>Credits</b> | <b>03</b>                        | <b>L-T-P-S</b>   <b>3:0:0:0</b> / |
| <b>CIE</b>          | <b>100 Marks (50% weightage)</b> | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                                   |

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| <b>Course Outcomes</b>                                                                                                 |
| Ability to apply knowledge of mathematics, science and engineering to understand the structure of medical informatics. |
| CO2: Ability to analyze a problem and formulate appropriate solutions to medical informatics applications              |

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CO3: An ability to Learn the importance of computers in clinical laboratory and medical imaging in Medical informatics

CO4: Ability to Learn and present the recent trends in medical informatics such as telemedicine and virtual reality applications through hospital visit and document

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| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                    | <b>09 hours</b> |
| <b>MEDICAL INFORMATICS</b> -Introduction - Structure of Medical Informatics, Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, e-health services, Functional capabilities of a computerized HIS, Failure strategies of HIS, Features of HIS and components of it, Health Informatics – Medical Informatics, Bioinformatics  |                                                                                                                                                                    |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                    | <b>06 hours</b> |
| <b>COMPUTERISED PATIENT RECORD</b> -Introduction - History taking by computer, Dialogue with the computer, Queries with patients from doctor, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients, Demo of HIS, Discussion on one real time incident in hospital..        |                                                                                                                                                                    |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                    | <b>07 hours</b> |
| <b>COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING</b> -Automated clinical laboratories, Automated methods in hematology, Cytology and histology, Intelligent Laboratory Information System, Computerized ECG, Computerized EEG, Computerized EMG, Nuclear Magnetic Resonance imaging, Ultrasonography, Computed X-ray tomography, Radiation therapy and planning.                                     |                                                                                                                                                                    |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                    | <b>09 hours</b> |
| <b>COMPUTER ASSISTED MEDICAL DECISION-MAKING</b> -Neuro computers, Artificial Neural Networks application, Expert systems, General model of CMD, Computer –assisted decision support system- production rule System, cognitive model Networks, Decisions analysis in clinical medicine, computers in the care of critically patients, Computer assisted surgery, Designing of decision system – an example. |                                                                                                                                                                    |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                    | <b>08 hours</b> |
| <b>RECENT TRENDS IN MEDICAL INFORMATICS</b> -Virtual reality, Virtual reality applications in medicine, Computer assisted surgery, Tele medicine-medical peripheral devices., Medical peripheral devices. Application of telemedicine, Hand held computers palm-top, Personal digital assistant (PDA), Basic application and medical applications of PDA, Revision.                                         |                                                                                                                                                                    |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                    |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                          | R.D.Lele- Computers in medicine progress in medical informatics, Tata McGraw Hill Publishing computers Ltd,2005, New Delhi                                         |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                          | Mohan Bansal, Medical informatics Tata McGraw Hill Publishing computers Ltd, 2003 New Delhi.                                                                       |                 |
| <b>REFERENCE BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                    |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                          | Medical informatics by Dinesh Bhatia PHI Publications                                                                                                              |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                          | Guide To Medical Informatics: <a href="https://www.crcpress.com/Guide...Health-Informatics">https://www.crcpress.com/Guide...Health-Informatics</a>                |                 |
| <b>E-BOOKS:-</b>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                    |                 |
| 1                                                                                                                                                                                                                                                                                                                                                                                                           | <a href="http://www.springer.com/in/book/9782817804774">www.springer.com/in/book/9782817804774</a>                                                                 |                 |
| 2                                                                                                                                                                                                                                                                                                                                                                                                           | <a href="http://ebooks.himss.org/product/medical-informatics-executive-primer">ebooks.himss.org/product/medical-informatics-executive-primer</a>                   |                 |
| <b>Online course Links:</b>                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                    |                 |
| 3                                                                                                                                                                                                                                                                                                                                                                                                           | <a href="http://www.bu.edu">www.bu.edu</a> › BU Online Home › Programs                                                                                             |                 |
| 4                                                                                                                                                                                                                                                                                                                                                                                                           | <a href="http://study.com/.../Online_Graduate_Courses_and_Classes_in_Healthcare_Inf...">study.com/.../Online_Graduate_Courses_and_Classes_in_Healthcare_Inf...</a> |                 |
| 5                                                                                                                                                                                                                                                                                                                                                                                                           | <a href="https://www.umb.edu/academics/caps/certificates/healthcare_informatics">https://www.umb.edu/academics/caps/certificates/healthcare_informatics</a>        |                 |

## VII SEMESTER SYLLABUS

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| <b>Course Title</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | <b>MEDICAL DEVICE TESTING ON SUSTAINABILITY</b> |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <b>16ML7DCMDT</b>                               | <b>Credits</b> | <b>06</b>                        | <b>L-T-P-S</b> | <b>3:0:1:2</b>  |
| <b>CIE</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>100 Marks (50% weightage)</b>                | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                 |                |                                  |                |                 |
| CO1. Understand and apply modern software testing processes in relation to software development and testing.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                 |                |                                  |                |                 |
| CO2. Implement test strategies and plans, design test cases, prioritize and execute them.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                 |                |                                  |                |                 |
| CO3. Apply testing protocols for Medical devices and analyze preventive maintenance Measures for sustainability.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                 |                |                                  |                |                 |
| CO4: Apply the concepts learnt to device testing and maintenance of specific medical device in a group, record and present it.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                 |                |                                  |                |                 |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                 |                |                                  |                | <b>07hours</b>  |
| <b>Testing as an Engineering Activity</b> – Role of Process in Software Quality – Testing as a Process – Basic Definitions – Software Testing Principles – The Tester’s Role in a Software Development Organization – Origins of Defects – Defect Classes – The Defect Repository and Test Design – Defect Examples – Developer/Tester Support for Developing a Defect Repository.                                                                                                                                                                                                                                                                                                                                                                          |                                                 |                |                                  |                |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                 |                |                                  |                | <b>08 hours</b> |
| <b>Introduction to Testing Design Strategies</b> – The Smarter Tester – Test Case Design Strategies – Using Black Box Approach to Test Case Design Random Testing –Requirements based testing – positive and negative testing — Boundary Value Analysis – decision tables - Equivalence Class Partitioning state-based testing– cause effect graphing – error guessing - compatibility testing – user documentation testing – domain testing Using White–Box Approach to Test design – Test Adequacy Criteria – static testing vs. structural testing – code functional testing - Coverage and Control Flow Graphs – Covering Code Logic – Paths – Their Role in White–box Based Test Design – code complexity testing – Evaluating Test Adequacy Criteria. |                                                 |                |                                  |                |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                 |                |                                  |                | <b>08 hours</b> |
| <b>The Need for Levels of Testing</b> – Unit Test – Unit Test Planning –Designing the Unit Tests. The Test Harness – Running the Unit tests and Recording results – Integration tests – Designing Integration Tests – Integration Test Planning – scenario testing – defect bash elimination -System Testing – types of system testing - Acceptance testing – performance testing - Regression Testing – internationalization testing – ad-hoc testing - Alpha – Beta Tests – testing OO systems – usability and accessibility testing                                                                                                                                                                                                                      |                                                 |                |                                  |                |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                 |                |                                  |                | <b>07 hours</b> |
| <b>People and organizational issues in testing</b> – organization structures for testing teams – testing services - Test Planning – Test Plan Components – Test Plan Attachments – Locating Test Items – test management – test process - Reporting Test Results – The role of three groups in Test Planning and Policy Development – Introducing the test specialist – Skills needed by a test specialist – Building a Testing Group.                                                                                                                                                                                                                                                                                                                      |                                                 |                |                                  |                |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                 |                |                                  |                | <b>09hours</b>  |
| <b>Software test automation</b> – skills needed for automation – scope of automation – design and architecture for automation – requirements for a test tool – challenges in automation - Test metrics and measurements –project, progress and productivity metrics – Status Meetings – Reports and Control Issues – Criteria for Test Completion – SCM – Types of reviews – Developing a review program – Components of Review Plans– Reporting Review Results. – Evaluating software quality – defect prevention – testing maturity model                                                                                                                                                                                                                 |                                                 |                |                                  |                |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                 |                |                                  |                |                 |

# Medical Electronics

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| 1.                      | Srinivasan Desikan and Gopalaswamy Ramesh, “ Software Testing – Principles and Practices”, Pearson education, 2006. |
| 2.                      | Aditya P.Mathur, “Foundations of Software Testing”, Pearson Education, 2008                                         |
| <b>REFERENCE BOOKS:</b> |                                                                                                                     |
| 1.                      | Boris Beizer, “Software Testing Techniques”, Second Edition,Dreamtech, 2003                                         |
| 2.                      | Elfriede Dustin, “Effective Software Testing”, First Edition, Pearson Education, 2003.                              |
| 3.                      | Renu Rajani, Pradeep Oak, “Software Testing – Effective Methods, Tools and Techniques”, Tata McGraw Hil, 2004,      |

| Course Title                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                           | CLINICAL DATA ANALYTICS |                           |         |                 |
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| Course Code                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 16ML7DCCDA                | Credits                 | 06                        | L-T-P-S | 3:0:1:2         |
| CIE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 100 Marks (50% weightage) | SEE                     | 100 Marks (50% weightage) |         |                 |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                         |                           |         |                 |
| Co1. Ability to apply knowledge of mathematics, science and Engineering to develop the solution using biostatistical concepts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                           |                         |                           |         |                 |
| CO2. Ability to analyse a problem and formulate appropriate solution for biostatistical concepts application.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |                         |                           |         |                 |
| CO3. An ability to design and perform statistical test and interpret results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                           |                         |                           |         |                 |
| CO4. Ability to implement and demonstrate statistical analysis using modern tool usage.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                           |                         |                           |         |                 |
| CO5. Implement the concepts practically in group perform an open ended experiment/mini Project and document the same.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                           |                         |                           |         |                 |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                           |                         |                           |         | <b>08 hours</b> |
| <b>Introduction to Biostatistics:</b> Introduction, Some basic concepts, Measurement and Measurement Scales, Simple random sample, Computers and biostatistical analysis. Descriptive Statistics: Introduction, ordered array, grouped data-frequency distribution, descriptive statistics – measure of central tendency, measure of dispersion, measure of central tendency probability distributions of discrete variables, binomial distribution, Poisson distribution, continuous probability distribution, normal distribution                                                                                                                                                                                     |                           |                         |                           |         |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                           |                         |                           |         | <b>08 hours</b> |
| <b>Sampling distributions:</b> distribution of sample mean, distribution of the difference between two sample means, distribution of sample proportion, distribution of the difference between two sample proportions, Estimation: confidence interval for a population mean, t-distribution, confidence interval for differences between two population means, confidence interval for a population proportion, confidence interval for difference between two populations determination of sample size for estimating means, for estimating proportions, confidence interval for the variance of normally distributed population, confidence interval for ratio of variances of two normally distributed populations. |                           |                         |                           |         |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                           |                         |                           |         | <b>08 hours</b> |
| <b>Hypothesis Testing:</b> Introduction, hypothesis testing – single population mean, difference between two population means, paired comparisons, hypothesis testing-single population proportion, difference between                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                           |                         |                           |         |                 |

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| two population proportions, single population variance, ratio of two population variances.                                                                                                                                                                                                                                                                                                                                 |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                             | <b>07 hours</b> |
| <b>Analysis of Variance (ANOVA):</b> Introduction, completely randomized design, randomized complete block design, repeated measures design, factorial experiment                                                                                                                                                                                                                                                          |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                                              | <b>09hours</b>  |
| <b>Linear Regression and Correlation:</b> the regression model, sample regression equation, evaluating and using regression equation, correlation model correlation coefficient Multiple linear regression model, obtaining multiple regression equation, evaluating multiple regression equation, using the multiple regression equation, multiple correlation model, mathematical properties of Chi- square distribution |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                         |                 |
| <ol style="list-style-type: none"> <li>1. “Biostatistics-A Foundation for Analysis in the Health Sciences” Wayne W. Daniel, John Wiley &amp; Sons Publication, 6th Edition</li> <li>2. Fundamentals of Biostatistics by khan and khanum, Ukaaz publications, 2nd revise edition</li> <li>3. “An introduction to statistical Method and data analysis”, by R. Lyman ott</li> </ol>                                          |                 |
| <b>REFERENCE BOOKS</b>                                                                                                                                                                                                                                                                                                                                                                                                     |                 |
| “Principles of Biostatistics”, Marcello Pagano and Kimberlee Gauvreu, Thomson Learning Publications, 2006                                                                                                                                                                                                                                                                                                                  |                 |
| <b>E-book:</b> <a href="http://ebookey.org/Biostatistics-A-Methodology-For-the-Health-Sciences__">http://ebookey.org/Biostatistics-A-Methodology-For-the-Health-Sciences__</a>                                                                                                                                                                                                                                             |                 |
| <b>Online course</b>                                                                                                                                                                                                                                                                                                                                                                                                       |                 |
| ocw.mit.edu › Courses › Mathematics › Linear Algebra                                                                                                                                                                                                                                                                                                                                                                       |                 |
| <a href="http://www.extension.harvard.edu › Open Learning Initiative.mathematical-biostatistics-boot-camp-2-co">www.extension.harvard.edu › Open Learning Initiative.mathematical-biostatistics-boot-camp-2-co</a>   <a href="https://www.coursera.org">coursera</a>                                                                                                                                                       |                 |

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| <b>Course Title</b>                                                                                                                         | <b>BIOMEDICAL CIRCUITS WITH VLSI</b> |                |                                  |                |                |
| <b>Course Code</b>                                                                                                                          | <b>16ML7DE2VM</b>                    | <b>Credits</b> | <b>03</b>                        | <b>L-T-P-S</b> | <b>3:0:0:0</b> |
| <b>CIE</b>                                                                                                                                  | <b>100 Marks (50% weightage)</b>     | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                |
| <b>Course Outcomes</b>                                                                                                                      |                                      |                |                                  |                |                |
| CO1: Understand the basics of MOSFET operation.                                                                                             |                                      |                |                                  |                |                |
| CO2: Learn logic gate as a switch and transmission gate for designing FET-arrays.                                                           |                                      |                |                                  |                |                |
| CO3: Understand the operation of different Complex logic circuits.                                                                          |                                      |                |                                  |                |                |
| CO4: Understand the fundamental concepts in fabrication of CMOS integrated circuits.                                                        |                                      |                |                                  |                |                |
| CO5: Learn the applications of CMOS circuits for biomedical devices.                                                                        |                                      |                |                                  |                |                |
| <b>UNIT-I</b>                                                                                                                               |                                      |                |                                  |                | <b>07hours</b> |
| An Overview of VLSI: Complexity and design. Basic concepts, Physical structure CMOS integrated circuits: Integrate circuit layers, MOSFETS. |                                      |                |                                  |                |                |

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| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                  | <b>07 hours</b> |
| Ideal switches and Boolean operation, MOSFETS and switches, Basic logic gates in CMOS, Complex logic gates in CMOS, Transmission gate circuits, CMOS layers, Designing FET array.                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                  |                 |
| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                  | <b>08 hours</b> |
| Electronic analysis of CMOS Logic gates, DC characteristics of the CMOS Inverter, Inverter Switching characteristics, Power dissipation, DC characteristics of NAND and NOR gates, NAND and NOR transient response, Analysis of complex logic gates, Gate design for transient performance.                                                                                                                                                                                                                                                                                               |                                                                                                                  |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                  | <b>07 hours</b> |
| Fabrication of CMOS integrated circuits, Overview of silicon processing, material growth and deposition, lithography, CMOS process flow.                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                  |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                  | <b>09 hours</b> |
| CMOS Circuits for Biomedical Implantable Devices: Introduction, Inductive Link to Deliver Power to Implants, High Data rate Transmission Through Inductive links, Energy and Bandwidth Issues in Multi-Channel Biopotential Recordings. Self-Powered Sensors and circuits for biomechanical Implants: Introduction, Fundamentals of Piezoelectric Transduction and power Delivery. CMOS Circuits for Wireless Medical Applications: Introduction, Integrated Receiver Architecture, Integrated Transmitter Architecture, Low noise Amplifier, Mixers, Poly phase Filter, Power Amplifier. |                                                                                                                  |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                  |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | JOHN P. UYEMURA, John Wiley, "Introduction to VLSI circuits and systems", Wiley 2001 edition. For Unit: 1, 2, 3. |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Krzysztof Iniewski "VLSI circuits for Biomedical Applications" Artech House 2008 edition. For Unit 4 and 5.      |                 |
| <b>REFERENCE BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                  |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Douglas A. Pucknell and Kamran Eshraghian, "Basic VLSI Design", PHI third edition, 2005.                         |                 |

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| <b>Course Title</b>                                                                                                                               | <b>MOBILE HEALTH</b>             |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                | <b>16ML7DE2MH</b>                | <b>Credits</b> | <b>03</b>                        | <b>L-T-P-S</b> | <b>3:0:0:0</b>  |
| <b>CIE</b>                                                                                                                                        | <b>100 Marks (50% weightage)</b> | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>UNIT-I</b>                                                                                                                                     |                                  |                |                                  |                | <b>07hours</b>  |
| Overview of Health Informatics, Healthcare Data, Information and Knowledge, Healthcare Data Analysis.                                             |                                  |                |                                  |                |                 |
| <b>UNIT-II</b>                                                                                                                                    |                                  |                |                                  |                | <b>07 hours</b> |
| Electronic Health Records, Health Information Exchange, Health Data Standards, Architectures of Information Systems, Consumer Health informatics. |                                  |                |                                  |                |                 |

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| <b>UNIT-III</b>                                                                                                                                                                                                         |                                                                                                                                                      | <b>08 hours</b> |
| Mobile Technology and mHealth, Online Medical Resources, Medical Information Retrieval, Disease Management and Disease Registries, Telemedicine, Medical Imaging Informatics, Bioinformatics, Public Health Informatics |                                                                                                                                                      |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                          |                                                                                                                                                      | <b>07 hours</b> |
| Patient Safety and Health Information Technology, Quality Improvement Strategies, Health Information Privacy and Security, Health Informatics Ethics                                                                    |                                                                                                                                                      |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                           |                                                                                                                                                      | <b>09hours</b>  |
| Android Overview, App Fundamentals, Android UI Basics, Android app structure, Activity Intents, Activity lifecycle, 2D Graphics, basic android networking.                                                              |                                                                                                                                                      |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                      |                                                                                                                                                      |                 |
| 1.                                                                                                                                                                                                                      | Health Informatics: Practical Guide for Healthcare and Information Technology Professionals (Sixth Edition). By Robert E. Hoyt and Ann K. Yoshihashi |                 |
| 2.                                                                                                                                                                                                                      | Mobile Health Solutions for Biomedical Applications by Phillip Olla.                                                                                 |                 |
| 3.                                                                                                                                                                                                                      | Mobile Health: A Technology Road Map, Mar 2015 by Sasan Adibi.                                                                                       |                 |
| 4.                                                                                                                                                                                                                      | Android Programming: The Big Nerd Ranch Guide by Bill Phillips and Chris Stewart                                                                     |                 |
| 5.                                                                                                                                                                                                                      | Android Programming: Pushing the Limits by Erik Hellman                                                                                              |                 |
| <b>MOOC Course:</b>                                                                                                                                                                                                     |                                                                                                                                                      |                 |
| 1.                                                                                                                                                                                                                      | COMP107x Introduction to Mobile Application Development using Android                                                                                |                 |
| 2.                                                                                                                                                                                                                      | <a href="https://www.coursera.org/course/introbiomedhlthinfo">https://www.coursera.org/course/introbiomedhlthinfo</a>                                |                 |

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| <b>Course Title</b>                                                                                                                                                                                                                                                                                                                                                                                                                    | <b>IMAGE AND SIGNAL PROCESSING FOR NETWORKED E-HEALTH APPLICATIONS</b> |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>16ML7DE2NE</b>                                                      | <b>Credits</b> | <b>04</b>                        | <b>L-T-P-S</b> | <b>3:1:0:0</b>  |
| <b>CIE</b>                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>100 Marks (50% weightage)</b>                                       | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Course Outcomes</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                        |                |                                  |                |                 |
| CO1: Ability to apply the knowledge of mathematics science and engineering fundamentals in the understanding of fundamental issues and challenges of machine learning: data, model selection, model complexity, etc.                                                                                                                                                                                                                   |                                                                        |                |                                  |                |                 |
| CO2: Ability to analyze the strengths and weaknesses of many popular machine learning approaches.                                                                                                                                                                                                                                                                                                                                      |                                                                        |                |                                  |                |                 |
| CO3: Ability to comprehend the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning.                                                                                                                                                                                                                                                         |                                                                        |                |                                  |                |                 |
| CO4: Ability to design and implement various machine learning algorithms in a range of real-world applications.                                                                                                                                                                                                                                                                                                                        |                                                                        |                |                                  |                |                 |
| <b>UNIT-I</b>                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                        |                |                                  |                | <b>07hours</b>  |
| <b>Introduction:</b> Introduction to machine learning, Examples of Machine Learning Applications.<br><b>Parametric regression:</b> linear regression, polynomial regression, locally weighted regression, numerical optimization, gradient descent, kernel methods.                                                                                                                                                                    |                                                                        |                |                                  |                |                 |
| <b>UNIT-II</b>                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                        |                |                                  |                | <b>08 hours</b> |
| <b>Generative learning:</b> Gaussian parameter estimation, maximum likelihood estimation, MAP estimation, Bayesian estimation, bias and variance of estimators, missing and noisy features, nonparametric density estimation, Gaussian discriminant analysis, naive Bayes.<br><b>Discriminative learning:</b> linear discrimination, logistic regression, logit and logistic functions, generalized linear models, softmax regression. |                                                                        |                |                                  |                |                 |

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| <b>UNIT-III</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                             | <b>08 hours</b> |
| <p><b>Neural networks:</b> the perceptron algorithm, multilayer perceptrons, backpropagation, nonlinear regression, multiclass discrimination, training procedures, localized network structure, dimensionality reduction interpretation.</p> <p><b>Support vector machines:</b> functional and geometric margins, optimum margin classifier, constrained optimization, Lagrange multipliers, primal/dual problems, KKT conditions, dual of the optimum margin classifier, soft margins, kernels, quadratic programming, SMO algorithm.</p> |                                                                                             |                 |
| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                             | <b>08 hours</b> |
| <p><b>Graphical and sequential models:</b> Bayesian networks, conditional independence, Markov random fields, inference in graphical models, belief propagation, Markov models, hidden Markov models, decoding states from observations, learning HMM parameters.</p>                                                                                                                                                                                                                                                                       |                                                                                             |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                             | <b>08hours</b>  |
| <p><b>Unsupervised learning:</b> K-means clustering, expectation maximization, Gaussian mixture density estimation, mixture of naive Bayes, model selection.</p> <p><b>Dimensionality reduction:</b> feature selection, principal component analysis, linear discriminant analysis, factor analysis, independent component analysis, multidimensional scaling, and manifold learning.</p>                                                                                                                                                   |                                                                                             |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                             |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Elements of Statistical Learning, T. Hastie, R. Tibshirani and J. Friedman, Springer, 2001. |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Machine Learning, Ethem Alpaydin, MIT Press, 2010.                                          |                 |
| <b>REFERENCE BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                             |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Pattern Recognition and Machine Learning, C. Bishop, Springer, 2006.                        |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Machine Learning: A Probabilistic Perspective, K. Murphy, MIT Press, 2012.                  |                 |
| 3.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Pattern Classification, R. Duda, E. Hart, and D. Stork, Wiley-Interscience, 2000.           |                 |
| 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Machine Learning, T. Mitchell, McGraw-Hill, 1997.                                           |                 |

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| <b>Course Title</b>                                                                                                                                                                    | <b>LASERS AND FIBER OPTICS IN MEDICINE</b> |                |                                  |                |                 |
| <b>Course Code</b>                                                                                                                                                                     | <b>16ML7GE2LF</b>                          | <b>Credits</b> | <b>03</b>                        | <b>L-T-P-S</b> | <b>3:0:0:0</b>  |
| <b>CIE</b>                                                                                                                                                                             | <b>100 Marks (50% weightage)</b>           | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                 |
| <b>Course Outcomes</b>                                                                                                                                                                 |                                            |                |                                  |                |                 |
| CO1: Ability to apply the knowledge of mathematics science and engineering fundamentals to understand the mechanisms describing the interaction of laser radiation with bodily tissue. |                                            |                |                                  |                |                 |
| CO2: Ability to analyze the properties of lasers and light delivery systems relevant to applications in medicine.                                                                      |                                            |                |                                  |                |                 |
| CO3: Ability to discuss selected applications of lasers and optical techniques which are presently important in medicine.                                                              |                                            |                |                                  |                |                 |
| <b>UNIT-I</b>                                                                                                                                                                          |                                            |                |                                  |                | <b>07hours</b>  |
| <b>Medical Lasers:</b> Introduction, Laser physics-fundamentals, principles, Medical Laser Systems-solid state laser, gas laser, dye laser, semiconductor laser, Laser safety          |                                            |                |                                  |                |                 |
| <b>UNIT-II</b>                                                                                                                                                                         |                                            |                |                                  |                | <b>07 hours</b> |
| <b>Laser interaction with tissue-</b> photocoagulation, photo thermal ablation, photochemical ablation photo disruption                                                                |                                            |                |                                  |                |                 |
| <b>UNIT-III</b>                                                                                                                                                                        |                                            |                |                                  |                | <b>07 hours</b> |
| <b>Laser Applications in Medical Therapy-</b> application in dermatology, ophthalmology, general surgery, cardiovascular surgery, tumor surgery, gynecology                            |                                            |                |                                  |                |                 |
| <b>UNIT-IV</b>                                                                                                                                                                         |                                            |                |                                  |                | <b>10 hours</b> |

# Medical Electronics

**Optical Fibers:** Elements of optical fiber transmission link 1Basic Optical Laws and Definitions, optical fiber mode and configurations, Fiber materials, Fiber fabrication, signal degradation in optical fibers connectors ,splices and couplers, Optical Fiber Bundles: Introduction, non-ordered fiber optic bundles for light guides-fundamentals & principles, ordered fiberoptic bundles for imaging devices• fundamentals & principles, fiberscopes

**UNIT-V**

**07 hours**

**Endoscopy:** Introduction, fundamentals, principles, types of endoscopes, Clinical Applications of Fiber Optic Laser Systems: in gastroenterology, neurosurgery, oncology, ophthalmology/ orthopedics 1 otolaryngology (ENT), urology,

**TEXT BOOKS:**

1. Lasers and Optical Fibers in Medicine by Abraham Katzir, Academic Press, 1998.
2. Handbook of Biomedical Instrumentation, by R.S.Khandpur, 2nd edition,
3. Optical Fiber communications/ by Gerd Keiser1 3rdedition Mc Graw-Hill International Editions

**REFERENCE BOOKS:**

1. Therapeutic Lasers - Theory and practice by G.David Baxterr Churchill Livingstone

|                     |                                          |                |                                  |                |                |
|---------------------|------------------------------------------|----------------|----------------------------------|----------------|----------------|
| <b>Course Title</b> | <b>Advanced Medical Image Processing</b> |                |                                  |                |                |
| <b>Course Code</b>  | <b>16ML7GE2IP</b>                        | <b>Credits</b> | <b>03</b>                        | <b>L-T-P-S</b> | <b>3:0:0:0</b> |
| <b>CIE</b>          | <b>100 Marks (50% weightage)</b>         | <b>SEE</b>     | <b>100 Marks (50% weightage)</b> |                |                |

**Course Outcomes**

CO1: To apply knowledge of Mathematics and Engineering to use Morphological operations in image Processing.

CO2: An ability to identify and analyze a problem and formulate the computing requirements for segmentation of images

CO3: An ability to implement the processes to detect and recognize an object in the images.

CO4: To apply wavelet transform to compress and enhance the quality of images.

CO5: An ability to use current techniques and modern tools to improve the image analysis.

**UNIT-I**

**09 hours**

**MORPHOLOGICAL IMAGE PROCESSING:** Preliminaries, Erosion and Dilation, Duality, Opening and Closing, The Hit-or-Miss Transformation, Basic Morphological Algorithms: Boundary Extraction, Hole Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Morphological Reconstruction, Gray-Scale Morphology, Erosion and Dilation, Opening and Closing.

**UNIT-II**

**08 hours**

**IMAGE SEGMENTATION:** Fundamentals, Point, Line, and Edge Detection, Detection of Isolated Points, Edge Models, Edge Linking and Boundary Detection, Thresholding, Basic Global Thresholding, Optimum Global Thresholding using Otsu's Method. Region Based Segmentation, Region Growing, Region Splitting and Merging, Segmentation Using Morphological watersheds, watershed segmentation Algorithm..

**UNIT-III**

**08 hours**

**REPRESENTATION AND DESCRIPTION:** Representation of Boundary (Border), Chain Codes, Polygonal Approximations Using Minimum-Perimeter Polygons, Signatures, Boundary Segments, Skeletons, Boundary Descriptors, Shape Numbers, Fourier Descriptors, Statistical Moments, Regional Descriptors, Topological Descriptors, Texture, Moment Invariants, Use of Principal

Components for Description.

|                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                      |                 |
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| <b>UNIT-IV</b>                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                      | <b>06 hours</b> |
| <b>OBJECT RECOGNITION:</b> Patterns and Pattern Classes, Recognition Based on Decision-Theoretic Methods, Matching, Optimum Statistical Classifiers, Neural Networks, Structural Methods, Matching Shape Numbers, String Matching.                                                                                                                                                                                 |                                                                                                                      |                 |
| <b>UNIT-V</b>                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                      | <b>08hours</b>  |
| <b>WAVELETS AND MULTIREOLUTION PROCESSING:</b> Image Pyramids, Sub band Coding, The Haar Transform, Multi resolution Expansions, Series Expansions, Scaling Functions, Wavelet Functions, Wavelet Transforms in One Dimension, The Wavelet Series Expansions, The Discrete Wavelet Transform, The Continuous Wavelet Transform. The Fast Wavelet Transform. Wavelet Transforms in Two Dimensions. Wavelet Packets. |                                                                                                                      |                 |
| <b>TEXT BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                      |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                 | Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, Third Edition. Pearson Education Inc.             |                 |
| 2                                                                                                                                                                                                                                                                                                                                                                                                                  | Image Processing, Analysis and Machine-Vision by Milan Sonka, Vaclav Hlavac & Roger Boyle, Second Edition.           |                 |
| <b>REFERENCE BOOKS:</b>                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                      |                 |
| 1.                                                                                                                                                                                                                                                                                                                                                                                                                 | Digital Image Processing using MATLAB by Rafael. Gonzalez & Richard E. Woods, Second Edition. Pearson Education Inc. |                 |
| 2.                                                                                                                                                                                                                                                                                                                                                                                                                 | Digital Image Processing by S Jayakumaran, S Esakkirajan, T Veerakumar, Tata McGraw Hill Education Private Ltd,.     |                 |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                  | nptel Video Lectures .                                                                                               | —               |

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VIII SEMESTER SYLLABUS

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|---|---------------------------------------|----------------|----------------------------------|----------------|-----------------|
| Course Title | PROJECT MANAGEMENT AND FINANCE | | | | |
| Course Code | 16ML8GCPMF | Credits | 03 | L-T-P-S | 2:0:0:1 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |
| Course Outcomes | | | | | |
| CO1: Apply the Knowledge of project management principles and to implement project management methodologies required for successful project completion | | | | | |
| CO2: Develop Ethical principles in project planning and execution as a team and documentation in project implementation. | | | | | |
| CO3: Identify and Apply finance aspects for project implantation in time. | | | | | |
| CO4: Use modern tools to simulate their respective projects and case studies and investigate the behavior under various operating conditions. | | | | | |
| UNIT-I | | | | | 05hours |
| Concepts of Project Management Concepts of project , Categories of project , Project life cycle phases, Project management concepts, tools and techniques for project management, The project manager, Basic education for a project manager, Roles and responsibilities of project manager ,Project manager as profession, Summary | | | | | |
| UNIT-II | | | | | 05 hours |
| Establishing the Project - Scope, Time , Cost and performance goals, Feasibility report, Financing Arrangements, Preparation of cost estimates, Finalization of project implementation schedule, Evaluation of the project profitability, Appointing a project manager, Fixing the Zero date, Summary | | | | | |
| UNIT-III | | | | | 05 hours |
| Organizing Human Resources and Contracting - Delegation , Project managers authority, Project organization , Accountability in Project Execution , Contracts , R's of contracting, Tendering and Selection of Contractors, Team building, Summary | | | | | |
| UNIT-IV | | | | | 05 hours |
| Organizing Systems and Procedures for Project Implementation -Working of systems, Design of Systems, Project work system design , Work breakdown structure, Project execution plan, Project procedure manual, Project control system, Planning, Scheduling and Monitoring, Monitoring contracts, Project diary , Summary. | | | | | |

Medical Electronics

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| UNIT-V | | 06 hours |
| Financing of Projects - Capital structure, Menu of financing , Internal accruals , Equity capital, Preference capital , Debentures (or bonds) , Methods of offering term loans , Working capital advances, Miscellaneous sources , Raising venture capital, Project financing structures, Financial closure , Financial institutions ,Summary. | | |
| TEXT BOOKS: | | |
| 3. Project Management – S Choudary, Tata McGRAW Hill Publishing Company Limited | | |
| 4. Projects- Planning, Analysis, Selection, Financing, Implementation and Review –Dr.Prasanna Chandra McGRAW Hill Publishing Company Limited | | |
| Reference books: | | |
| 1 Project Management – David I Cleland – Mcgraw Hill International edition
2 Project Management – Gopalakrishnan – Mcmillan India Ltd
3 Project Management – harry – Maylor- Peason Publication | | |
| E Books: | | |
| 1. Nptel lecture on Introduction to project management by prof. Arun Kanda
2. https://www.youtube.com/watch?v=5pwc2DYIKQU | | |

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|---|---|-----------------|----------------------------------|----------------|----------------|
| Course Title | INTELLECTUAL PROPERTY RIGHTS AND CYBER LAW | | | | |
| Course Code | 16ML8GCIPL | Credits | 03 | L-T-P-S | 2:0:0:1 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |
| Course Outcomes | | | | | |
| CO1: understand and commit to professional ethics and responsibilities to obtain Intellectual property Rights like Patents, Copyright & Trademarks | | | | | |
| CO2: Understand the impact of Patents, Copyright & Trademarks and demonstrate the knowledge of Cyber Law for the societal and environmental context. | | | | | |
| CO3: Ability to use IPRs and Cyber Law to access societal, health, safety & Cultural issues | | | | | |
| CO4: Ability to work in multiple teams to effectively communicate IP & Cyber Law. | | | | | |
| UNIT-I | | 09 hours | | | |
| Basic principles of IP laws & Patents: Introduction, Concept of property, Constitutional aspects of IP, Evolution of the patent system in UK, US and India, Basis for protection, Origin and meaning of the term patent, Objective of a patent law, principles underlying the patent law in India, the legislative provisions regulating patents, Non-patentable inventions. | | | | | |
| UNIT-II | | 08 hours | | | |
| Procedure for obtaining patent: Submission of application, Filing provisional and complete | | | | | |

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| <p>specification, Examination of the application, advertisement of the acceptance, opposition, Grant and sealing of patent, Term of the patent, compulsory license. Provisional and complete specification: Definition of Specification, Kinds of specification, provisional specification, complete specification, Claims, Conditions for amendment.</p> <p>Rights conferred on a patentee: Patent rights, Exception and limitations, Duties of a Patentee.</p> <p>Transfer of patent: Forms of transfer of Patent rights, Assignment, kinds of assignment, License, kinds of license, Rights conferred on a licensee, Transmission of patent by operation of law.</p> <p>Infringement of patents: Construction of claims and infringement, patents held to be infringed, patents held to be not infringed.</p> <p>Action for Infringement: Where a suit is to be instituted, procedure followed in the suit, Onus of establishment infringement, Defence by the defendant, The Relief's, Injunction, Damages or account of profits, patent agents, patent drafting, database searching, and Case studies.</p> | |
| UNIT-III | 08 hours |
| <p>Copy Right: Meaning and characteristics of copy right, Indian copy right law, requirement of copy right, Illustrations copy right in literary work, Musical work, Artistic work, work of architecture, Cinematograph film, sound recording.</p> <p>Author and Ownership of copy right: Ownership of copy right, Contract of service, Contract for service, rights conferred by copy right, terms of copy right, license of copy right. Infringement of copy right: Acts which constitute infringement, general principle, direct and indirect evidence of copying, Acts not constituting infringements, Infringements in literary, dramatic and musical works, Remedies against infringement of copy right, Case studies. Trade Marks: Introduction, Statutory authorities, procedure of registration of trademarks, rights conferred by registration of trademarks, licensing in trade mark, infringement of trade mark and action against infringement.</p> | |
| UNIT-IV | 06 hours |
| <p>Cyber Law: An introduction, definition, why cyber law in India, Evolving cyber law practices – for corporates, privacy in Indian cyber space. Terrorism and cyber crime. Cyber theft and Indian telegraph act, Cyber Stalking.</p> | |
| UNIT-V | 08hours |
| <p>Indian Cyber Law: Protecting Indian children online, Spam, contempt in cyber space, Indian consumer and cyber space, -courts of India</p> | |
| TEXT BOOKS: | |
| 1. | Dr.T Ramakrishna, "Basic principles and acquisition of Intellectual Property Rights", CIPRA, NSLIU-2005. |
| 2. | Dr.B.L.Wadehra, "Intellectual Property Law Handbook", Universal Law Publishing Co.Ltd.,2002. |
| 3. | Cyberlaw-The Indian perspective by Pavan Duggal, 2009 Edition. |
| REFERENCE BOOKS: | |
| 1. | Dr.TRamakrishna, "Ownership and Enforcement of Intellectual Property Rights", |

Medical Electronics

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| | CIPRA,NSLIU-2005. |
| 2. | "Intellectual Property Law(Bare Act with short comments)",Universal Law Publishing Co.Ltd.2007. |
| 3. | "The Trade marks Act1999 (Bare Act with short comments)",Universal Law Publishing Co.Ltd.,2005. |

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| Course Title | MACHINE LEARNING | | | | |
| Course Code | 16ML8DE3ML | Credits | 03 | L-T-P-S | 3:0:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |
| Course Outcomes | | | | | |
| CO1 Ability to apply the knowledge of mathematics science and engineering fundamentals in the understanding of fundamental issues and challenges of machine learning: data, model selection, model complexity, etc. | | | | | |
| CO2 Ability to analyze the strengths and weaknesses of many popular machine learning approaches. | | | | | |
| CO3 Ability to comprehend the underlying mathematical relationships within and across Machine Learning algorithms and the paradigms of supervised and un-supervised learning. | | | | | |
| CO4 Ability to design and implement various machine learning algorithms in a range of real-world applications. | | | | | |
| UNIT-I | | | | | 07hours |
| Introduction: Introduction to machine learning, Examples of Machine Learning Applications.
Parametric regression: linear regression, polynomial regression, locally weighted regression, numerical optimization, gradient descent, kernel methods. | | | | | |
| UNIT-II | | | | | 08 hours |
| Generative learning: Gaussian parameter estimation, maximum likelihood estimation, MAP estimation, Bayesian estimation, bias and variance of estimators, missing and noisy features, nonparametric density estimation, Gaussian discriminant analysis, naive Bayes.
Discriminative learning: linear discrimination, logistic regression, logit and logistic functions, generalized linear models, softmax regression. | | | | | |
| UNIT-III | | | | | 08 hours |
| Neural networks: the perceptron algorithm, multilayer perceptrons, backpropagation, nonlinear regression, multiclass discrimination, training procedures, localized network structure, dimensionality reduction interpretation.
Support vector machines: functional and geometric margins, optimum margin classifier, constrained optimization, Lagrange multipliers, primal/dual problems, KKT conditions, dual of the optimum margin classifier, soft margins, kernels, quadratic programming, SMO algorithm. | | | | | |
| UNIT-IV | | | | | 08 hours |
| Graphical and sequential models: Bayesian networks, conditional independence, Markov random fields, inference in graphical models, belief propagation, Markov models, hidden Markov models, decoding states from observations, learning HMM parameters. | | | | | |
| UNIT-V | | | | | 08hours |

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Unsupervised learning: K-means clustering, expectation maximization, Gaussian mixture density estimation, mixture of naive Bayes, model selection.

Dimensionality reduction: feature selection, principal component analysis, linear discriminant analysis, factor analysis, independent component analysis, multidimensional scaling, and manifold learning.

TEXT BOOKS:

1. Elements of Statistical Learning, T. Hastie, R. Tibshirani and J. Friedman, Springer, 2001.
2. Machine Learning, Ethem Alpaydin, MIT Press, 2010.

REFERENCE BOOKS:

1. Pattern Recognition and Machine Learning, C. Bishop, Springer, 2006.
2. Machine Learning: A Probabilistic Perspective, K. Murphy, MIT Press, 2012.
3. Pattern Classification, R. Duda, E. Hart, and D. Stork, Wiley-Interscience, 2000.
4. Machine Learning, T. Mitchell, McGraw-Hill, 1997.

| Course Title | BIOSENSORS | | | | |
|---|----------------------------------|---------|----------------------------------|---------|-----------------|
| Course Code | 16ML8DE3BS | Credits | 03 | L-T-P-S | 3:0:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |
| Course Outcomes | | | | | |
| CO1: Apply the basic principles of science and engineering to understand the desirable performance characteristics of biosensors | | | | | |
| CO2: Identify, analyse and discuss biosensing requirements and deploy sensors based on semiconductors, enzymes, SPR and SPV based techniques | | | | | |
| CO3: Develop biosensing mechanisms for typical applications and interpret the results | | | | | |
| CO4: Use procedures to develop improved biosensing techniques, by applying the theoretical knowledge of assays. | | | | | |
| UNIT-I | | | | | 07hours |
| Introduction to Biosensors: Introduction, Components and characteristics of Biosensors, , Birth and Growth of Biosensors, Immobilization techniques, Measurement of H+. Principles of Transduction, Biosensor applications. | | | | | |
| UNIT-II | | | | | 08 hours |
| Semiconductor electrodes and Amperometric assay techniques CHEMFETS: Principle, Modes of operation, Immunosensitive FET. Cyclic voltammetry: Potential step technique, Non-steady state measurement, Sources of errors and reduction of their effects, Microelectrode fabrication and applications, solid state and molecular transistors. | | | | | |
| UNIT-III | | | | | 07 hours |
| Electrochemical enzyme assay: Introduction, Experimental setup and procedures, Results and discussions – Noncompetitive and Competitive enzyme binding assays, Future directions. <i>Piezoelectric immunosensors:</i> Quartz crystal microbalance – theory and applications in clinical, environmental and food analysis. Future directions. | | | | | |
| UNIT-IV | | | | | 08 hours |
| Surface Plasmon Resonance Biosensors: Introduction, related techniques, qualitative characterization of molecular interactions, measurement of analyte concentration, determination of interaction constants, nonexponential binding behaviour, Choice of right model, Mass transport limitations. | | | | | |
| UNIT-V | | | | | 07 hours |
| Surface Photovoltage types and Sensors for Neurotransmission: <i>Surface Photovoltage-based biosensors:</i> Introduction, Principle, enzyme sensors, Immunosensors, Biological oxygen demand | | | | | |

Medical Electronics

sensors- Methods, Optimization. *Biosensors for measurement of Neurotransmitter function:* Introduction, types of probes, in vivo microdialysis, voltammetric biosensors, Antibody microprobes..

TEXT BOOKS:

1. **Elizabeth A. H Hall**, Biosensors, Open University press, Milton Keynes. ISBN-10: 0471932264.cf

2. **Victor C. Yang and That T. Ngo**, Biosensors and their applications, Springer, 2007

REFERENCE BOOKS:

1. **Evtugyn, Gennady**, Biosensors : essentials, Springer, 2014

2. **Rasooly, Avraham, Herold, Keith E**, Biosensors and Biodetection, Springer

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|--|--|----------------|----------------------------------|----------------|-----------------|
| Course Title | ScC FOR BIOMEDICAL APPLICATIONS | | | | |
| Course Code | 16ML8DE3SB | Credits | 03 | L-T-P-S | 3:0:0:0 |
| CIE | 100 Marks (50% weightage) | SEE | 100 Marks (50% weightage) | | |
| Course Outcomes | | | | | |
| CO1: Understand the fundamentals of ASIC and its design methods | | | | | |
| CO2: Understand ASICs and FPGAs, standard cells, cell libraries, IPs. | | | | | |
| CO3: To gain knowledge on programmable architectures for SOCs | | | | | |
| CO4: Understand the role of computer-aided design (CAD) tools in automating the design flow. | | | | | |
| CO5: To design a core from specs to GDSII for biomedical devices. | | | | | |
| UNIT-I | | | | | 09hours |
| Motivation for SoC Design - Review of Moore's law and CMOS scaling, benefits of system- on-chip integration in terms of cost, power, and performance. Comparison on System-on- Board, System-on-Chip, and System-in-Package, SOP. Typical goals in SoC design – cost reduction, power reduction, design effort reduction, performance maximization. Productivity gap issues and the ways to improve the gap – IP based design and design reuse. | | | | | |
| UNIT-II | | | | | 09 hours |
| System On Chip Design Process: A canonical SoC Design, SoC Design flow, waterfall vs spiral, top down vs bottom up, Specification requirement, Types of Specification, System Design Process, System level design issues, Soft IP vs Hard IP, IP verification and Integration, Verification strategy, On chip buses and interfaces. Embedded Memories –cache memories, flash memories, embedded DRAM. | | | | | |
| UNIT-III | | | | | 08 hours |
| Biosensor SOP: Introduction, Biosensor for SOP miniaturized biomedical implants, Building blocks of biosensor SOP, Bio sensing, Signal Conversion, Signal Detection and Electronic Processing, Future Trends | | | | | |
| UNIT-IV | | | | | 06 hours |
| Integrated Circuits for Neural Interfacing: Introduction, Neural Signals, Design, Requirements Circuit Architecture and Design Techniques, Noise vs. Layout Area, Neuromimetic ICs. | | | | | |
| UNIT-V | | | | | 07 hours |
| Silicon-Based Microfluidic Systems for Nucleic Acid Analysis: From Tubes to Chips, Architectural | | | | | |

Optimizations for Digital Microfluidic Biochips. Case Study: ADC Circuits for Biomedical Applications.

TEXT BOOKS:

1. Rao R. Tummala, Madhavan Swaminathan, "Introduction to system on package Miniaturization of the Entire System", McGraw-Hill, 2008.
2. James K. Peckol, "Embedded Systems: A Contemporary Design Tool", Wiley Student Edition.
3. Krzysztof Iniewski "VLSI circuits for Biomedical Applications" Artech House 2008 edition. For Unit 4 and 5.

Reference Books:

Michael Keating, Pierre Bricaud, "Reuse Methodology Manual for System on Chip designs", Kluwer Academic Publishers, 2nd edition 2008

E-BOOKS

1. Lecture Series on VLSI Design by Dr. Nandita Dasgupta, Department of Electrical Engineering, IIT Madras.
2. <http://freevideolectures.com/Course/2341/Embedded-Systems/10>

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