Panchajanya Vidya Peetha Welfare Trust (Regd)

Dr. Ambedkar Institute of Technology

An Autonomous Institution, Affiliated to Visvesvaraya Technological University, Belagavi,
Aided by Govt. of Karnataka, Approved by All India Council for Technical Education (AICTE), New Delhi
Accredited by NBA and NAAC with 'A' Grade
BDA Outer Ring Road, Mallathalli, Bengaluru - 560 056

Department of Medical Electronics Engineering

Ref. No. .....

Date : 4.1.2023

Sl.No	Name of the Course	Course Code	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development	Year
1.	Analog Electronic Circuits	18MD31	Employability	2021
2.	Logic Design And VHDL	18MD32	Employability	2021
3.	Analog Electronic Circuits Lab	18MDL37	Employability	2021
4.	Logic Design Lab	18MDL38	Employability	2021
5.	Biomedical Instrumentations	18MD44	Employability	2021
6.	Oops And Data Structure Lab	18MDL46	Employability	2021
7.	Microcontrollers Lab	18MDL47	Employability	2021
8.	Linear Integrated Circuits Lab	18MDL48	Employability	2021
9.	Digital Image Processing	18ML51	Employability	2021
10.	Medical Imaging Systems	18ML52	Employability	2021
11.	Physiological Control Systems	18ML53	Employability	2021
12.	Embedded & IOT Applications	18ML551	Employability	2021
13.	Clinical Engineering	18ML552	Employability	2021
14.	Biomedical Instrumentation Lab	18MLL57	Employability	2021
15.	Digital Signal Processing Lab	18MLL58	Employability	2021
16.	Biomedical Digital Signal And Image Processing Lab	18MLL59	Employability	2021
17.	Biomedical Digital Signal Processing	18ML61	Employability and for entrepreneurship	2021
18.	Biomedical Equipments	18ML63	Employability and for entrepreneurship	2021
19.	Medical Informatics	18ML652	Employability	2021
20.	Operation And Testing Medical Devices Lab	18MLL67	Employability	2021
21.	Neural Network And Machine Learning	18ML71	Employability	2021
22.	Medical Device Regulations	18ML72	Employability and for entrepreneurship	2021
23.	Biomechanics	18ML73	Employability and for entrepreneurship	2021
24.	Rehabilitation Engineering	18ML742	Employability	2021
25.	Bio Materials And Artificial Organs	18ML751	Employability	2021
26.	Java Lab	18MLL77	Employability	2021
27.	Project Phase2	18MLP81	Employability	2021
28.	Technical Seminar	18MLS82	Skill development	2021
29.	Internship	18MLI83	Employability	2021

A. P.
BOS Chairman

Principal

Ph : 23211232, Fax : 080-23217789, E-mail : principal@drait.edu.in, Website : www.drait.edu.in

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Date : 4.1.2023.

Sl.No	Name of the Course	Course Code	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development	Year
1.	Analog Electronic Circuits	18ML31	Employability	2020
2.	Logic Design And VHDL	18ML32	Employability	2020
3.	Analog Electronic Circuits Lab	18MLL37	Employability	2020
4.	Logic Design Lab	18MLL38	Employability	2020
5.	Biomedical Instrumentations	18ML44	Employability	2020
6.	Linear Ics And Applications	18ML45	Employability	2020
7.	Oops And Data Structure Lab	18MLL46	Employability	2020
8.	Microcontrollers Lab	18MLL47	Employability	2020
9.	Linear Integrated Circuits Lab	18MLL48	Employability	2020
10.	Digital Image Processing	18ML51	Employability	2020
11.	Medical Imaging Systems	18ML52	Employability	2020
12.	Physiological Control Systems	18ML53	Employability	2020
13.	Digital Signal Processing	18ML54	Employability	2020
14.	Clinical Engineering	18ML552	Employability	2020
15.	Biomedical Instrumentation Lab	18MLL57	Employability	2020
16.	Digital Signal Processing Lab	18MLL58	Employability	2020
17.	Biomedical Digital Signal And Image Processing Lab	18MLL59	Employability	2020
18.	Biomedical Digital Signal Processing	18ML61	Employability and for entrepreneurship	2020
19.	Biomedical Equipments	18ML63	Employability and for entrepreneurship	2020
20.	Medical Informatics	18ML652	Employability	2020
21.	Operation And Testing Medical Devices Lab	18MLL67	Employability	2020
22.	Mini Project	18MLP68	Employability	2020
23.	Biomedical Digital Signal Processing	ML71	Employability and for entrepreneurship	2020
24.	Digital Image Processing	ML72	Employability and for entrepreneurship	2020
25.	Biomechanics	ML73	Employability	2020
26.	Biomaterials & Artificial Organs	ML742	Employability	2020
27.	Medical Devices And Regulations	ML752	Employability	2020
28.	Seminar	MLS76	Skill development	2020
29.	Bio-Medical Digital Signal Processing Lab	MLL75	Employability	2020
30.	Project Phase-I	MLP77	Employability	2020
31.	Neural Network And Pattern Recognition	ML811	Employability	2020
32.	Rehabilitation Engineering	ML822	Employability	2020
33.	Project Phase II	MLP83	Employability	2020

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Ref. No. .....

Date : 4.1.2023

Sl.No	Name of the Course	Course Code	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development	Year
1.	Analog Electronic Circuits	18ML31	Employability	2019
2.	Logic Design And VHDL	18ML32	Employability	2019
3.	Analog Electronic Circuits Laboratory	18MLL37	Employability	2019
4.	Logic Design Laboratory	18MLL38	Employability	2019
5.	Biomedical Instrumentation	18ML44	Professional skills for employability	2019
6.	Oops And Data Structure Laboratory	18MLL46	Employability	2019
7.	Microcontroller Laboratory	18MLL47	Employability	2019
8.	Linear Intergrated Circuits Laboratory	18MLL48	Employability	2019
9.	Biomedical Instrumentation	ML52	Employability	2019
10.	Physiological Control Systems	ML53	Employability	2019
11.	Digital Signal Processing	ML54	Employability	2019
12.	Clinical Engineering	ML552	Employability	2019
13.	Medical Electronics Lab	MLL56	Employability	2019
14.	Digital Signal Processing Lab	MLL57	Employability	2019
15.	Medical Imaging Systems	ML62	Employability	2019
16.	Biomedical Equipments	ML63	Employability	2019
17.	Medical Informatics	ML652	Employability	2019
18.	Signal Processing Lab Using Labview	MLL66	Employability	2019
19.	Physiology Lab	MLL67	Employability	2019
20.	Java Lab	MLL68	Employability	2019
21.	Mini-Project	MLP69	Employability	2019
22.	Biomedical Digital Signal Processing	ML71	Employability and for entrepreneurship	2019
23.	Digital Image Processing	ML72	Employability and for entrepreneurship	2019
24.	Biomaterials & Artificial Organs	ML732	Employability	2019
25.	Medical Devices And Regulations	ML742	Employability	2019
26.	Bio-Medical Digital Signal Processing Lab	MLL75	Employability	2019
27.	Seminar	MLS76	Skill development	2019
28.	Neural Network And Pattern Recognition	ML811	Employability	2019
29.	Rehabilitation Engineering	ML822	Employability	2019
30.	Project Phase II	MLP83	Employability	2019

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Date : 4:1:2023

Department of Medical Electronics Engineering

Sl.No	Name of the Course	Course Code	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development	Year
1.	Analog Electronics Circuits	ML31	Employability	2018
2.	Logic Design	ML32	Employability	2018
3.	Oops & Data Structure Lab	MLL36	Employability	2018
4.	Microcontrollers Lab	MLL46	Employability	2018
5.	Linear Integrated Circuits Lab	MLL47	Employability	2018
6.	Biomedical Instrumentation	ML52	Employability	2018
7.	Physiological Control Systems	ML53	Employability	2018
8.	Digital Signal Processing	ML54	Employability	2018
9.	Clinical Engineering	ML552	Employability	2018
10.	Embedded Systems& IOT	ML551	Employability	2018
11.	Medical Imaging Systems	ML62	Employability	2018
12.	Biomedical Equipments	ML63	Employability	2018
13.	Medical Informatics	ML652	Employability	2018
14.	Signal Processing using LABVIEW	MLL66	Employability	2018
15.	Physiology Lab	MLL67	Professional skills for employability	2018
16.	Java Lab	MLL68	Employability	2018
17.	Mini Project	MLP69	Employability	2018
18.	Biomedical Digital Signal Processing	ML71	Employability and for entrepreneurship	2018
19.	Digital Image processing	ML72	Employability and for entrepreneurship	2018
20.	Biomaterials & Artificial Organs	ML732	Employability	2018
21.	Medical Devices And Regulations	ML742	Employability	2018
22.	Bio-Medical Digital Signal Processing Lab	MLL75	Employability	2018
23.	Seminar	MLS76	Skill development	2018
24.	Neural Network And Pattern Recognition	ML811	Employability	2018
25.	Rehabilitation Engineering	ML822	Employability	2018
26.	Project Phase II	MLP83	Employability	2018

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Ref. No. ..... **Department of Medical Electronics Engineering** Date : 4.1.2023

Sl.No	Name of the Course	Course Code	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development	Year
1.	Analog Electronics Circuits	ML31	Employability	2017
2.	Logic Design	ML32	Employability	2017
3.	Oops & Data Structure Lab	MLL36	Employability	2017
4.	Microcontrollers Lab	MLL46	Employability	2017
5.	Linear Integrated Circuits Lab	MLL47	Employability	2017
6.	Biomedical Instrumentation	ML52	Employability	2017
7.	Physiological Control Systems	ML53	Employability	2017
8.	Digital Signal Processing	ML54	Employability	2017
9.	Embedded C	ML551	Employability	2017
10.	Medical Electronics Lab	MLL56	Employability	2017
11.	Digital Signal Processing Lab	MLL57	Employability	2017
12.	Medical Imaging Systems	ML62	Employability	2017
13.	Biomedical Equipments	ML63	Employability	2017
14.	Medical Informatics	ML652	Employability	2017
15.	Signal Processing using LABVIEW	MLL66	Employability	2017
16.	Physiology Lab	MLL67	Employability	2017
17.	Java Lab	MLL68	Employability	2017
18.	Mini Project	MLP69	Employability	2017
19.	Biomedical Digital Signal Processing	ML71	Employability and for entrepreneurship	2017
20.	Digital Image processing	ML72	Employability and for entrepreneurship	2017
21.	Biomaterials & Artificial Organs	ML732	Employability	2017
22.	Medical Devices and Regulations	ML742	Employability	2017
23.	Bio-Medical Digital Signal Processing Lab	MLL75	Employability	2017
24.	Neural Network And Pattern Recognition	ML811	Employability	2017
25.	Rehabilitation Engineering	ML822	Employability	2017
26.	Seminar	MLS83	Skill development	2017
27.	Project Phase II	MLP84	Skill development, Employability	2017

A.P.
BOS Chairman

Principal

Ph : 23211232, Fax : 080-23217789, E-mail : principal@drait.edu.in, Website : www.drait.edu.in

Dr. Ambedkar Institute of Technology

Department of Medical Electronics Engineering

The enclosed documents are verified and approved.

HOD

Head of the Department
Dept. of Medical Electronics Engineering
Dr. Ambedkar Institute of Technology
Bangalore - 560 056.

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Department of Medical Electronics Engineering

Name of the Course	Course Code	Activities/Content with direct bearing on Employability/ Entrepreneurship/ Skill development	Nature of Employability
Analog Electronic Circuits	ML31/18ML31/18MD31	Employability	Design ,Service, Calibration Engineer
Logic Design And VHDL	ML32/18ML32/18MD32	Employability	Design Engineer
Analog Electronic Circuits Lab	18MLL37/18MDL37	Employability	Design ,Service, Calibration Engineer
Logic Design Lab	18MLL38/18MDL38	Employability	Design Engineer
Biomedical Instrumentations	ML52/18MD44	Employability	Biomedical Engineer, Sales, Customer support Engineer
Oops And Data Structure Lab	MLL36/18MLL36/ 18MDL46	Employability	Data Scientist
Microcontrollers Lab	MLL46/18MLL47 18MDL47	Employability	Programmer & Developer
Linear Integrated Circuits Lab	MLL47/18MLL48 18MDL48	Employability	Design ,Service, Calibration Engineer
Physiological Control Systems	ML53	Employability	Research Assistants, Junior Research Fellow
Digital Signal Processing	ML54/18ML54	Employability	Programmer , Developer
Embedded C	ML551	Employability	Programmer ,Developer
Medical Electronics Lab	MLL56	Employability	Biomedical Engineer, Sales, Customer support Engineer
Digital Signal Processing Lab	MLL57	Employability	Programmer , Developer
Digital Image Processing	ML72/18ML51	Employability /Entrepreneur	Health Industry Software Industry
Medical Imaging Systems	ML62/18ML52	Employability	Health Industry

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Physiological Control Systems	18ML53	Employability	Research Assistants, Junior Research Fellow
Embedded & IOT Applications	18ML551	Employability	Programmer , Developer
Clinical Engineering	ML552/18ML552	Employability	Hospital Management
Biomedical Instrumentation Lab	18MLL57	Employability	Biomedical Engineer, Sales, Customer support Engineer ,Maintenance
Digital Signal Processing Lab	18MLL58	Employability	Programmer , Developer
Biomedical Digital Signal And Image Processing Lab	18MLL59	Employability	Software Developer
Biomedical Digital Signal Processing	18ML61/ML71	Employability /Entrepreneur	Software Developer Start-ups
Biomedical Equipments	ML63/18ML63	Employability /Entrepreneur	Biomedical Engineer, Sales, Customer support Engineer ,Maintenance Start-ups
Medical Informatics	ML652/18ML652	Employability	Hospital Management
Signal Processing Lab Using LabView	MLL66	Employability	Design Engineer
Operation And Testing Medical Devices Lab	18MLLL67	Employability	Biomedical Engineer, Sales, Customer support Engineer ,Maintenance
Neural Network And Pattern Recognition	ML811	Employability	Software Developer, Data Scientist
Bio-Medical Digital Signal Processing Lab	MLL75	Employability	Software Developer
Neural Network And Machine Learning	18ML71	Employability	Software Developer, Data Scientist
Medical Device Regulations	ML742/18ML72	Employability	Service Provider, Franchise, Sales
Biomechanics	ML73/18ML73	Employability	Research & Development
Rehabilitation Engineering	ML822/18ML742	Employability	Rehabilitation Engineer

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Bio Materials And Artificial Organs	ML732/18ML751	Employability	Application Engineer
Java Lab	MLL68/18MLL77	Employability	Software Engineer
Mini-Project	MLP69/18MLP68	Employability	Design & Development
Project Phase2	MLP83/18MLP81	Employability	Biomedical Engineer, Sales, Programmer, Developer, Researcher, Maintenance
Technical Seminar	MLS76/18MLS82	Skill development	Technical writers, Business analyst
Internship	18MLI83	Employability	Biomedical Engineer, Sales, Programmer, Developer, Researcher, Maintenance

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Sub Title : ANALOG ELECTRONIC CIRCUITS		
Sub Code: ML31	**No of Credits :4= 4: 0: 0(L-T-P)**	**No of lecture hours/week : 4**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To make the Student understand:

1. The behavior of diode and study the application circuits of diode.
2. The transistor operating point and biasing circuits.
3. FET construction and characteristics.
4. MOSFET device construction and working
5. Design and analysis of MOSFET circuits .
6. Feedback concepts and Power amplifier circuit.

UNIT No	Syllabus Content	No of Hours
1	Diode Circuits: Clippers and clampers Field Effect Transistor: Introduction, construction and characteristics of JFET, Transfer Characteristics	**10**
2	**Transistor Biasing:** Operating point, load line, Voltage Divider Bias Configuration, Transistor switch. **Transistor at Low Frequencies:** Hybrid equivalent model, Voltage divider bias, frequency response of BJT amplifier: low frequency & high frequency- study of capacitors affecting frequency response (limited to circuit diagram & response curves, no derivations)	**12**
3	**MOSFETS:** Introduction, Device structure and physical operation - Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small VDs, Operation as VDs is increased, Derivation of the id-VDS relationship, The P- Channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the sub threshold region . **Current voltage Characteristics** – Circuit symbol, id-VDS 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 VGS, Biasing by fixing VG and connecting a resistor in the source , Biasing using a drain to gate feedback resistor, biasing using a current source.	**12**

4	**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 gm, the T equivalent circuit model. IC Biasing - Current sources, current mirror and current steering circuits - The basic MOSFET current source, MOS current steering circuits	**10**
5	**Feedback Amplifier:** Feedback concept, Feedback connections type. **Power Amplifiers**: Definitions and amplifier types, Transformer coupled Class A amplifiers, Class B push-pull amplifier circuits	**08**

Note1: Unit 2 & Unit 3 will have internal choice
Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student would have learnt to

CO1:Design the diode application circuits such as clipping and clamping circuits
CO2:Design and analysis of BJT & MOSFET Amplifier
CO3:Analyse the frequency response of the amplifier
CO4:Would have understood the concepts of feedback amplifiers, power amplifiers

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3,PO4
CO3	PO1,PO2,PO3,PO4
CO4	PO1,PO2,PO3,PO4,PO7

TEXT BOOK:

1. **Electronic Devices and Circuit Theory,** Robert L. Boylestad and Louis Nashelsky, PHI/Pearson Education, 9th Edition.
2. **Microelectronic Circuits Theory and Applications,** Adel S Sedra and Kenneth C Smith Oxford International Student edition , 6th edition

REFERENCE BOOKS:

1. **Integrated Electronics,** Jacob Milman & Christos C. Halkias, Tata - McGraw Hill, 1991 Edition.
2. **Electronic Devices and Circuits,** David A. Bell, PHI, 4th Edition, 2004.

Sub Title : LOGIC DESIGN		
Sub Code: ML32	**No of Credits : 4=3:2:0(L-T-P)**	**No of lecture hours/week : 3+2=5**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:65**

COURSE OBJECTIVES: To make the Student understand

1. Principles of combinational and sequential logic.
2. Different Boolean expression reduction techniques.
3. The design and analysis of combinational circuits.
4. The integrated circuit technologies.
5. Different flip flops and its applications.
6. Sequential circuit models

UNIT No	Syllabus Content	No of Hours	Tutorials
1	**Principles of combinational logic-1:** Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3, 4 and 5 variables, Incompletely specified functions (Don't Care terms), Simplifying Max term equations. **Principles of combinational Logic-2:** Quine-McCluskey minimization technique- Quine-McCluskey using don't care terms, Reduced Prime Implicant Tables. **Introduction to VHDL:** Structure of VHDL Module, Operators, Data types, Types of Descriptions, simulation and synthesis. Data flow description, behavioral description and structural description.	**10**	**5**
2	**Analysis and design of combinational logic - I:** General approach, Decoders-BCD decoders, Encoders. **Analysis and design of combinational logic - II:** Digital multiplexers- Using multiplexers as Boolean function generators. Adders and subtractors-Cascading full adders, Binary comparators. **Integrated Circuit Technologies**: Characteristics and Parameters: TTL Circuits: NOT and NAND, ECL : OR, CMOS: NOR, Comparison **VHDL Implementation: D**ecoder, Encoder, Comparator, Adder/Subtractor	**8**	**5**
3	**Sequential Circuits – 1:** Basic Bistable Element, Latches, SR Latch, Application of SR Latch, A Switch Debouncer, The $\overline{S}\,\overline{R}$ Latch, The gated SR Latch, The gated D Latch, Master-Slave SR Flip-Flops, The Master-Slave JK Flip-Flop,T Flip Flop,D Flip flop. V**HDL Implementation** – Sequential Circuits: Flip Flops	**8**	**5**

4	**Sequential Circuits – 2:** Characteristic Equations, Registers, Counters - Binary Ripple Counters, Asynchronous counters, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters using JK Flip-Flop, D Flip-Flop, T Flip-Flop.	**8**	**5**
5	**Sequential Design - I:** Introduction, Mealy and Moore Models, State Machine Notation, Synchronous Sequential Circuit Analysis. **Sequential Design – II:** Construction of state diagrams, counter design.	**8**	**3**

Note1: Unit 2 & Unit 5 will have internal choice
Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student would have learnt to

CO1: Design and analyze various combinational and sequential logic circuits.
CO2: Analyze different IC technologies.
CO3: Design and develop applications of combinational and sequential circuits.
CO4: Design and simulate the logical circuits using VHDL.

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5
CO2	PO1,PO2,PO3,PO4,PO7
CO3	PO1,PO2,PO3,PO4,PO5,PO7
CO4	PO3,PO5,PO6,PO12

TEXT BOOKS:
1. **Digital Logic Applications and Design**, John M Yarbrough, Thomson Learning, 2001.
2. **Digital Principles and Design,** Donald D Givone, Tata McGraw Hill Edition, 2002.
3. **Fundamentals of Logic Design:** C H Roth, Thomas Learning, 5th Edition.

REFERENCE BOOKS:
1. **Fundamentals of logic design,** Charles H Roth, Jr, Thomson Learning, 2004.
2. **Logic and computer design Fundamentals,** Mono and Kim, Pearson, Second edition, 2001.

Note1: Unit 1 & Unit 2 will have internal choice
Note2: Assignment-1 Laboratory experiment on Inducing various errors and measurement.
Asssignment-2 from unit 3, 4 and 5

Sub Title: OOPs AND DATA STRUCTURES		
Sub Code: ML35	**No. of Credits :3=3:0:0(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: The course will enable the student to learn

1. Object Oriented Programming concepts
2. Objects and classes
3. File Handling
4. Function overloading, operator overloading and data conversions
5. The concepts of inheritance and data structures

UNIT No	Syllabus Content	No of Hours
1	**C++ PROGRAMMING BASICS:** Need of object oriented programming, procedural languages, characteristics of OOP, preprocessor directives, data types, manipulators, Structures, enumerated data types, Boolean type, Functions: passing arguments, returning values, reference arguments, overloaded functions, inline functions, variable and storage classes.	**9**
2	**OBJECTS AND CLASSES:** objects as data types, constructors, destructors, overloaded constructors. Arrays: Arrays as class member data types, passing arrays, arrays as objects, strings, arrays of strings. Pointers, pointers to objects, linked list, virtual functions, static functions, files and streams, input/output operations.	**9**
3	**OPERATOR OVERLOADING:** over loading of unary operators, binary operators, data conversion.	**7**
4	**INHERITANCE:** Inheritance, derived class and base class, overriding member functions, scope resolution, levels of inheritance, multiple inheritances.	**7**
5	**DATA STRUCTURES:** data representation, Data structure types, stacks, Queues, Linked lists and binary trees. Programs practice on Classes and Objects, Stack, Queue and Linked lists.	**7**

Note1: Unit 1 & Unit 2 will have internal choice
Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student would have learnt to

CO1:Write programs in object oriented programming language.
CO2:Analyze the various concepts of OOPs based language and also the concept of data structures.
CO3:Develop algorithm and write application oriented programs .

COs	Mapping with POs
CO1	PO3,PO5
CO2	PO3,PO5
CO3	PO11, PO12

TEXT BOOKS:

1. **Object oriented programming in TURBO C++**-Robert Lafore, Galgotia Publications,2002.
2. **Data Structures, Algorithms and Applications in C++-** Sartaj Sahni, Tata McGrawHill Publications.

REFERENCE BOOKS:

1. **Object Oriented Programming with C++**-E Balaguruswamy, TMH, Third edition, 2006.
2. **C++ the complete reference**-Herbert Schildt, TMH, Fourth edition, 2003.
3. **Data Structures using C++-** D.S.Malik, Thomson, 2003.

Sub Title: OOPs AND DATA STRUCTURES LAB		
Sub Code: MLL36	**No of Credits :1= 0:0:1(L-T-P)**	**No of lecture hours/week : 2**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To enable the students to write programs

1. To access/store different data
2. Making use of functions
3. To Sort/Search an element
4. For Dynamic memory allocation

UNIT NO	Contents: Write Programs for the following problems
1	Read and display student information by structure variable initialization.
2	Find the largest number.
3	Swap two numbers using functions(pass by value, pass by reference)
4	Store student details using array of objects.
5	Sort an array of elements in ascending/descending order.
6	Search a given element in an array.(Binary search)
7	Display the memory address of an object.
8	Perform the stack operation using static/dynamic memory allocation.
9	Perform the queue operation using static/dynamic memory allocation.
10	Perform the circular queue operation.
11	Illustrate single, double linked list.
12	Implement binary tree.

COURSE OUT COMES:

CO1**:**The student will be able to realize the oops concepts and develop programs incorporating these concepts

COs	Mapping with POs
CO1	PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12

Sub Title : ANALOG ELECTRONIC CIRCUITS LAB		
Sub Code: MLL37	**No of Credits:1.5=0:0:1.5(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To wire up and understand the working of the following circuits

1. Diode circuits such as rectifiers, clipping and clamping circuits
2. Design of RC coupled amplifiers
3. RC phase shift oscillators
4. Power Amplifiers
5. Verify the Network theorems.

UNIT No	Syllabus Content
1	Half wave, Full wave and Bridge Rectifier circuits.
2	Design of Diode clipping (Single/Double ended) circuits for peak clipping, peak detection.
3	Design of Clamping circuits: positive clamping /negative clamping.
4	Design of RC Coupled Amplifier
3	Design of BJT-RC Phase shift Oscillator
4	Design of BJT – Hartley & Colpitts Oscillators.
7	Testing of a transformer less Class – B push pull power amplifier and determination of its conversion efficiency.
9	Verification of Thevinin's Theorem and Maximum Power Transfer theorem for DC Circuits.
10	Characteristics of Series and Parallel resonant circuits.
11	Open Ended experiment

COURSE OUTCOMES: The students would have learnt

CO1:To design and test fundamental analog electronic circuits.

CO2: To assemble and test an application device of their interest.

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO2	PO11,PO12

Sub Title : LOGIC DESIGN LAB		
Sub Code: MLL38	**No of Credits:1.5=0:0:1.5(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration: 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To design and Implement the following digital circuits:

1. Basic Gates, and simple logic circuits
2. Typical Combinational circuits
3. All types of flip flops
4. Typical Sequential circuits

UNIT No	Syllabus Content
1	Design of Half/Full adder and Half/Full Subtractors using logic gates.
2	(i) Realization of parallel adder/Subtractors using 7483 chip (ii) BCD to Excess-3 code conversion and vice versa.
3	Design of Binary to Gray code convertors and vice versa.
4	Study of 74153 IC(MUX) and designing different combinational circuits based on 74153.
5	Designing of One/Two bit comparator and study of 7485 magnitude comparator.
6	i)Design a decoder circuit for seven segment LED display ii) Study of Priority encoder
7	Implementation of given flip flops both at gate and IC level.
8	Designing of 3 bit counters and MOD – N counter (7476, 7490)
9	Design of Universal shift register using 74LS95.
10	Design sequence generator using Ring counter/Johnson counter.

COURSE OUTCOMES:
CO1:Testing and understanding of basic combinational and sequential circuits.
CO2: Design any given combinational and sequential circuits using logic gates and standard ICs.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO2	PO9,PO10,PO11,PO12

Sub Title : MICROCONTROLLER LAB		
Sub Code: MLL46	**No of Credits:1.5=0:0:1.5(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To make the student proficient in

1. The complete instruction set.
2. Writing and executing Standard programming examples like sorting, code conversion etc.
3. Writing and execution of certain interfacing programs.
4. Working with a programming tool such as Keil.

UNIT No	Syllabus Content
	I. PROGRAMMING
1	Write programs for all kinds of data manipulations.
2	Write programs for implementing ALU for given specifications.
3	Write programs to count different events.
4	Implementation of subroutines
5	Write programs to implement standard code convertors.
6	Programs to generate delay, Programs using serial port and on-Chip timer / counter.
	II. INTERFACING:
1	Alphanumeric LCD panel, LED and Hex keypad input interface
2	Generate different waveforms Sine, Square, Triangular, Ramp etc. using DAC interface
3	Stepper and DC motor control interface

COURSE OUTCOMES: On the completion of the course the students would have learnt to

CO1:Write program based on 8051 for any problem.
CO2: Interface the external hardware to 8051
CO3: Handle versatile tool: Keil IDE.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5
CO2	PO2,PO3,PO4,PO5,PO9,PO10
CO3	PO3,PO6,PO11,PO12

Sub Title: LINEAR INTEGRATED CIRCUITS LAB		
Sub Code: MLL47	**No of Credits:1.5=0:0:1.5(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: The student will learn

1. To rig up ,test and verify the BASIC linear integrated circuits .
2. The application circuits such as filters, waveform generators, multivibrators.

Unit No	Syllabus Content
1.	Study of Opamp characteristics.
2.	Design of Inverting and non-inverting amplifier.
3.	Design of various application circuits of Opamp: i)Adder and Subtractor ii)Integrator iii)Differentiator.
4.	Design Waveform generator using Schmitt trigger.
5.	Design of active first order filter: Low pass, High Pass, Band pass, Band elimination.
6.	Design of active second order filter: Low pass, High Pass, Band pass, Band elimination
7.	Design of multivibrator using 555 timer. i) Astable ii) Bistable
8	Experiments on TI board
Open end experiment based on Telemedicine concepts.	

COURSE OUTCOME:

CO1:Design of electronic circuits using linear IC 741
CO2: The student will also learn to find hardware solution to problems using linear IC.

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12
CO2	PO1,PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12

Sub Title: BIOMEDICAL INSTRUMENTATION		
Sub Code: ML52	**No. of Credits : 3=3: 0: 0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: Is to make the student understand

1. The human physiology, anatomy and evolution of bio signals.
2. The concepts of bio signal transducers and measurement.
3. The working of all major biomedical equipments.
4. The safety of biomedical devices.

Unit No	Syllabus Content	No of Hours
1	**FUNDAMENTAL CONCEPTS:** Sources of biomedical signals, Basic medical instrumentation system, performance requirements of medical instrumentation systems, General constraints in design of medical instrumentation systems. Bioelectric Signals and Electrodes: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrodes for ECG, Electrodes for EEG, Electrodes of EMG. EOG, EGG,	**8**
2	**BIO AMPLIFIER**: Need for bio amplifier- single ended bio amplifier-right leg driven ECG amplifier, Band Pass filtering, isolation amplifiers-transformer and optical isolation- isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference	**7**
3	**BIOMEDICAL RECORDERS:** Electrocardiograph-block diagram description, ECG leads, Artefacts, Vectorcardiograph, Phonocardiograph, Electroencephalograph, Electromyograph, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiratory rate.	**10**
4	**OXIMETERS:** Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter. Cardiac Output Measurement-indicator dilution, dye dilution. Blood Flow Meters Electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters.	**8**
5	**CARDIAC PACEMAKERS AND DEFIBRILLATORS:** Need for cardiac pacemaker, External pacemaker, Implantable pacemaker, Types of Implantable pacemakers, Programmable pacemaker, Rate-responsive pacemakers. DC defibrillator, Implantable defibrillators.	**6**

	PATIENT SAFETY: Electric shock hazards, Leakage currents, macro shock, micro shock hazards and preventions, safety codes and analyzer. safety & precautions	

Note1: Unit 3 & Unit 4 will have internal choice
Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: By the completion of this course the student would have learnt to

CO1:Select suitable transducers for bio-signal application
CO2:Electrical interpretation of various biological signals & in-depth analysis
CO3:Design and develop systems for acquiring and measuring various physiological parameters.
CO4:Adherence to universal safety standards
CO5:Explore the latest trends & happenings in the subject

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO12
CO2	PO1,PO3
CO3	PO1,PO3
CO4	PO7,PO8
CO5	PO10,PO12

TEXT BOOK:

1. **Handbook of Biomedical Instrumentation**, R.S.Khandpur, Tata McGraw Hill, 2nd Edition, 2003.
2. **Medical Instrumentation Application and Design, John G WebsterJohn Wiley and Sons, New York 2004**

REFERENCE BOOK:

1. **BIOMEDICAL TRANSDUCERS AND INSTRUMENTS**, Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. **Biomedical Instrumentation and Measurement** , Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, Prentice-Hall India Pvt. Ltd.
3. **Introduction to Biomedical Equipment Technology** , Joseph J Carr and John M Brown , Pearson Education ,4th Edition , 2001 .

Sub Title : PHYSIOLOGICAL CONTROL SYSTEMS		
Sub Code: ML53	**No of Credits :3=3: 0: 0(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES:

1. To study various concepts of Engineering control system.
2. To distinguish physiological and engineering control system.
3. To learn mathematical modeling of the physiological system.
4. To learn the time domain and frequency domain analysis applied to physiological system.
5. To identify and optimization of physiological control system.

UNIT No	Syllabus Content	No of Hours
1	**INTRODUCTION TO PHYSIOLOGICAL CONTROL SYSTEMS** Preliminary considerations, Historical Background, System analysis, Physiological systems-A simple example, Differences between	6
2	**MATHEMATICAL MODELING** Generalized system properties, Models with combination of system elements, Linear models of Physiological systems, Distributed Vs Lumped parameter models, Linear systems & superposition principle, Laplace transforms & transfer functions, Impulse response & linear convolution, state space analysis.	8
3	**STATIC ANALYSIS OF PHYSIOLOGICAL SYSTEMS** introduction, open loop Vs closed loop, determination of steady state operating point, regulation of cardiac output, regulation of glucose, chemical regulation of ventilation. **TIME DOMAIN ANALYSIS OF LINEAR CONTROL SYSTEMS** Linearized respiratory mechanics, open & closed loop transient responses for 1^{st} & 2^{nd} order models, Impulse & step response descriptors, transient response analysis. Simulink experiments on modeling physiological systems	10

4	**FREQUENCY DOMAIN ANALYSIS OF LINEAR CONTROL SYSTEMS** Steady state responses to sinusoidal inputs, Graphical representation of frequency response, frequency response model of a circulatory control, frequency response of glucose-insulin regulation. **STABILITY ANALYSIS – LINEAR APPROACHES** stability & transient responses, root locus plots, routh-hurwitz stability criterion, stability analysis of pupillary light reflexes. Simulink experiments on Physiological Systems	9
5	**IDENTIFICATION OF PHYSIOLOGICAL CONTROL SYSTEMS** basic problems in physiological system analysis, non-parametric & parametric identification methods, Problems in parameter estimation, Identification of closed loop systems, identification under closed-loop conditions.	6

Note1: Unit 3 & Unit 4 will have internal choice
Note2: Assignment-1. from unit 1, and 2 and 3
Asssignment-2 from unit 3, 4 and 5 and report on simulation experiments

COURSE OUTCOMES: Students would have learnt

CO1: Mathematically model the physiological systems & relate it to the engineering control system
CO2: Analyze parameters in both time and frequency domain
CO3: Analysing & optimizing different PCS
CO4: Explore the latest trends & happenings in the subject.
CO5: Modelling and analysis of physiological systems using Simulink software

Cos	Mapping with Pos
CO1	PO1,PO2,PO6
CO2	PO3,PO4
CO3	PO3
CO4	PO10,PO12
CO5	PO5, PO12

TEXT BOOK

1. **Physiological Control Systems – Analysis, Simulation & Estimation**, Michael C Khoo, Wiley IEEE press.

Sub Title: EMBEDDED C		
Sub Code: ML551	**No of Credits : 4= 4:0: 0(L-T-P)**	**No of lecture hours/week :4**
Exam Duration : 3 hours	**CIE + Assignment + SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES :To make the student learn

1.The concepts of embedded programming in the context of 8051
2 .Design constraints of 8051 for embedded applications
3. Embedded C
4. TI Processor- MSP 430

Unit No	Syllabus Content	No of Hours
1	**Programming Embedded Systems in C** Introduction ,What is an embedded system, Which processor should you use, Which programming language should you use, Which operating system should you use, How do you develop embedded software, Conclusions **Introducing the 8051 Microcontroller Family** Introduction The external interface of the Standard 8051, Reset requirements, Clock frequency and performance, Memory issues, I/O pins, Timers, Interrupts, Serial interface, Power consumption ,Conclusions	**12**
2	**Reading Switches** Introduction, Basic techniques for reading from port pins, Example: Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, Dealing with switch bounce, Example: Reading switch inputs (basic code), Example: Counting goats, Conclusions	**10**

3	**Adding Structure to the Code** Introduction, Object-oriented programming with C, The Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the 'Hello Embedded World' example, Example: Restructuring the goat-counting example, Further examples, Conclusions	**8**
4	**Meeting Real-Time Constraints** Introduction, Creating 'hardware delays' using Timer 0 and Timer 1, Example: Generating a precise 50 ms delay, Example: Creating a portable hardware delay, The need for 'timeout' mechanisms, Creating loop timeouts, Example: Testing loop timeouts, Example: A more reliable switch interface, Creating hardware timeouts, Example: Testing a hardware timeout,	**12**
5	**Case Study:** Intruder Alarm System: State diagram representation, program **MSP430G2553:** Block diagram, **MSP EXP 430 G2 Launch Pad –** components. **Examples-** LED control using a switch, serial communication	**10**

Note1: Unit 2 & Unit 4 will have internal choice
Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The student would have learnt

CO1: Design and development of embedded system using microcontroller 8051
CO2: Apply the programming skills of embedded C for any microcontroller and hence design any embedded application.
CO3: Using the hardware resources in the given microcontroller family to develop the software applications
CO4: TI -MSP430 processor and coding using the launch pad

Cos	Mapping with Pos
CO1	PO3,PO4,
CO2	PO3,PO4,
CO3	PO3,PO4, PO12
CO4	PO5, PO12

TEXT BOOKS:
1. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008
2. TI- MSP430 Launch Pad Manual
REFERENCE BOOKS:

1. PICmicro MCU C-An introduction to programming, The Microchip PIC in CCS C - Nigel Gardner

Sub Title: CLINICAL ENGINEERING		
Sub Code: ML552	**No of Credits : 4= 4: 0: 0(L-T-P)**	**No of lecture hours/week :4**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES :To make the student

1. To understand the role of clinical engineer and importance of clinical engineering.
2. To learn the hospital managerial skills in all aspects.
3. The routine maintenance safety and other issues of medical devices.

Unit No	Syllabus Content	No of Hours
1	Definition, role of clinical engineering within the hospital organization, major functions of a clinical engineering department, flowchart and model of a clinical engineering department, computerized maintenance and management system, clinical information systems, picture archiving and communication systems (PACS).	**10**
2	Duties and responsibilities, clinical engineer as consultant, clinical engineer as investigator and expert witness. patient safety and clinical engineers, accident investigation, electromagnetic interference, WMTS interference issues.	**11**
3	Technology evaluation, strategic technology planning, technology and alternatives, risks, hazards, and clinical efficacy, conceptual needs analysis, testing laboratory and engineering evaluation, technical specifications and other requirements.	**10**
4	Management engineering in health care, cost effectiveness and productivity, personnel management, medical technology assessment process, in-house clinical and technical evaluations, planning strategies, quality.	**10**
5	Medical technology management practices, health care strategic planning utilizing technology assessment, vendor and service management, medical device research and design, maintenance and repair of medical devices, medical device troubleshooting, safety standards and regulations.	**11**

Note1: Unit 2 & Unit 5 will have internal choice

Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The student would have learnt

CO1: The role of clinical engineer in health care management.
CO2:The importance of clinical engineer in maintaining safety standards in a clinical environment
CO3:Maintenance and repair of medical devices and also medical device research and design

COs	Mapping with POs
CO1	PO2,PO6,PO9,PO10,PO11
CO2	PO6,PO7,PO8,PO9,PO10,PO11
CO3	PO2,PO3,PO4,PO6,PO7,PO8,PO9,PO10,PO11,PO12

Text Book:

1. Joseph Dyro B.S. Clinical Engineering Handbook, Elsevier Academic Press, 2004.

Reference Books:

1. Yadin David, Clinical Engineering, Principles and Applications in Engineering Series, CRC Press, 2003.
2. Michael Nowicki, The Financial Management of Hospitals and Healthcare Organizations, Blackwell
Publishing Ltd, 2004.

Sub Title: MEDICAL ELECTRONICS LAB		
Sub Code: MLL56	**No of Credits :1.5= 0: 0: 1.5(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours		**Exam Marks : 50**

COURSE OBJECTIVES: The student will understand

1. The transducer principle, type,measurement of physiological parameter
2. The bio signal measurement
3. Analytical instruments such as colorimeter, pH meter
4. Medical Instrumentation such as X- ray, Ultrasound, Recorders

UNIT No	Syllabus Content
1	Plotting the characteristics & Determination of parameters of: Resistive strain gage (b) Photoelectric transducer (c) Temperature transducers: RTD / thermocouple / thermistor.
2	Determination of characteristics of: (a) Polarized electrode; (b) Non-polarized electrode (c) Multipoint electrode.
3	Design & Testing of: (a) DC amplifier (b) Isolation amplifier.
4	Design & Testing of: (a) Instrumentation amplifier; (b) Transducer bridge with amplifier.
5	Recording of ECG: (a) Determination of time & amplitude of QRS complex, (b) Calculation of Heart Rate, (c) Determination of Cardiac Vector.
6	Recording of EEG .
7	Measurement of Hearing threshold using Audiometer and plot its characteristics.
8	Measurement of pH of a given solution using pH meter.
9	Determination of solution concentration using Colorimeter/Spectrophotometer.
10	Measurement of Blood Pressure using Sphygmomanometer & Digital meter.
11	Study of (a) Ultrasound transducers & Ultrasonic blood flow meters, (b) X-ray
12	Hospital Training –Diagnostics and therapeutic instruments. Global standards and safety measures.Training duration -10 working days and a training report has to be submitted.

COURSE OUTCOMES: Awareness about biomedical engineer professional ethics.

CO1: Study of medical electronics laboratory provides the knowledge of measurements of physiological parameters. Hospital training provides thorough knowledge of the practical application of the medical instruments and working.

COs	Mapping with POs
CO1	PO6,PO7,PO8,PO9,PO10,PO11,PO12

Sub Title: DIGITAL SIGNAL PROCESSING LAB		
Sub Code: MLL57	**No of Credits:1.5= 0:0:1.5(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3	**Exam Marks : 50**	

COURSE OBJECTIVES: To make the students

1. Verify sampling theorem, linear & circular convolution, and correlation
2. To implement and verify FFT algorithm.
3. Realization of FIR and IIR filter.
4. Familiarize with programming of DSP Processor

UNIT No	Syllabus Content
1	Representation and display of basic sequences.
2	Verify the Sampling theorem.
3	Determine linear convolution, Circular convolution and Correlation of two given sequences. Verify the result using theoretical computations.
4	Computation and verification of FFT of a sequence.
5	Determine the linear convolution and correlation of two given point sequences , using FFT algorithm..
6	Display of original sequence along with operation on sequence like shifting, folding, time scaling and multiplication.
7	Compute DTFS , DTFT of a sequence.
8	Realization and design of FIR filter for a given specification and verification for
9	Design and test FIR filter using Windowing method (Hamming window and Kaiser window) for the given order and cut-off frequency.
10	Realization of design of IIR filter for a given specification and verification.
11	Convolution, FIR filters using DSP Processor TMS32C6713.

COURSE OUTCOMES: The students would have learnt

CO1:To write programs for all DSP operations both in MATLAB and also DSP processor TMS32C6713

CO2:Open ended project will ensure that the student is capable of developing any DSP application

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12
CO2	PO1,PO2,PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12

Sub Title: MEDICAL IMAGING SYSTEMS		
Sub Code: ML62	**No of Credits:4= 4:0:0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES:

1. To understand fundamentals of x-ray and its generation and biological effects.
2. To study different x-ray diagnostic methods.
3. To study CT imaging concepts, fundamental of Magnetic resonance imaging..
4. To study fundamentals of ultrasound and working different ultrasound techniques.
5. To study the principles of Radionuclide imaging.

UNIT No	Syllabus Content	No of Hours
1	**X-RAY IMAGING:** Fundamentals of X-ray – 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, Filters, Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers, X-ray detectors, X-ray image characteristics – Spatial resolution, Image noise, Image contrast, Receiver operating curve (ROC), Biological	**8**
2	**X-RAY DIAGNOSTIC METHODS:** Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography, Image subtraction. **COMPUTED TOMOGRAPHY:** Conventional tomography, Computed tomography – Radon Transform (Projections) and Fourier Slice theorem, Algorithms for image reconstruction: parallel and Fan beam data, Spiral CT. Recent developments – Digital radiography.	**10**
3	**ULTRASOUND IMAGING:** Fundamentals of acoustic propagation - Stress strain relationship, Characteristic impedance, Intensity, Reflection and refraction, Attenuation, absorption & scattering, Doppler effect, Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers, **ULTRASONIC DIAGNOSTIC METHODS :**Pulse echo systems- Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Constant depth mode (C-mode), Doppler methods, Duplex imaging, Tissue characterization, Colour Doppler flow imaging, Image characteristics – Ultrasonic texture or speckle, Speckle reduction, Compensation of phase aberration, Biological effects of ultrasound.	**13**

4	**RADIONUCLIDE IMAGING:**Introduction, Fundamentals of Radioactivity – 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 & Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, Radionuclide imaging systems- Gamma Camera, SPECT, PET. **BASICS OF MAGNETIC RESONANCE IMAGING:** fundamentals of nuclear magnetic resonance- 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, Pulse sequences.	**13**
5	**MRI SYSTEM & IMAGING METHODS:**magnetic field gradients, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. Imaging Methods- Introduction, slice selection, frequency encoding, phase encoding, Spin-Echo imaging- Gradient echo imaging, Characteristics of MRI images- spatial resolution, image contrast. Biological effects of magnetic fields- Static magnetic fields, Radio-frequency fields, Gradient magnetic fields, Imaging safety, Functional MRI.DICOM Standards **Mandatory** assignments/seminars on latest developments in each of	**8**

Note1: Unit 3 & Unit 4 will have internal choice

Note2: Assignment-1 from unit 1 and 2.

Asssignment-2 from unit 3,4 and 5

COURSE OUTCOMES: On the completion of the course the students would have learnt

CO1: Different imaging modalities such as x-ray, CT, Ultrasound & MRI

CO2: Advanced imaging techniques

CO3: Reconstruction of images from above imaging modalities using different transforms.

CO4: The medical image communication standard.

CO5: Explore the latest trends & happenings in the subject

COs	**Mapping with POs**
CO1	PO1,PO6,PO12
CO2	PO1,PO6,PO12
CO3	PO5,PO12
CO4	PO6,PO8,PO12
CO5	PO10,PO11, PO12

.

TEXT BOOKS:

1. **Principles of Medical Imaging**, Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 1992.
2. **Handbook of Biomedical Instrumentation**, R.S.Khandpur, Tata McGraw Hill, 2nd Edition, 2003.
3. **Fundamentals of Medical Imaging**, Paul Suetens, Cambridge University Press, 2002.

Sub Title: BIOMEDICAL EQUIPMENTS		
Sub Code: ML63	**No of Credits :4= 4: 0: 0(L-T-P)**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES:

1. To study spectrophotometer, clinical flame photometer.
2. To study different blood gas analyzers
3. To study different types of Audiometers
4. To understand the working principle of surgical diathermy.
5. To study haemodialysis and different ventilators

UNIT No	Syllabus Content	No of Hours
1	**CLINICAL LABORATORY INSTRUMENTS:** Medical diagnosis with clinical tests, spectrophotometry-components, clinical flame photometer, ion-selective electrode based analyzers.	**8**
2	**BLOOD GAS ANALYZERS:** Acid-base balance, blood pH measurement, measurement of blood pCO2, measurement of blood pO2, intra-arterial blood gas monitoring, complete blood gas analyzer. **BLOOD CELL COUNTERS**: Types of blood cells, Coulter counter, automatic recognition and differential counting of cells.	**10**
3	**AUDIOMETER AND HEARING AIDS:** Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, audiometer system Bekesy, evoked response audiometer system, hearing aids-digital hearing aid, cochlear implants.	**10**
4	**INSTRUMENTS OF SURGERY:** Principles of surgical diathermy, surgical diathermy machine, automated electro-surgical systems, electrodes used with surgical diathermy, safety aspects in electro- surgical units, surgical diathermy analyzer. **PHYSIOTHERAPY AND ELECTROTHERAPY EQUIPMENTS:** High frequency ,heat therapy, short wave diathermy, microwave diathermy, ultrasound therapy unit, electro diagnostic therapeutic apparatus, pain relief through electrical stimulation ,bladder and cerebral stimulators.	**12**

5	**HAEMODIALYSIS MACHINE:** Function of kidney, artificial kidney, dialyzer, membranes for hemodialysis, portable kidney machine. **VENTILATORS:** Mechanics of respiration, artificial ventilation, ventilators, types of ventilators, ventilator terms, classification of ventilators, pressure volume flow diagrams, modern ventilators, high frequency ventilators, humidifiers, nebulizers and aspirators	**12**

Note1: Unit 4 & Unit 5 will have internal choice
Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3,4 and 5

COURSE OUTCOMES: On the completion of the course the students would have learnt

CO1: Biomedical equipments such as clinical test equipments, blood gas analyzers, blood cell counters and surgical equipments.
CO2: To record and interpret the auditory response of the human. Suggest suitable hearing aid.
CO3: The principles of designing & developing artificial organs such as kidney & lungs.
CO4: Explore the latest trends & happenings in the subject

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO7
CO2	PO7
CO3	PO3,PO7,PO8,PO11,PO12
CO4	PO10,PO11, PO12

TEXT BOOK:

1. **Handbook of Biomedical Instrumentation** – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003

REFERENCE BOOK:

1. **Biomedical Instrumentation and Measurement** – by Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, Prentice-Hall India Pvt. Ltd.

Sub Title: MEDICAL INFORMATICS		
Sub Code: ML652	**No of Credits :4= 4: 0: 0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To make the student learn

1. Identify the fundamentals medical informatics
2. Develop practical health care applications using suitable database management system
3. Utilise knowledge, skills and concepts on health information technology
4. Apply principles of information security, ethics and policy information
5. Assesses existing information exchange system standards
6. Analyse and develop project, manage strategies health information technology

UNIT No	Syllabus Content	No of Hours
1	Medical Informatics: Introduction - Structure of Medical Informatics – Internet and Medicine -Security issues, Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, e-health services, Cloud computing: Introduction, cloud computing in medical applications	**12**
2	Computerised Patient Record : Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for	**12**
3	Computers in Clinical Laboratory and Medical Imaging: Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine, ultrasound imaging ultrasonography-computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance	**9**
4	Computer Assisted Medical Decision-Making**:** Neuro computers and Artificial Neural Networks application, Expert system – General model of CMD, Computer –assisted decision support system-production rule system, cognitive model, semester networks , decisions analysis in clinical medicine-computers in the care of critically patients-computer assisted surgery-designing	**10**

5	Recent Trends in Medical Informatics: Virtual reality applications in medicine, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery computer aids for the handicapped, computer assisted instrumentation in Medical Informatics - Computer assisted patient education and health - Medical education and health care information	**9**

Note1: Unit 2 & Unit 4 will have internal choice

Note2: Assignment-1 from unit 1 and 2.

Asssignment-2 Based on industry expert talk on cloud computing, recent trends in medical informatics

COURSE OUTCOMES: On the completion of the course the students would have learnt

CO1:Concepts of medical informatics systems,security,ethics,standards & policy information..

CO2: Develop Practical Health Care Applications Using Suitable Data Base Management Systems

CO3:Application of computers in clinical laboratory,medical imaging,education & decision making..

CO4: Explore the latest trends & happenings in the subject

COs	**Mapping with POs**
CO1	PO1,PO6,PO7,PO8
CO2	PO2,PO3,PO5
CO3	PO1,PO2,PO7,PO12
CO4	PO10,PO11, PO12

TEXT BOOKS:

1. **Medical Informatics**, Mohan Bansal, T M H, 2003 .
2. **Introduction to Bioinformatics** , T. K. Attwood & D. J. Parry-Smith, Pearson Education Low Price Edition, 2004.

References:

1. **Computers In Medicine Progress In Medical Informatics**, R. D. Lele, TMH, 2005.

Sub Title: SIGNAL PROCESSING LAB USING LABVIEW		
Sub Code: MLL66	**No of Credits :1.5= 0:0:1.5(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 Hours		**Exam Marks : 50**

COURSE OBJECTIVES:

The course is designed to make the student familiarise with the software tool Lab VIEW. The basic concepts of signal processing and DSP operations are implemented using Lab VIEW.

Sl. No	Contents
	Getting started with Labview
1	To add, multiply, subtract and divide two numeric inputs.
2	To evaluate the expression.
3	To realize code converters,half adder,full adder
4	To illustrate the use of for loop,while loop and delays.
5	To create vi for array and matrix manipulation.
6	To illustrate the use of formula node, Mathscript.
	Signal Processing.
1	To display step,ramp,exponential,sine,cosine,square signal.
2	To perform linear convolution,correlation.
3	To calculate FFT of a signal.
4	To calculate power spectral density of a signal.
5	To perform lowpass,high pass and bandpass filtering.
6	To perform filtering using window technique.

COURSE OUTCOME:

CO1:The student will develop the proficiency in Lab VIEW and learn to implement DSP operations in Lab VIEW

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12

Sub Title: PHYSIOLOGICAL LAB		
Sub Code: MLL67	**No of Credits :1.5= 0:0:1.5(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours		**Exam Marks : 50**

COURSE OBJECTIVES:

The course is meant to provide the student a comprehensive study of bio medical signals, involving real time bio signal acquisition, telemetry and analysis. The student will also learn to design required physiological variable converting into bioelectrical signals.Furthermore the student will be able to analyze the data.

Unit No	Syllabus Content
Experiments using Power Lab and LabVIEW/Lab chart	
1	Real Time data Acquisition and Analysis of the following physiological parameters ECGs (EKGs), EMGs, and EEGs
2	Blood Pressure (BP) Amplifier
3	Recording of Electromyogram/ nerve conduction velocity.
4	The Galvanic Skin Response Amplifier
5	Study of lung and cardiovascular models
Transducers and Instrumentation	
6	Bridge Amplifier: Testing of various transducers including commonly available force, pressure, and displacement transducers, temperature probes, light meters, and similar devices
7	Study and usage of Automatic defibrillators
Telemetry of bio signals	
8	Optical fibre communication link – biotelemetry

COURSE OUTCOME:

CO1:The student will be fluent in handling Power Lab (bio acquisition system) biomedical applications. The student will learn about the vvarious transducers, physiological variables, bio amplifiers, analysis of acquired signals electrical safety methods

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12

Sub Title : JAVA LAB		
Sub Code: MLL68	**No. of Credits:2=0: 0:2(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES

To enable the students learn the fundamentals of programming language Java and also develop programming skills in Java

1	Simple Java Programs to illustrate the data operators
2	Program for string reversal
3	Program for demonstration of control statements
4	Program for demonstrating constructors
5	Program for demonstrating Overloading and overriding
6	Program for demonstrating multilevel Inheritance
7	Program for exception handling (try & catch methods and nested try statement and)
8	Program for demonstration of multi threading : Implementing runnable & extends, producer-consumer problem synchronization
9	Program for demonstrating event handling
10	Developing Applet program

COURSE OUTCOME: The students would have

CO1: Acquired programming skills in Java and will be able to develop applications using Java

COs	**Mapping with POs**
CO1	PO1,PO2,PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12

Sub Title: MINIPROJECT		
Sub Code: MLP69	**No of Credits : 00:00:2**	**No of lecture hours/week : -**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To enable the students to come up with their own innovative ideas and realize it.

Note:

- Mini project should be carried by a group of 3 or 4 and not more than 4 in a group.
- PCB soldering and Testing
- Evaluation should be based on the demonstration, viva-voce and final report.

COURSE OUTCOME:

CO1:The students will develop and conceptualise new ideas and build working models for biomedical applications

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12

Sub Title: BIOMEDICAL DIGITAL SIGNAL PROCESSING		
Sub Code: ML71	**No. of Credits : 3=3: 0: 0(L-T-**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to study

1. To learn the nature of various biomedical signals and its analysis.
2. To know about neurological signal generation.
3. To study sleep EEG types and their features.
4. To study adaptive filters and their applications in biomedical signal processing.
5. To gain knowledge about various artefacts and methods to eliminate it.
6. To study cardiological signal processing

UNIT No	Syllabus Content	No of Hours
1	**INTRODUCTION TO BIOMEDICAL SIGNALS:** The nature of biomedical signals, the action potential, objectives of biomedical signal analysis, Difficulties in biomedical signal analysis, computer aided diagnosis. Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics, EEG analysis. EMG signal characteristic and analysis	**7**
2	**SLEEP EEG:** Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, and Event history analysis for modeling sleep.	**6**
3	**ADAPTIVE FILTERS:** Principle of an adaptive filter, the steepest descent algorithm, adaptive noise canceller, cancellation of 60 Hz interference in electrocardiography, applications of adaptive filters. Canceling donor - heart interference in heart-transplant electrocardiography, Cancellation of ECG signal from the electrical activity of the chest muscles, canceling of maternal ECG in fetal ECG,	**9**
4	**SIGNAL AVERAGING:** Basics of signal averaging, a typical signal averager, signal averaging as a digital filter, Removal of artifacts by averaging. Filtering for removal of artifacts**:** Introduction, Random noise, structured noise and physiological interference, stationary versus non stationary process, high frequency noise in ECG, motion artifact in ECG, power line interference in ECG signals, Maternal interference in Fetal ECG, muscle contraction interference in VAG signals.	**9**

5	**CARDIOLOGICAL SIGNAL PROCESSING:** Pre-processing. ECG QRS Detection techniques. Rhythm analysis. Arrhythmia detection Algorithms. Automated ECG Analysis. ECG Pattern Recognition. Heart rate variability analysis, ST–segment analyzer, portable, arrhythmia monitors.	**8**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The students will be able to
CO1: Understand the characteristics & analysis of EEG signal
CO2: Acquire and Analyse sleep EEG signals
CO3: Understand the principle & application of adaptive filter in acquiring physiological signals
CO3: Cancel the effects of ECG signals in other physiological signals of interest
CO4: Filter the interferences caused in ECG signal and the nature of the noise
CO5: Analysis of ECG signals

Cos	Mapping with Pos
CO1	PO1,PO2,PO4, PO6, PO7,PO12
CO2	PO2,PO3,PO4,PO6, PO7, PO12
CO3	PO2,PO3,PO4, PO6, PO7, PO12
CO4	PO2,PO3,PO4, PO6, PO7, PO12
CO5	PO2,PO3,PO4,PO6, PO7, PO12

TEXT BOOKS:

1. **Biomedical Digital Signal Processing**,Willis J.Tompkins, PHI.
2. **Biomedical Signal Processing- principles and techniques**, Tata McGraw-Hill, D.C.Reddy, 2005.
3. **Biomedical Signal Analysis**, Rangaraj M. Rangayyan, IEEE Press, 2001.
4. **Wavelet Transforms** , Raghuveer M. Rao and Ajit S. Bopardikar, Pearson, 1998.

REFERENCE BOOKS:

1. **Biomedical Signal Processing ,**Akay M, Academic Press ,1994
2. **Biomedical Signal Processing ,**Cohen.A, Vol. I , CRC Press, 1986.

Sub Title: DIGITAL IMAGE PROCESSING		
Sub Code: ML72	**No. of Credits : 3=3: 0: 0(L-T-**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVE: To enable the students to study

1. To discuss the fundamental concepts of digital image processing
2. To discuss image enhancement technique in spatial and frequency domain.
3. To discuss image segmentation and restoration technique in spatial and frequency domain

UNIT No	Syllabus Content	No of Hours
1	**DIGITAL IMAGE FUNDAMENTALS** Digital image representation, fundamental steps in digital image processing, Simple image model, basic relationships between pixels: neighborhood of a pixel, connectivity. Color models and transformations, pseudo color image processing,	8
2	**IMAGE ENHANCEMENT** Basic gray level transformations, histogram, histogram equalization, basics of spatial filtering, smoothing and sharpening spatial filters, edge detection method. Introduction to the frequency domain, smoothing and sharpening frequ domain filters, homomorphic filtering.	8
3	**IMAGE SEGMENTATION** Detection of discontinuities, edge linking & boundary detection, thresholding, region based segmentation, morphological watersheds.	8
4	**IMAGE RESTORATION** Degradation model, Noise models, restoration in the presence of noise only (Spatial and frequency domain filters), Inverse filtering, LMS filtering, Wiener filter.	8
5	**IMAGE COMPRESSION** Fundamentals, image compression models, error-free compression, lossy and lossless predictive coding, wavelet coding, JPEG 2000 coding,	7

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Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The students will be able to

CO1: Understand the basic image processing concepts such as relationship between pixels and color models
CO2: Implement image enhancement techniques in spatial & frequency domain
CO3: Understand and apply image segmentation techniques to any given image
CO4: Understand various degradation models and apply the image restoration techniques
CO5: Perform image compression using lossy and lossless techniques

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3
CO3	PO1,PO2,PO3,PO4, PO12
CO4	PO1,PO2,PO3,PO4,PO12
CO5	PO1,PO2,PO3,PO4,PO5, PO12

Text Books:

1. **Digital Image Processing** , R C Gonzalez & R E Woods, Pearson Education, 3 edition.
2. **Digital Image Processing and Computer Vision** , Milan Sonka, Cengage learning, First edition.

Reference Books:

1. **Digital Image Processing** , S.Jayaraman, S.Esakkirajan, T.Veerakumar, Tata Mcgraw Hill, 2009.
2. **Fundamentals of Digital Image processing** , A K Jain, PHI / Pearson Education, 1989.
3. **Digital Image Processing** , Sid Ahmed, McGraw Hill.

Sub Title : BIOMECHANICS		
Sub Code: ML73	**No of Credits :3= 3: 0: 0(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: Understand the mechanical aspects of human motion:

1. Quantitative and qualitative analysis of human motion and performance.
2. Use physical laws of motion to solve problems of human motion.
3. Understand the relationship between mechanical properties and anatomical functions.
4. Understand how biomechanical principles can be applied to examine human activities such as sport and orthopaedic rehabilitation.

UNIT No	Syllabus Content	No of Hours
1	**BIO-FLUID MECHANICS:** Newton's laws, stress, strain, elasticity, Hook's-law, viscosity, Newtonian Fluid, Non-Newtonian fluid, viscoelastic fluids. Vascular tree. Relationship between diameters, velocity and pressure of blood flow, Resistance against flow	08
2	**VISCOELASTIC FLUID:** Viscoelasticity, Viscoelastic Models: Maxwell, Voigt and Kelvin Models Response to harmonic variation. Use of viscoelastic models.	08
3	**RESPIRATORY MECHANICS:** Alveoli mechanics, Interaction of blood and lung P-V curve of lung. Breathing mechanism. Airway resistance. Physics of lung diseases.	08
4	**ORTHOPEDIC MECHANICS:** Mechanical properties of cartilage. Diffusion properties of articular, cartilage, Mechanical properties of bone. Kinetics and Kinematics of joints, Lubrication of joints. Fundamental concepts of Gait analysis.	08
5	Measuring principles of Cutometer, Durometer. Electrodynamometer, Microindentometer & Ballistometer.	07

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On the completion of the course the students will be able to

CO1: Understand the concepts of bio-fluids.
CO2: Understand the various viscoelastic models.
CO3: Understand the concepts of respiratory mechanics
CO4: Understand the concept of orthopaedic mechanics.
CO5: Understand the principles of various biomechanic measuring equipments.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO2,PO3,PO4
CO3	PO1,PO4, PO6, PO7
CO4	PO1,PO4,PO7
CO5	PO1,PO4,PO7

TEXT BOOKS:

1. **Biomechanics, Mechanical Properties of Living Tissues,** Y.C Fung,Springer Verlag, Edition2, 1993.
2. **Introduction to Biomechanics of Joints & Joint Replacement Mechanical Engg,** D.Dowson, V Wright publication, 1987.
3. **The Biomedical Hand Book**,Joseph.D.Bronzino ,CRC Press, 2nd Edition,2000.

Sub Title: BIOMATERIALS & ARTIFICIAL ORGANS		
Sub Code: ML742	**No. of Credits:3=3:0:0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to study

1. To know about various synthetic biomaterials.
2. To know about composite biodegradable polymeric and tissue derived material.
3. To understand the various artificial organs such as artificial heart, artificial kidney artificial lung.

UNIT No	Syllabus Content	No of Hours
1	**BIOMATERIALS:** Introduction to biomaterials, uses of biomaterials, biomaterials in organs & body systems, materials for use in the body, performance of biomaterials. **METALLIC BIOMATERIALS:** Introduction, Stainless steel, Cobalt-Chromium alloy, Titanium alloys, Titanium-Nickel alloys, Dental metals, Corrosion of metallic implants, Manufacturing of implants. **CERAMIC BIOMATERIALS:** Introduction, nonabsorbable /relatively bioinert bioceramics, biodegradable/resorbable ceramics, bioreactive ceramics, deterioration of ceramics, bioceramic-manufacturing techniques. **POLYMERIC BIOMATERIALS:** Introduction, polymerization and basic	**10**
2	**COMPOSITE BIOMATERIALS:** Structure, bounds on properties, anisotropy of composites, particulate composites, fibrous composites, porous materials, biocompatibility. **BIODEGRADABLE POLYMERIC BIOMATERIALS:** Introduction, Glycolide based biodegradable homopolymers polyesters, non-glycolide linear aliphatic polyesters, aliphatic and aromatic polycarbonates, and biodegradation properties of synthetic biodegradable polymers. **TISSUE DERIVED BIOMATERIALS:** Structure and properties of collagen and collagen-rich tissues, biotechnology of collagen, design of resorbable collagen-based medical implant. 3D Printing	**7**
3	**ARTIFICIAL ORGANS INTRODUCTION:** Substitutive medicine, outlook for organ replacement, design consideration, evaluation process. **ARTIFICIAL HEART AND CIRCULATORY ASSIST DEVICES:** Engineering design, Engg design of artificial heart	**8**

	and circulatory assist devices, blood interfacing implants – introduction, total artificial hearts & ventricular assist devices, vascular prostheses, Non-blood interfacing implants for soft tissues- sutures and allied augmentation devices, percutaneous and skin implants, maxillofacial implants, eye and ear implants. Cardiac Valve Prostheses: Mechanical valves, tissue valves, current types of prostheses, tissue versus mechanical, engineering concerns and hemodynamic assessment of prosthetic heart valves, implications for thrombus deposition, durability, current trends in valve design, vascular grafts-history, synthetic grafts, regional patency, thrombosis, neointimal hyperplasia, graft infections.	
4	**ARTIFICIAL KIDNEY:** Functions of the kidneys, kidney disease, renal failure, renal transplantation, artificial kidney, dialyzers, membranes for haemodialysis, haemodialysis machine, peritoneal dialysis equipment-therapy format, fluid and solute	**7**
5	**ARTIFICIAL LUNGS:** Gas exchange systems, Cardiopulmonary bypass (heart-lung machine)-principle, block diagram and working, artificial lung versus natural lung. Liver functions, hepatic failure, liver support systems, general replacement of liver functions	**7**

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: Completion of this course the student will be able to

CO1: Understand the different biocompatible materials such as metallic, ceramic and polymers.
CO2: Understand the biodegradable biomaterials
CO3: Identify different artificial implants and assistive devices for cardio-vascular system
CO4:Design of artificial organs such as heart, kidney and lung.

COs	Mapping with POs
CO1	PO1,PO3,PO6,PO7
CO2	PO1,PO2,PO3,PO4,PO6,PO7,PO8
CO3	PO1,PO2,PO3,PO4,PO6,PO7,PO8,PO12
CO4	PO10,PO11,PO12

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TEXT BOOK:

1. **Biomedical Engineering Handbook**, J.D.Bronzino ,CRC Press ,Volume1 ,2nd Edition, 2000.
2. **Biomedical Engineering Handbook,** J.D.Bronzino ,CRC Press ,Volume2 ,2nd Edition, 2000.
3. **Handbook of Biomedical Instrumentation ,** R.S.Khandpur **,**Tata McGraw Hill, 2nd Edition , 2003.

Sub Title: MEDICAL DEVICES AND REGULATIONS		
Sub Code: ML752	**No. of Credits : 3=3: 0: 0(L-T-P)**	**No. of lecture hours/week:03**
Exam Duration:3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to study

1. Device types, Regulations and Standards and approval process of Medical Devices
2. Knowledge of FDA terminologies
3. Validation process for medical device hardware and software

Unit No.	Syllabus Contents	No. of Hours
1	**Medical Device**: Definition, product definition process, overview of quality function deployment(QFD), QFD process, business proposal. **Reliability**: Concept of failure, various methods of CAPA. **Safety and Risk Management**: Personnel safety and hygiene, medical device safety and risk management, effectiveness/performance of medical devices, Phases in the life span of a medical device, risk management processes, shared responsibility for medical device safety and performance.	**7**
2	**The Food and Drug Administration:** Device classification, 510 (k) Process, Declaration of conformance, PMA application, Investigational Device Exemptions (IDEs), Good Laboratory Practices (GLPs), Good Manufacturing Practices (GMPs), Human Factors, Design Control. ***The European Union:*** European Directives, Conformity Assessment and Testing, European Organization for Testing and Certification, Benefits of the GHTF, Final documents from the GHTF, Global Medical Device Nomenclature (GMDN)	8
3	**Standards and Regulations Background** ***Standards:*** Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards, ISO 14000 Series of Standards. **The Medical Devices Directives:** Medical Devices Directives	8

	process, Choosing the appropriate directive, Essential requirements, Classification of the device based on conformity, Medical Devices Directives, Active Implantable Medical Devices Directives, *In-vitro* Diagnostic Medical Devices Directives. NABH, NABL, JCI, AERB , WHO guidelines on medical devices.	
4	**Software and Quality System Regulation** Software as a Technology, Domestic Software Regulations, Domestic Software Standards, International Software Regulations, International Software Standards, Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, corrective and preventive action.	8
5	**Medical Device Testing** The basis and types of testing, Parsing test requirements, Test protocol, Test methodology, Purpose of the test, Failure definition, Determining sample size and test length, Types of testing. **Validation:** Hardware verification and validation, Software verification and validation.	8

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Define the medical device, its processes encompassing safety and risk management.
CO2: Identify the objectives and functions of FDA and EU.
CO3: Analyze various medical device standards and regulations
CO4: Document the procedure in software quality system regulations
CO5: Implement test protocol for medical device testing.

COs	Mapping with POs
CO1	PO1,PO4,PO6
CO2	PO1,PO6,PO7,PO8
CO3	PO1,PO5,PO6,PO7,PO8
CO4	PO1,PO5,PO12
CO5	PO1,PO2,PO11,PO12

TEXT BOOKS

1. **Reliable Design of Medical Devices**, Second Edition by Richard Fries, CRC Press, 2006.
2. **Medical Device Quality Assurance and Regulatory Compliance** , Richard C Fries, CRC Press, 1998.

REFERENCE BOOKS

1. **Medical device regulations: global overview and guiding principles** , Michael Cheng, World Health Organization.
2. **Product Safety in the European Union** , Gabor Czitan, Attila Gutassy, Ralf Wilde, TUV Rheinland Academia, 2008.

Sub Title : BIO-MEDICAL DIGITAL SIGNAL & IMAGE PROCESSING LAB		
Sub Code: MLL76	**No. of Credits:1=0: 0:2(L-T-P)**	**No of lecture hours/week :02**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To enable the students to study

1. Signal conditioning of Biomedical signals using FIR and IIR filters and to plot and observe the nature of these signals using MATLAB.
2. And familiarize with the basic concepts of image processing such as enhancement and segmentation using MATLAB.

UNIT No	Syllabus Content
	Biomedical Signal Processing using MATLAB
1	Analysis of ECG data: Original signal, Noise signal and filtered signal
2	Realization of IIR and FIR filters for ECG
3	PSD estimation for ECG, EEG, and EMG
4	R-R interval sequence interpretation
5	Analysis of Real time ECG, EEG signals acquired through Power Lab data acquisition system
	Image Processing using MATLAB
6	Basic operations on an image: Logical operations, Resizing, Rotation, Translation, Negative of an image
7	Plotting Histogram and histogram equalization
8	Image Segmentation: Threshold, multiple threshold
9	Implementation of spatial domain filters: LP, Median, HP
10	Implementation of edge detection using gradient filters.
11	Display of bit planes of an image
Open End Experiment	

COURSE OUTCOME: The student will be able

CO1: To implement digital filters using acquired signals

CO2: To Compute frequency spectrum of ECG & EEG signals

CO3: To Implement image enhancement techniques

CO4: To implement image segmentation techniques

CO5: Design and develop any biomedical signal & image processing application using MATLAB

CO6: To maintain the document and accomplish the work in stipulated time

Cos	**Mapping with Pos**
CO1	PO3,PO4,PO5,PO12
CO2	PO3,PO4,PO5,PO12
CO3	PO3,PO4,PO5,PO12
CO4	PO3,PO4,PO5,PO12
CO5	PO3,PO4,PO5,PO12
CO6	PO10, PO11,

Sub Title: Seminar		
Sub Code: MLS77	**No of Credits 02:00:00**	**No of lecture hours/week :**
	Exam Marks : 50	

Course Objectives: To enable the students to learn

1. Read and disseminate technical papers
2. Prepare and present a document before the peers
3. Understand the latest happenings in their field of interest

The seminar topics must relate to the current trend in technology depending on the students interest in the field of medical electronics. And the students must carry out an elaborate literature survey on the related field referring standard international journals/conferences. The students will finally make a oral presentation and also submit a technical report.

Course Outcome: To enable the students to learn

CO1: Read and interpret technical papers

CO2: Express the ideas and communicate clearly

CO3: Prepare Technical documentation

COs	**Mapping with POs**
CO1	PO2,PO3,PO4,PO6
CO2	PO10
CO3	PO10,PO12

Sub Title: Project Phase I		
Sub Code: MLP78	**No of Credits 0:00:00**	**No of lecture hours/week :**
	Exam Marks :	

COURSE OBJECTIVES: To enable the students to learn

1. Develop their own ideas
2. Interact with outside world
3. Work in a group in a collaborative and productive manner

The project topics and batch mates are decided in Project Phase 1. The project work is carried out in group of 3 or 4. Industry projects are encouraged and promoted. The Project topic and the design presented in the phase I. The students will make a presentation of the abstract and synopsis and also submit a report showing the design & implementation along with the literature survey.

COURSE OUTCOME: The students will be able to

CO1: Carry out the literature survey
CO2: Convert the ideas of their interest into a conceptual model
CO3: Interact with outside world in identifying a suitable problem
CO4: Prepare proposals and approach funding agencies

COs	**Mapping with POs**
CO1	PO2,PO3,PO4,PO5, PO6, PO7, PO12
CO2	PO3, PO6, PO12
CO3	PO9,PO10, PO12
CO4	PO10, PO11,

Sub Title: NEURAL NETWORK & PATTERN RECOGNITION		
Sub Code: ML811	**No. of Credits:4=4:0:0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: The enable the students to learn

1. The concepts of biological neuron and analogy to the artificial neuron model
2. Different neural network architecture
3. Various learning paradigms and comparisons

UNIT No	Syllabus Content	No of Hours
1	**INTRODUCTION TO BIOLOGICAL NEURAL NETWORK:** Classic neuron, Bioelectric potential, Electrochemical mechanism of action potential, Nernst equation-electrochemistry give rise to electrical events, Membrane potential distributed model, Synaptic electrical events, slow potential theory of neurons. **ARTIFICIAL NEURAL NETWORK:** introduction to artificial neural network, model of a neuron, Types of activation function, neural networks viewed as directed graphs, architectural graph of a neuron with feedback, Network Architectures, Artificial intelligence and Neural Networks.	**10**
2	Learning Processes: Learning in context to neural Networks, learning paradigms, supervised & unsupervised learning, Five basic learning rules-Error correction Learning, Memory based learning. Hebbian learning, Competitive and Boltzmann learning, learning tasks, Memory, adaptation, Statistical nature of learning processes, Statistical learning theory.	**9**
3	**SINGLE LAYER PERCEPTION:** Introduction, Adaptive filtering problem, Unconstrained optimization techniques, Newton's method, Gauss-Newton method, Linear least square filter, Least mean square algorithm, Learning curves, Learning Rate, Annealing techniques, Perceptron, convergence theorem	**9**
4	**MULTILAYER PERCETRON:** Introduction, Some Preliminaries, Back propagation algorithm, XOR Problem, Heuristics for making the back propagation algorithm perform better, Feature detection, Hessian matrix, generalization, Cross validation, Virtues and limitations of back propagation algorithm.	**12**

5	**Random Variables-**Binomial distribution, Poission distribution Continuous Random variables uniform density, exponential density, normal density **Introduction to pattern Recognition** **Statistical Decision Making:** Introduction, Bayes' theorem, multiple features, conditionally independent features, Decision boundaries: Two Dimensional decision boundaries **Clustering:** Introduction, Hierarchical clustering-agglomerative, single linkage, average linkage, ward's method. Partitional clustering-Forgy's, k-means.	**12**

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The students will be able to

CO1: Understand the concepts of artificial intelligence and neural network.
CO2: Understand the different learning algorithms and neural network architecture
CO3: Apply perceptron and multiple perceptron for classification
CO4: Apply the probabilistic models for data classification

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4, PO6, PO7
CO2	PO2,PO3,PO4, PO6, PO7,PO12
CO3	PO2,PO3, PO4, PO6, PO7,PO12
CO4	PO2,PO3, PO4, PO6, PO7,PO12

TEXT BOOKS:

1. **An Introduction To Neural Networks,** James A. Anderson, PHI, 2nd edition ,1995.
2. **Neural Networks**, Simon Haykin Pearson Education/PHI, 2001.
3. **Neural Networks** , Satish Kumar, Tata Mcgraw-hill 2009
4. **Pattern Recognition & Image Analysis**, Earl Gose, Richard Johnsonbaugh Steve Jost, Prentice Hall of India, 2002.

REFERENCE BOOKS:-

1. **Introduction To Artificial Neural Systems**, Jacck M Zurada, Jaico publishing
2. **Artificial Neural Networks**, B Yegnanarayana, PHI, 2001
3. **Pattern Recognition**, Robert Schalkoff, Wiley India Pvt. Ltd.

Sub Title: REHABILITATION ENGINEERING		
Sub Code: ML822	**No. of Credits : 4=4: 0: 0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+ Assignment +SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To enable the students to Study

1. Concept of Rehabilitation, Diagnosis of disability.
2. Rehabilitation team role of physiatrist.
3. Therapeutic exercise technique.
4. Principle in Management of communication.
5. Orthotic devices in Rehabilitation Engg and to know about level of amputation.
6. Prosthetic device and mobility aids.

UNIT No	Syllabus Content	No of Hours
1	**INTRODUCTION TO REHABILITATION & REHABILITATION TEAM:** What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Physiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Effects of prolonged inactivity & Bed rest on body system. REHABILITATION TEAM**:** Classification of members, The Role of Physiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer.	**12**
2	**THERAPEUTIC EXERCISE TECHNIQUE :** Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.	**7**
3	**PRINCIPLES IN MANAGEMENT OF COMMUNICATION:** Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative	**7**

	communication-general form of communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids.	
4	**ORTHOTIC DEVICES IN REHABILITATION ENGINEERING:** General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Biomechanics of orthoses, merits & demerits of orthotics, Material design consideration in orthotics, Calipers-FO, AFO, KAFO, HKAFO. Spinal Orthosis, Cervical, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbo sacro orthosis, Splints-its functions & types. **AMPUTATION:** Levels of Amputation – Surgical process, Expected Outcomes, Post operative dressings – Rigid dressings, Semi rigid dressings, Soft dressings, Examination- Range of Motion, Muscle Strength, Status of Residual Limb, Status of the un involved limb, Functional status, emotional status.	**13**
5	**PROSTHETIC DEVICES:** Introduction, Partial Foot Prostheses-Foot-ankle assembly, Trans femoral Prostheses – Knee unit, Axis system, Friction Mechanisms, Extension aid, Stabilizers, Socket. Disarticulation Prostheses-Knee Disarticulation Prostheses, Hip Disarticulation Prostheses **MOBILITY AIDS:** Walking frames, Parallel bars, Rollators, Quadripods, Tripods & walking sticks, Crutches, Wheel chairs. Post cardiac operation rehab	**13**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3,4 and 5

COURSE OUTCOMES: The student will be able to

CO1: Understand the concept of rehabilitation and the role of rehabilitation team.
CO2: Implement and suggest therapeutic exercise techniques.
CO3: Understand aphasia and suggest different visual aids,hearing aids and writing aids.
CO4: Design and develop orthotic and prosthetic devices.
CO5: Differentiate between the different mobility aids.

COs	**Mapping with POs**
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3,PO4,PO7,PO8,PO12
CO3	PO1,PO2,PO3,PO4,PO7,PO8,PO12

TEXT BOOKS:

1. **Rehabilitation Medicine,** Dr. S. Sunder, Jaypee Medical Publications, New Delhi.
2. **Physical Rehabilitation**, Susan B O'Sullivan, Thomas J Schmitz. 5th edition

Sub Title: Project Phase II		
Sub Code: MLP83	**No of Credits 12:00:00**	**No of lecture hours/week :**
	Exam Marks : 100	

COURSE OBJECTIVES: To enable the students to Study

1. Realise their technical ideas into a working mode
2. Interact with outside world
3. Work in a group in a collaborative and productive manner

The project topics and batch mates are decided in Project Phase 1. The project work is carried out in group of 3 or 4. Industry projects are encouraged and promoted. The Project topic and the design presented in the phase I has to be implemented with the guidance of a teacher assigned to the batch. The students will finally make an oral presentation and also submit a technical report.

Course Outcome: The students will be able to

CO1: Realise innovative ideas into working models

CO2: Discuss ideas, plan and work in a peer team to develop a system

CO3: Design a cost effective model within the time

CO4: Interact with industry experts

CO5: Document and present the technical project report

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5,PO6,PO7, PO12
CO2	PO9,PO10, PO11,
CO3	PO4, PO5, PO11, PO12,
CO4	PO9, PO10,PO11, PO12
CO5	PO10, PO12

Sub Title : ANALOG ELECTRONIC CIRCUITS		
Sub Code: 18ML31	**No of Credits :3= 3: 0: 0(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To make the Student understand:

1. The behavior of diode and study the application circuits of diode.
2. The transistor operating point and biasing circuits.
3. FET construction and characteristics.
4. MOSFET device construction and working
5. Design and analysis of MOSFET circuits.
6. Feedback concepts and Power amplifier circuit.

UNIT No	Syllabus Content	No of Hours
1	BJT AC Analysis : Hybrid Equivalent model, Voltage Divider Configuration **BJT Frequency Response:**, Low frequency analysis (Bode Plot excluded), low frequency response of BJT amplifier, Miller effect capacitance, High frequency response of BJT amplifiers- study of capacitors affecting frequency response,	8
2	**Feedack Amplifier:** Feedback concepts, feedback connection types **Power Amplifiers**: Definitions and amplifier types, Transformer coupled Class A amplifiers, Class B push-pull amplifier circuits Field Effect Transistor: Introduction, construction and characteristics of JFET, Transfer Characteristics	7
3	**MOSFETS:** Introduction, Device structure and physical operation - Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small VDs, Operation as VDs is increased, Derivation of the id-VDS relationship, The P- Channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the sub threshold region .	**8**

4	**Current voltage Characteristics** – Circuit symbol, id-VDS 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.	**8**
5	**Biasing in MOS amplifier circuits** - Biasing by fixing VGS, Biasing by fixing VG and connecting a resistor in the source , Biasing using a drain to gate feedback resistor, biasing using a current source. **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 gm, the T equivalent circuit model.	**8**

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Draw equivalent circuit models for BJTs and MOSFET
CO2: Determine the cut off frequencies for practical transistor amplifiers
CO3: Classify feed back amplifiers and power amplifiers
CO4: Illustrate the procedure & working of construction of FET, MOSFET
CO5: Design biasing circuits MOSFETS
CO6: Differentiate the amplifier and switch functionality of MOSFETs

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3,PO4
CO3	PO1,PO2,PO3,PO4
CO4	PO1,PO2,PO3,PO4
CO5	PO1,PO2,PO3,PO4
CO6	PO1,PO2,PO3,PO4

TEXT BOOK:

1. **Electronic Devices and Circuit Theory,** Robert L. Boylestad and Louis Nashelsky, PHI/Pearson Education, 9th Edition.
2. **Microelectronic Circuits Theory and Applications,** Adel S Sedra and Kenneth C Smith Oxford International Student edition, 6th edition

Text Book 1: Unit 1, Unit 2, Unit 5
Text Book 1: Unit 3, Unit 4,

REFERENCE BOOKS:

3. **Integrated Electronics,** Jacob Milman & Christos C. Halkias, Tata - McGraw Hill, 1991 Edition.
4. **Electronic Devices and Circuits,** David A. Bell, PHI, 4th Edition, 2004.

Sub Title : LOGIC DESIGN and VHDL		
Sub Code: 18ML32	**No of Credits : 3=2:2:0(L-T-P)**	**No of lecture hours/week : 4**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To make the Student understand

1.Principles of combinational and sequential logic.
2.Different Boolean expression reduction techniques.
3.The design and analysis of combinational circuits.
4.The integrated circuit technologies.
5.Different flip flops and its applications.
6.Sequential circuit models

UNIT No	Syllabus Content	No of Hours	Tutorials
1	**Principles of combinational logic-1:** Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3, 4 and 5 variables, Incompletely specified functions (Don't Care terms), Simplifying Max term equations. **Principles of combinational Logic-2:** Quine-McCluskey minimization technique-Quine-McCluskey using don't care terms, Reduced Prime Implicant Tables. **Introduction to VHDL:** Structure of VHDL Module, Operators, Data types, Types of Descriptions, simulation and synthesis. Data flow description, behavioral description and structural description.	8	4
2	**Analysis and design of combinational logic - I:** General approach, Decoders-BCD decoders, Encoders. **Analysis and design of combinational logic - II:** Digital multiplexers- Using multiplexers as Boolean function generators. Adders and subtractors-Cascading full adders, Binary comparators. **VHDL Implementation: D**ecoder, Encoder, Comparator, Adder/Subtractor	**8**	**4**
3	**Sequential Circuits – 1:** Basic Bistable Element, Latches, SR Latch, Application of SR Latch, A Switch Debouncer, The $\overline{S}\,\overline{R}$ Latch, The gated SR Latch, The gated D Latch, Master-Slave SR Flip-Flops, The Master-Slave JK Flip-Flop,T Flip Flop,D Flip flop. V**HDL Implementation** – Sequential Circuits: Flip Flops	**8**	**4**
4	**Sequential Circuits – 2:** Characteristic Equations, Registers, Counters - Binary Ripple Counters, Asynchronous counters, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters using JK Flip-Flop, D Flip-Flop, T Flip-Flop.	8	-
5	**Sequential Design - I:** Introduction, Mealy and Moore Models, State Machine Notation, Synchronous Sequential Circuit Analysis. **Sequential Design – II:** Construction of state diagrams, counter design.	**8**	-

Note 1: Assignment-1 Comparative study of different logic families

Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Simplify the Boolean equation and build logical circuits.
CO2: Design combinational circuits
CO3: Design shift registers, synchronous/ asynchronous counters
CO4: Draw state diagram for Melay & Moore Models
CO5: Write & simulate VHDL programs using the software tool Xilinx-ISE

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5
CO2	PO1,PO2,PO3,PO4,PO7
CO3	PO1,PO2,PO3,PO4,PO5,PO7
CO4	PO3,PO4,PO6,
CO5	PO3,PO5,PO6,PO12

TEXT BOOKS:

1. **Digital Logic Applications and Design**, John M Yarbrough, Thomson Learning, 2001.
2. **Digital Principles and Design,** Donald D Givone, Tata McGraw Hill Edition, 2002.
3. **Fundamentals of Logic Design:** C H Roth, Thomas Learning, 5th Edition.

REFERENCE BOOKS:

1.Fundamentals of logic design, Charles H Roth, Jr, Thomson Learning, 2004.
2.Logic and computer design Fundamentals, Mono and Kim, Pearson, Second edition, 2001.

Sub Title : ANALOG ELECTRONIC CIRCUITS LAB		
Sub Code: 18MLL37	**No of Credits:1=0:0:1(L-T-P)**	**No of lecture hours/week :2**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To wire up and understand the working of the following circuits

1. Diode circuits such as rectifiers, clipping and clamping circuits
2. Design of RC coupled amplifiers
3. RC phase shift oscillators
4. Power Amplifiers
5. Verify the Network theorems.

UNIT No	Syllabus Content
1	Rectifiers: Half wave, Full wave and Bridge Rectifier circuits.
2	Clipping Circuits: Single & Double ended with and without bias voltages
3	Clamping circuits: Positive clamping & Negative clamping.
4	RC Coupled Amplifier: BJT & FET
5	BJT Oscillators-RC Phase shift Oscillator
6	BJT/ FET Oscillators – Hartley & Colpitts Oscillators
7	Power Amplifiers : Push Pull Amplifiers
8	Open Ended experiment

COURSE OUTCOMES: The student will be able to

CO1: To design and test Recifiers Circuits

CO2: To design clipping and clamping circuits to generate

CO3: To design Oscillators

CO4: To Test the working of power amplifiers

CO5: To design & develop a system based on analog circuits

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO2	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10

CO3	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO4	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO5	PO12

Sub Title : LOGIC DESIGN LAB		
Sub Code: 18MLL38	**No of Credits:1=0:0:1(L-T-P)**	**No of lecture hours/week : 2**
Exam Duration: 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To design and Implement the following digital circuits:

1. Basic Gates, and simple logic circuits
2. Typical Combinational circuits
3. All types of flip flops
4. Typical Sequential circuits

UNIT No	Syllabus Content
1	Design of Half/Full adder and Half/Full Subtractors using logic gates.
2	(i) Realization of parallel adder/Subtractors using 7483 chip (ii) BCD to Excess-3 code conversion and vice versa.
3	Design of Binary to Gray code convertors and vice versa.
4	Study of 74153 IC(MUX) and designing different combinational circuits based on 74153.
5	Designing of One/Two bit comparator and study of 7485 magnitude comparator.
6	i)Design a decoder circuit for seven segment LED display ii) Study of Priority encoder
7	Implementation of given flip flops both at gate and IC level.
8	Designing of 3 bit counters and MOD – N counter (7476, 7490)
9	Design of Universal shift register using 74LS95.
10	Design sequence generator using Ring counter/Johnson counter.

COURSE OUTCOMES: The student will be able to
CO1: Design and Verify basic combinational and sequential circuits.
CO2: Design any given combinational and sequential circuits using logic gates and standard ICs.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO2	PO9,PO10,PO11,PO12

Sub Title: BIOMEDICAL INSTRUMENTATION		
Sub Code: 18ML44	**No. of Credits : 4=4: 0: 0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: Is to make the student understand

1. The human physiology, anatomy and evolution of bio signals.
2. The concepts of bio signal transducers and measurement.
3. The working of all major biomedical equipments.
4. The safety of biomedical devices.

Unit No.	Syllabus Content	No. of Hours
1	**FUNDAMENTAL CONCEPTS:** Sources of biomedical signals, Basic medical instrumentation system, performance requirements of medical instrumentation systems, General constraints in design of medical instrumentation systems. **Bioelectric Signals and Electrodes**: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrodes for ECG, Electrodes for EEG, Electrodes of EMG. EOG, EGG.	**10**
2	**BIO POTENTIAL AMPLIFIERS**: Need for bio amplifier- single ended bio amplifier-right leg driven ECG amplifier, Transient protection, Common-Mode and Other Interference -Reduction Circuits, Amplifiers for other bio potential signals, Band Pass filtering, isolation amplifiers-transformer and optical isolation- isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.	**10**
3	**BIOMEDICAL RECORDERS:** Electrocardiograph-block diagram description, ECG leads, artefacts, Vector cardiograph, Phonocardiograph, Electroencephalograph, Electromyograph, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiratory rate.	**12**
4	**OXIMETERS:** Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter. **Cardiac Output Measurement:** Indicator-Dilution Method- Continuous infusion, Rapid injection. **Blood Flow Meters:** Electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters, Photoplethysmography.	**10**
5	**CARDIAC PACEMAKERS AND DEFIBRILLATORS:** Need for cardiac pacemaker, External pacemaker, Implantable pacemaker, Types of Implantable	**10**

	pacemakers, Programmable pacemaker, Rate-responsive pacemakers. DC defibrillator, Implantable defibrillators. **PATIENT SAFETY:** Physiological effects of electrical currents on humans. Electric shock hazards, Leakage currents, macro shock, micro shock hazards and preventions, Electrical safety analyzer & precautions. Electrical safety codes standards.	

Note: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: By the completion of this course the student will be able to

CO1: Understand the generation of bio electric signals, identify the basic components of a measuring system
CO2: Understand the working of electrical amplifiers & filters for acquiring and measuring the physiological parameters
CO3: Record ECG according to 5/12 lead standard system
CO4: Understand the principle of measurement of blood pressure, blood flow , body temperature and pulse rate
CO5: Understand the working and also the application of cardiac pacemakers & defibrillators
CO6: Understand the patient safety standards

COs	Mapping with POs
CO1	PO1,PO2,PO3
CO2	PO1,PO3,PO4,PO6
CO3	PO1,PO3, PO4,PO6
CO4	PO3, PO4,PO6,PO7,
CO5	PO3, PO4,PO6,PO7,
CO6	PO8

TEXT BOOK:

1. **Handbook of Biomedical Instrumentation**, R.S.Khandpur, Tata McGraw Hill, 2nd Edition, 2003.
2. **Medical Instrumentation Application and Design, John G WebsterJohn Wiley and Sons, New York 2004**

REFERENCE BOOK:

1. **BIOMEDICAL TRANSDUCERS AND INSTRUMENTS**, Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. **Biomedical Instrumentation and Measurement**, Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, Prentice-Hall India Pvt. Ltd.
3. **Introduction to Biomedical Equipment Technology**, Joseph J Carr and John M Brown Pearson Education ,4th Edition , 2001 .
4. **The Biomedical Engineering Handbook**, Ed.Joseph Bronzino, Boca Raton: CRC Press LLC, 2000.

Sub Title: OOPs AND DATA STRUCTURE LAB		
Sub Code: 18MLL46	**No of Credits :1= 0:0:1(L-T-P)**	**No of lecture hours/week : 2**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To enable the students to write programs

1. To access/store different data
2. Making use of functions
3. To Sort/Search an element
4. For Dynamic memory allocation

UNIT NO	Contents: Write Programs for the following problems
1	Read and display student information by structure variable initialization.
2	Find the largest number.
3	Swap two numbers using functions(pass by value, pass by reference)
4	Store student details using array of objects.
5	Sort an array of elements in ascending/descending order.
6	Search a given element in an array.(Binary search)
7	Display the memory address of an object.
8	Perform the stack operation using static/dynamic memory allocation.
9	Perform the queue operation using static/dynamic memory allocation.
10	Perform the circular queue operation.
11	Illustrate single, double linked list.
12	Implement binary tree.

COURSE OUT COMES: The student will be able to

CO1**:** Write Programs using structures ; C02: Write Programs using functions
CO3: Write Program implementing data Structure

COs	Mapping with POs
CO1, CO2, CO3	PO3,PO4,PO5,PO8,PO9,PO10, PO12

Sub Title : MICROCONTROLLER LAB		
Sub Code: 18MLL47	**No of Credits:1=0:0:1(L-T-P)**	**No of lecture hours/week : 2**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To make the student proficient in

1. The complete instruction set.
2. Writing and executing Standard programming examples like sorting, code conversion etc.
3. Writing and execution of certain interfacing programs.
4. Working with a programming tool such as Keil.

UNIT No	Syllabus Content
	I. PROGRAMMING for 8051
1.	Familiarisation of Addressing modes
2.	Write programs for all kinds of data manipulations.
3.	Write programs for implementing ALU for given specifications.
4.	Write programs to count different events.
5.	Implementation of subroutines
6.	Write programs to implement standard code convertors.
7.	Programs to generate delay, Programs using serial port and on-Chip timer / counter.
	II. INTERFACING:
8	Alphanumeric LCD panel, LED and Hex keypad input interface
9	Generate different waveforms Sine, Square, Triangular, Ramp etc. using DAC interface
10	Stepper and DC motor control interface

COURSE OUTCOMES: On the completion of the course the students will be able to

CO1: Write program based on 8051.

CO2: Interface typical external hardware to 8051

CO3: Handle versatile tool: Keil IDE.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5
CO2	PO2,PO3,PO4,PO5,PO9,PO10
CO3	PO3,PO6,PO11,PO12

Sub Title: LINEAR INTEGRATED CIRCUITS LAB		
Sub Code: 18MLL48	**No of Credits:1=0:0:1(L-T-P)**	**No of lecture hours/week :02**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: The student will learn

1. To rig up ,test and verify the BASIC linear integrated circuits .
2. The application circuits such as filters, waveform generators, multivibrators.

Unit No	Syllabus Content
1.	Study of Opamp characteristics.
2.	Design of Inverting and non-inverting amplifier.
3.	Design of various application circuits of Opamp: i)Adder and Subtractor ii)Integrator iii)Differentiator.
4.	Design Waveform generator using Schmitt trigger.
5.	Design of active first order filter: Low pass, High Pass, Band pass, Band elimination.
6.	Design of active second order filter: Low pass, High Pass, Band pass, Band elimination
7.	Design of multivibrator using 555 timer.: i) Astable ii) Bistable
8	Building of PAM, PWM and PPM
9	Experiments on TI board
Open end experiment based on Telemedicine concepts.	

COURSE OUTCOME: The students will be able to

CO1: Design & Testing of linear circuits using opamp IC 741
CO2: Design & test Digital Communication Circuits Using 555
CO3: Build & test applications of 555 Timer IC
CO4: Realise different modules using Industry standard TI Board and develop application circuits

COs	Mapping with Pos
CO1	PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12
CO2	PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12
CO3	PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12
CO4	PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12

Sub Title: DIGITAL IMAGE PROCESSING		
Sub Code:18ML51	**No. of Credits : 3=3: 0: 0(L-T-P)**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVE: To enable the students to study

1. To discuss the fundamental concepts of digital image processing
2. To discuss image enhancement technique in spatial and frequency domain.
3. To discuss image segmentation and restoration technique in spatial and frequency domain

UNIT No	Syllabus Content	No of Hours
1	**DIGITAL IMAGE FUNDAMENTALS** Digital image representation, fundamental steps in digital image processing, Simple image model, basic relationships between pixels: neighborhood of a pixel, connectivity. Color models and transformations, pseudo color image processing,	8
2	**IMAGE ENHANCEMENT** Basic gray level transformations, histogram, histogram equalization, basics of spatial filtering, smoothing and sharpening spatial filters, edge detection method. Introduction to the frequency domain, smoothing and sharpening frequenc domain filters, homomorphic filtering.	8
3	**IMAGE SEGMENTATION** Detection of discontinuities, edge linking & boundary detection, thresholding, region based segmentation, morphological watersheds.	8
4	**IMAGE RESTORATION** Degradation model, Noise models, restoration in the presence of noise only (Spatial and frequency domain filters), Inverse filtering, LMS filtering, Wiener filter.	8
5	**IMAGE COMPRESSION** Fundamentals, image compression models, error-free compression, lossy and lossless predictive coding, wavelet coding, JPEG 2000 coding,	7

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Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: The students will be able to

CO1: Understand the basic image processing concepts such as relationship between pixels and color models
CO2: Implement image enhancement techniques in spatial & frequency domain
CO3: Understand and apply image segmentation techniques to any given image
CO4: Understand various degradation models and apply the image restoration techniques
CO5: Perform image compression using lossy and lossless techniques

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3
CO3	PO1,PO2,PO3,PO4,PO5,PO7,PO11,PO12
CO4	PO1,PO2,PO3,PO4,PO5,PO7,PO11,PO12
CO5	PO1,PO2,PO3,PO4,PO5,PO7,PO11,PO12

Text Books:

1. **Digital Image Processing** , R C Gonzalez & R E Woods, Pearson Education, 3 edition.
2. **Digital Image Processing and Computer Vision** , Milan Sonka, Cengage learning, First edition.

Reference Books:

1. **Digital Image Processing** , S.Jayaraman, S.Esakkirajan, T.Veerakumar, Tata Mcgraw Hill, 2009.
2. **Fundamentals of Digital Image processing** , A K Jain, PHI / Pearson Education, 1989.
3. **Digital Image Processing** , Sid Ahmed, McGraw Hill.

Sub Title: MEDICAL IMAGING SYSTEMS		
Sub Code: 18ML52	**No of Credits:3 =3:0:0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES:

1. To understand x-ray generation and biological effects.
2. To study different x-ray diagnostic methods.
3. To study CT imaging concepts, fundamental of Magnetic resonance imaging..
4. To study Generation and detection of ultrasound and its techniques.
5. To study the principles of Radionuclide imaging.

UNIT No	Syllabus Content	No of Hours
1	**X-RAY IMAGING:** Generation and Detection of X-rays – X-ray generation, X-ray generators, Filters, Beam restrictors and grids, Intensifying screens, fluorescent screens, and image intensifiers, X-ray detectors, X-ray image characteristics – Spatial resolution, Image noise, Image contrast, Receiver operating curve (ROC), Biological effects of ionizing radiation.	**7**
2	**X-RAY DIAGNOSTIC METHODS:** Conventional X-ray radiography, Fluoroscopy, Angiography, Mammography and Xeroradiography, Image subtraction. **COMPUTED TOMOGRAPHY:** Conventional tomography, Computed tomography – Radon Transform (Projections) and Fourier Slice theorem, Algorithms for image reconstruction: parallel and Fan beam data, Spiral CT. Recent developments – Digital radiography.	**8**
3	**ULTRASOUND IMAGING:** Generation and detection of Ultrasound-Piezoelectric effect, Ultrasonic transducers, **ULTRASONIC DIAGNOSTIC METHODS :**Pulse echo systems-Amplitude mode (A-mode), Brightness mode (B-mode), Motion mode (M-mode), Constant depth mode (C-mode), Doppler methods, Duplex imaging, Tissue characterization, Colour Doppler flow imaging, Image characteristics – Ultrasonic texture or speckle, Speckle reduction, Compensation of phase aberration, Biological effects of ultrasound.	**8**

4	**RADIONUCLIDE IMAGING:** Generation & Detection of Nuclear Emission – Radionuclide generators, nuclear radiation detectors, Collimators, Radionuclide imaging systems- Gamma Camera, SPECT, PET. **BASICS OF MAGNETIC RESONANCE IMAGING:** fundamentals of nuclear magnetic resonance- 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, Pulse sequences.	**8**
5	**MRI SYSTEM & IMAGING METHODS : M**agnetic field gradients, NMR Coil/Probe, Transmitter, Receiver, Data acquisition. Imaging Methods- Introduction, slice selection, frequency encoding, phase encoding, Spin-Echo imaging- Characteristics of MRI images- spatial resolution, image contrast. Functional MRI.DICOM Standards **Mandatory** assignments/seminars on latest developments in each of the modalities.	**8**

Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3,4 and 5

COURSE OUTCOMES: On the completion of the course the students will be able to

CO1: Understand the different imaging modalities such as x-ray, CT, Ultrasound & MRI

CO2: Understand the reconstruction of images from above imaging modalities using different transforms.

CO3: Understand the properties of radio nuclides and its applications

CO4: Understand the medical image communication standard.

CO5: Explore the latest trends & happenings in the subject

COs	Mapping with POs
CO1	PO1,PO6,PO7, PO12
CO2	PO1,PO6,PO12
CO3	PO5,PO12
CO4	PO6,PO8,PO12
CO5	PO10,PO11, PO12

.

TEXT BOOKS:

1. **Principles of Medical Imaging**, Kirk Shung, Michael B. Smith and Banjamin Tsui, Academic Press, 1992.
2. **Handbook of Biomedical Instrumentation**, R.S.Khandpur, Tata McGraw Hill, 2nd Edition, 2003.

REFERENCE BOOK:

1. **Fundamentals of Medical Imaging**, Paul Suetens, Cambridge University Press, 2002.

Sub Title : PHYSIOLOGICAL CONTROL SYSTEMS		
Sub Code:18ML53	**No of Credits : 4=3:2:0(L-T-P)**	**No of lecture hours/week : 3+2=5**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:65**

COURSE OBJECTIVES:

1. To discuss the mathematical modeling of systems.
2. To distinguish physiological and engineering control system.
3. Learn the time response of feedback control systems.
4. Learn the different methods of stability analysis (in time domain and frequency domain).

UNIT No	Syllabus Content	No of Lecture Hours	No of Tutorial Hours
1	**Modeling of Systems:** The control system, Mathematical models of physical systems – Introduction, Differential equations of physical systems – Mechanical systems, Friction, Translational systems (Mechanical accelerometer,	**7**	**5**
2	**Introduction To Physiological Control Systems:** Preliminary considerations, Historical Background, System analysis, Physiological systems-A simple example, Differences between engineering & physiological control systems. **Mathematical Modeling:** Generalized system properties, Models with combination of system elements, Linear models of physiological systems-respiratory and muscle mechanics.	**7**	**1**
3	**Time Response of feedback control systems**: Standard test signals, Unit step response of First and second order systems, Time response specifications, Time response specifications of second order systems, steady – state errors and error constants. **Static Analysis Of Physiological Systems:** regulation of cardiac output, regulation of glucose,	**8**	**5**

4	**Stability analysis:** Concepts of stability, Necessary conditions for Stability, Routh-stability criterion, Relative stability analysis; More on the Routh stability criterion. frequency response model of a circulatory control, frequency response of glucose-insulin regulation. stability analysis of pupillary light reflexes.	**9**	**7**
5	**Stability in the frequency domain:** Mathematical preliminaries, Nyquist Stability criterion, Assessment of relative stability using Nyquist criterion, **Frequency domain analysis:** Introduction, Correlation between time and frequency response, Bode plots, frequency response model of a circulatory control, frequency response of glucose-insulin regulation. **MATLAB Exercise (Practice only) :** **Verifying the parameters computed for numerical examples using MATLAB for Root locus, Bode Plot and Nyquist Plot**	**9**	**7**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5 and simulation experiments using MATLAB

COURSE OUTCOMES: The students will be able to

CO1: Understand and develop mathematical modeling of mechanical & electrical systems.
CO2: Mathematically model the physiological systems & relate it to the engineering control system
CO3: Understand and determine the time domain parameters of first and second order system.
CO4: Apply the different methods of stability analysis in time domain & frequency domain
CO5: Verify the systems using simulation tools such as MATLAB.

Cos	Mapping with Pos
CO1	PO1,PO3
CO2	PO1,PO3
CO3	PO3,PO4, PO6,
CO4	PO3,PO4, PO6,
CO5	PO5, PO12

TEXT BOOK :

1**. Control Systems Engineering**, J. Nagarath and M.Gopal, New Age International (P) Limited, Fourth edition ,2005.

2. **Physiological Control Systems – Analysis, Simulation & Estimation**, Michael C Khoo, Wiley IEEE press.

REFERENCE BOOKS:

1. **Modern Control Engineering ,** K. Ogata, Pearson Education Asia/ PHI, 4th Edition, 2002.
2. **Concepts of Control Systems,** P. S. Satyanarayana; Dynaram publishers, 2001.
3. **Control Systems Principles and Design,** M. Gopal, TMH, 1999.
4. **Feedback control system analysis and synthesis,** J. J. D'Azzo and C. H. Houpis, McGraw Hill, International student Edition.
5. **Biological Control System Analysis** by Milsum John, McGraw Hill
6. **Control Theory and Physiological Feedback Mechanism** by William Baltimore

Sub Title: EMBEDDED SYSTEMS & IOT APPLICATIONS		
Sub Code: 18ML551	**No of Credits : 3= 3:0: 0(L-T-P)**	**No of lecture hours/week :3**
Exam Duration : 3 hours	**CIE + Assignment + SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES :To make the student learn

1.The concepts of embedded programming in the context of 8051
2 .Design constraints of 8051 for embedded applications
3. Embedded C
4. TI Processor- MSP 430

Unit No	Syllabus Content	No of Hours
1	**Introduction to Embedded Systems** Embedded system, Choice of processor, programming language and operating system, Conclusions **Reading Switches:** Introduction, Basic techniques for reading from port pins, Example: Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, Dealing with switch bounce, Example: Reading switch inputs (basic code), Example: Counting goats, Conclusions**.**	**7**
2	**Adding Structure to the Code** Introduction, Object-oriented programming with C, The Project Header (MAIN.H), The Port Header (PORT.H), Examples	**8**
3	**MSP430G2553:** Block diagram and study. **MSP EXP 430 G2 Launch Pad –** components. **Examples-** LED control using a switch, serial communication	**8**
4	**Interfacing**: seven segment displays and Liquid Crystal displays with MSP430, Introduction to MSP 430 timer modules and its modes of operation, generating Pulse Width Modulation using Timer Capture	**8**
5	**Internet of Things** Embedded Systems-an overview, features. Networked Embedded System- types and overview, wireless communication standards-zigbee, Bluetooth & Wi-Fi. OSI & TCP/IP model in a nutshell. Introduction to the Internet and understand how internet works. Introduction to Smart Objects or Things. **IOT applications**	**8**

	IOT- understand what IOT is and discuss its application in health-care systems- Patient Monitoring & diagnostics, Home healthcare & Personal care & Fitness. Case Study: Wireless Patient Monitor system. Application Design: Design of IOT based pulse oximeter, block diagram, concepts of analog front end, signal process and Wi-Fi integration.	

Note 1: No questions on Review portions from Unit 1

Note 2: Assignment-1 from unit 1 and 2.

Asssignment-2 Reports based on Training on MSP 430 & IOT Applications

COURSE OUTCOMES: The student will be able to

CO1: Design and development of embedded system using microcontroller 8051

CO2: Apply the programming skills of embedded C for any microcontroller

CO3: Understand TI -MSP430 processor and develop coding using the launch pad

CO4: Design & Develop interfacing applications using MSP 430

CO5: Understand the fundamentals of IOT protocols & IOT applications

Cos	Mapping with Pos
CO1	PO3,PO4,
CO2	PO3,PO4,
CO3	PO3,PO4,PO5,PO12
CO4	PO5, PO12
CO5	PO3, PO4,PO5, PO12

TEXT BOOKS:

1. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008
2. TI- MSP430 Launch Pad Manual

REFERENCE BOOKS:

1. PICmicro MCU C-An introduction to programming, The Microchip PIC in CCS C - Nigel Gardner
2. Getting Started with Internet of Things- CunoPfister, 2011
3. Interconnecting Smart Objects with IP- J. P Vasseur, Adam Dunkels, 2010

Sub Title: CLINICAL ENGINEERING		
Sub Code: 18ML552	**No of Credits : 3= 3: 0: 0(L-T-P)**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES :To make the student

1. To understand the role of clinical engineer and importance of clinical engineering.
2. To learn the hospital managerial skills in all aspects.
3. The routine maintenance safety and other issues of medical devices.

Unit No	Syllabus Content	No. of Hours
1	Definition, role of clinical engineering within the hospital organization, major functions of a clinical engineering department, flowchart and model of a clinical engineering department, computerized maintenance and management system, clinical information systems, picture archiving and communication systems (PACS).	**08**
2	Duties and responsibilities, clinical engineer as consultant, clinical engineer as investigator and expert witness. patient safety and clinical engineers, accident investigation, electromagnetic interference, WMTS interference issues.	**08**
3	Technology evaluation, strategic technology planning, technology and alternatives, risks, hazards, and clinical efficacy, conceptual needs analysis.	**07**
4	Management engineering in health care, cost effectiveness and productivity, personnel management, medical technology assessment process, planning strategies.	**08**
5	Medical technology management practices, health care strategic planning utilizing technology assessment, medical device research and design, maintenance and repair of medical devices, medical device troubleshooting, safety standards and regulations.	**08**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 Quiz based on talks by clinical engineers

COURSE OUTCOMES: The student will be able to

CO1: Understand the role and functions of clinical engineer in health care management.
CO2:Understand the importance of clinical engineer in maintaining safety standards in a clinical environment
CO3: Apply management Principles in Health care
CO4: Prepare the framework for the maintenance & repair of medical devices
CO5: Understand the general approach for troubleshooting

COs	**Mapping with POs**
CO1	PO2,PO6,
CO2	PO6,PO7,PO8,
CO3	PO2,PO3,PO4,PO6,
CO4	PO2,PO3,PO4, PO12
CO5	PO2,PO3,PO4, PO12

Text Book:

1. Joseph Dyro B.S. Clinical Engineering Handbook, Elsevier Academic Press, 2004.

Reference Books:

1. Yadin David, Clinical Engineering, Principles and Applications in Engineering Series, CRC Press, 2003.
2. Michael Nowicki, The Financial Management of Hospitals and Healthcare Organizations, Blackwell Publishing Ltd, 2004.

Sub Title: BIOMEDICAL INSTRUMENTATION LAB		
Sub Code: 18MLL57	**No of Credits :1= 0: 0: 1(L-T-P)**	**No of lecture hours/week :02**
Exam Duration : 3 hours		**Exam Marks : 50**

COURSE OBJECTIVES: The student will understand

1.The transducer principle, type,measurement of physiological parameter
2.The bio signal measurement
3.Analytical instruments such as colorimeter, pH meter
4.Medical Instrumentation such as X- ray, Ultrasound, Recorders

UNIT	Syllabus Content
1	Plotting the characteristics & Determination of parameters of: a) Resistive strain gage (b) Photoelectric transducer (c) Temperature transducers: RTD / thermocouple / thermistor.
2	Determination of characteristics of: (a) Polarized electrode; (b) Non-polarized electrode (c) Multipoint electrode.
3	Design & Testing of: (a) DC amplifier (b) Isolation amplifier.
4	Design & Testing of: (a) Instrumentation amplifier; (b) Transducer bridge with amplifier.
5	Recording of ECG: (a) Determination of time & amplitude of QRS complex, (b) Calculation of Heart Rate, (c) Determination of Cardiac Vector.
6	Recording of EEG.
7	Measurement of Hearing threshold using Audiometer and plot its characteristics.
8	Measurement of pH of a given solution using pH meter.
9	Determination of solution concentration using Colorimeter/Spectrophotometer.
10	Measurement of Blood Pressure using Sphygmomanometer & Digital meter.
11	Study of (a) Ultrasound transducers & Ultrasonic blood flow meters, (b) X-ray

COURSE OUTCOMES: The student will be able to

CO1: Measure the parameters, temperature, PH, Blood pressure using the transducers
CO2: Design & test instrumentation amplifier for physiological parameters
CO3: Record EEG, ECG signal & measure hearing threshold using the recorders available in the lab
CO4: Understand the working concepts of ultrasound transducers
CO5: Document the observations & time management & to work in a team

COs	Mapping with Pos
CO1	PO6, PO12
CO2	PO6, PO12
CO3	PO5,PO6, PO12
CO4	PO6, PO12
CO5	PO9, PO10, PO11

Sub Title: DIGITAL SIGNAL PROCESSING LAB		
Sub Code: 18MLL58	**No of Credits:1= 0:0:1(L-T-P)**	**No of lecture hours/week :02**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To make the students

1. To compute linear ,circular convolution, and correlation
2. To implement and verify FFT algorithm
3. Implementing DSP concepts using LABVIEW.

UNIT No	Syllabus Content
	MATLAB
1	Generation of standard signals
2	Verification of the Sampling theorem.
3	Determine linear convolution, Circular convolution and Correlation of two given sequences. Verify the result using theoretical computations.
4	Determine the linear convolution and correlation of two given point sequences, using FFT algorithm.
5	Implementation of IIR filters & FIR filters
	LABVIEW
6	To perform arithmetic and logical operations.
7	To realize code converters, adders.
8	To illustrate the use of control and flow statements.
9	To create vi for array and matrix manipulation.
10	To display step, ramp, exponential, sine, cosine, square signal.
11	To perform linear convolution, correlation.
12	To compute the FFT of a signal.
	Open End Project

COURSE OUTCOMES: The students would have learnt

CO1: To Implement & verify the theoretical concepts of convolution, correlation and sampling theorem using the software tools MATLAB/ LABVIEW

CO2: To generate any given signal using MATLAB & LABVIEW

CO3: To design digital filters for a given specification using MATLAB & LABVIEW

CO4: Develop and demonstrate a simple application through Open end project

CO5: Document the observations & time management & to work in a team

Cos	**Mapping with Pos**
CO1	PO1,PO2,PO3,PO4,PO5,PO9,PO12
CO2	PO1,PO2,PO3,PO4,PO5,PO9,PO12
CO3	PO1,PO2,PO3,PO4,
CO4	PO10,PO11,PO12
CO5	PO10,PO11,PO12

Sub Title : BIO-MEDICAL DIGITAL SIGNAL & IMAGE PROCESSING LAB		
Sub Code: 18MLL59	**No. of Credits:1=0: 0:1(L-T-P)**	**No of lecture hours/week :02**
Exam Duration : 3	**Exam Marks : 50**	

COURSE OBJECTIVES:

To familiarize the student with the signal conditioning of Biomedical signals using FIR and IIR filters and to plot and observe the nature of these signals using MATLAB. And also familiarize the student with the basic concepts of image processing such as enhancement and segmentation using MATLAB.

UNIT No	Syllabus Content
	Biomedical Signal Processing using MATLAB
1	Analysis of ECG data: Original signal, Noise signal and filtered signal
2	Realization of IIR and FIR filters for ECG
3	PSD estimation for ECG, EEG, and EMG
4	R-R interval sequence interpretation
5	Analysis of Real time ECG signals acquired through Power Lab data acquisition system
	Image Processing using MATLAB
6	Basic operations on an image: Logical operations, Resizing, Rotation, Translation, Negative of an image
7	Plotting Histogram and histogram equalization
8	Image Segmentation: Threshold, multiple threshold
9	Implementation of spatial domain filters: LP, Median, HP
10	Implementation of edge detection using gradient filters.
11	Display of bit planes of an image
Open End Experiment	

COURSE OUTCOME: The student will be able

CO1: To implement digital filters using acquired signals

CO2: To Compute frequency spectrum of ECG & EEG signals

CO3: To Implement image enhancement techniques

CO4: To implement image segmentation techniques

CO5: Design and develop any biomedical signal & image processing application using MATLAB

CO6: To maintain the document and finish the work in stipulated time

Cos	**Mapping with Pos**
CO1	PO3,PO4,PO5,PO12
CO2	PO3,PO4,PO5,PO12
CO3	PO3,PO4,PO5,PO12
CO4	PO3,PO4,PO5,PO12
CO5	PO3,PO4,PO5,PO12
CO6	PO10, PO11,

Sub Title: BIOMEDICAL DIGITAL SIGNAL PROCESSING		
Sub Code: 18ML61	**No. of Credits : 3=3: 0: 0(L-T-**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES:

1. To learn the nature of various biomedical signals and its analysis.
2. To know about neurological signal generation.
3. To study sleep EEG types and their features.
4. To study adaptive filters and their applications in biomedical signal processing.
5. To gain knowledge about various artefacts and methods to eliminate it.
6. To study cardiological signal processing

UNIT No	Syllabus Content	No of Hours
1	**INTRODUCTION TO BIOMEDICAL SIGNALS:** The nature of biomedical signals, the action potential, objectives of biomedical signal analysis, Difficulties in biomedical signal analysis, computer aided diagnosis. Neurological signal processing: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics, EEG analysis. EMG signal characteristic and analysis	**7**
2	**SLEEP EEG:** Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, and Event history analysis for modeling sleep.	**8**
3	**ADAPTIVE FILTERS:** Principle of an adaptive filter, the steepest descent algorithm, adaptive noise canceller, cancellation of 60 Hz interference in electrocardiography, applications of adaptive filters. Canceling donor - heart interference in heart-transplant electrocardiography, Cancellation of ECG signal from the electrical activity of the chest muscles, canceling of maternal ECG in fetal ECG,	**8**
4	**SIGNAL AVERAGING:** Basics of signal averaging, a typical signal averager, signal averaging as a digital filter, Removal of artifacts by averaging. Filtering for removal of artifacts**:** Introduction, Random noise, structured noise and physiological interference, stationary versus non stationary process, high frequency noise in ECG, motion artifact in ECG, power line interference in ECG signals, Maternal interference in Fetal ECG, muscle contraction interference in VAG	**8**

5	**CARDIOLOGICAL SIGNAL PROCESSING:** Pre-processing. ECG QRS Detection techniques. Rhythm analysis. Arrhythmia detection Algorithms. Automated ECG Analysis. ECG Pattern Recognition. Heart rate variability analysis, ST–segment analyzer, portable, arrhythmia monitors.	**8**

Note 1 : Assignment-1 from unit 1 and 2.
Asssignment- Quiz & Report based on visit to one of the sleep EEG labs

COURSE OUTCOMES: The students would have learnt to

CO1: Analyze and interpret EEG & EMG
CO2: Acquire EEG & interpret the models of sleep EEG
CO3: Design and develop Adaptive filters.
CO4: Identify noise sources in ECG signal & apply filtering
CO5: Classify & detect abnormality in ECG signals.

COs	Mapping with POs
CO1	PO1,PO2,PO4
CO2	PO1,PO2,PO3,PO4, PO12
CO3	PO1,PO2,PO3,PO4
CO4	PO2,PO3,PO4
CO5	PO2,PO3,PO4

TEXT BOOKS:

1.Biomedical Digital Signal Processing,Willis J.Tompkins, PHI.
2.Biomedical Signal Processing- Principles and Techniques, Tata McGraw-Hill, D.C.Reddy, 2005.
3.Biomedical Signal Analysis, Rangaraj M. Rangayyan, IEEE Press, 2001.
4.Wavelet Transforms , Raghuveer M. Rao and Ajit S. Bopardikar, Pearson, 1998.

REFERENCE BOOKS:

1. **Biomedical Signal Processing ,** Akay M, Academic Press ,1994
2. **Biomedical Signal Processing ,** Cohen.A, Vol. I , CRC Press, 1986.

Sub Title: BIOMEDICAL EQUIPMENTS		
Sub Code: 18ML63	**No of Credits :3= 3: 0: 0(L-T-P)**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES:

1. To study spectrophotometer, clinical flame photometer.
2. To study different blood gas analyzers
3. To study different types of Audiometers
4. To understand the working principle of surgical diathermy.
5. To study haemodialysis and different ventilators

UNIT No	Syllabus Content	No of Hours
1	**CLINICAL LABORATORY INSTRUMENTS:** Medical diagnosis with clinical tests, spectrophotometry-components, clinical flame photometer, ion-selective electrode based analyzers.	**7**
2	**BLOOD GAS ANALYZERS:** Acid-base balance, blood pH measurement, measurement of blood pCO2, measurement of blood pO2, intra-arterial blood gas monitoring, complete blood gas analyzer. **BLOOD CELL COUNTERS**: Types of blood cells, Coulter counter, automatic recognition and differential counting of cells.	**8**
3	**AUDIOMETER AND HEARING AIDS:** Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech audiometer, audiometer system Bekesy, evoked response audiometer system, hearing aids-digital hearing aid, cochlear implants.	**8**
4	**INSTRUMENTS OF SURGERY:** Principles of surgical diathermy, surgical diathermy machine, automated electro-surgical systems, electrodes used with surgical diathermy, safety aspects in electro- surgical units, surgical diathermy analyzer. **PHYSIOTHERAPY AND ELECTROTHERAPY EQUIPMENTS:** High frequency ,heat therapy, short wave diathermy, microwave diathermy, ultrasound therapy unit, electro diagnostic therapeutic apparatus, pain relief through electrical stimulation ,bladder and cerebral stimulators.	**8**

5	**HAEMODIALYSIS MACHINE:** Function of kidney, artificial kidney, dialyzer, membranes for hemodialysis, portable kidney machine. **VENTILATORS:** Mechanics of respiration, artificial ventilation, ventilators, types of ventilators, ventilator terms, classification of ventilators, pressure volume flow diagrams, modern ventilators, high frequency ventilators, humidifiers, nebulizers and aspirators	**8**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3,4 and 5

COURSE OUTCOMES: On the completion of the course the students will be able to

CO1: Understand the working & application of clinical lab equipments such as blood gas analyzers, blood cell counters and surgical equipments.
CO2: Understand the human hearing mechanism, identify the defects in hearing mechanism
CO3: Understand the functioning of breathing mechanism, ventilators
CO4: Understand the functioning of kidney and working of artificial kidney
CO5: Design & develop artificial organs such as ventilators & kidney and hearing aids

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO1, PO2, PO3, PO4
CO3	PO1, PO2, PO3, PO4, PO12
CO4	PO1, PO2, PO3, PO4, PO12
CO5	PO1, PO2, PO3, PO4, PO12

TEXT BOOK:

1. **Handbook of Biomedical Instrumentation** – by R.S.Khandpur, 2nd Edition, Tata McGraw Hill, 2003

REFERENCE BOOK:

1. Biomedical Instrumentation and Measurement – by Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, Prentice-Hall India Pvt. Ltd.

Sub Title: MEDICAL INFORMATICS		
Sub Code: 18ML652	**No of Credits :3= 3: 0: 0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To make the student learn

1. Identify the fundamentals medical informatics
2. Develop practical health care applications using suitable database management system
3. Utilise knowledge, skills and concepts on health information technology
4. Apply principles of information security, ethics and policy information
5. Assesses existing information exchange system standards
6. Analyse and develop project, manage strategies health information technology

UNIT No	Syllabus Content	No of Hours
1	**Medical Informatics:** Introduction - Structure of Medical Informatics – Internet and Medicine -Security issues, Computer based medical information retrieval, Functional capabilities of a computerized HIS, e-health services, **Cloud computing:** Introduction, Cloud Computing Architecture and Management, Security in Cloud Computing, Cloud computing in Medical Applications.	**08**
2	**Computerised Patient Record** : Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.	**07**
3	**Computers in Clinical Laboratory Medical Imaging**: Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, **Computers in Medical Imaging** Computer assisted medical imaging-nuclear medicine, ultrasound imaging ultrasonography-computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance	**08**

4	**Computer Assisted Medical Decision-Making:** Neuro computers and Artificial Neural Networks application, Expert system – General model of CMD, Computer –assisted decision support system-production rule system, cognitive model, semester networks , decisions analysis in clinical medicine-computers in the care of critically patients-computer assisted surgery-designing	**08**
5	**Recent Trends in Medical Informatics**: Virtual reality applications in medicine, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, computer aids for the handicapped, computer assisted instrumentation in Medical Informatics - Computer assisted patient education and health - Medical education and health care information	**08**

Note 1: Assignment-1 from unit 1 and 2.

Asssignment-2 Based on industry expert talk on cloud computing, recent trends in medical informatics

COURSE OUTCOMES: On the completion of the course the students will be able to

CO1: Understand the concepts of medical information systems.

CO2: Develop Computerized Patient Record (CPR)System

CO3: Application of computers for data storage in clinical laboratory, medical imaging, education & decision making.

CO4: Develop assistive aids for physically challenged

CO5: Understand the concepts of tele-surgery

COs	**Mapping with Pos**
CO1	PO1,PO6,PO7,PO8
CO2	PO2,PO3,PO5
CO3	PO1,PO2,PO7,PO12
CO4	PO10, PO12
CO5	PO1,PO2,PO7,PO12

TEXT BOOKS:

1. **Medical Informatics**, Mohan Bansal, T M H, 2003.
2. **Computers in Medicine Progress in Medical Informatics**, R. D. Lele, TMH, 2005.

References:

1.**Introduction to Bioinformatics** , T. K. Attwood & D. J. Parry-Smith, Pearson Education Low Price Edition, 2004.

2. **Essentials of CLOUD COMPUTING**, K. Chandrasekaran, Taylor & Francis Group, CRC Press is an imprint of Taylor & Francis Group, an Informa business, 2015.

3. **Medical Informatics**, Dinesh Bhatia, PHI Leaning, India, 2015

Sub Title : Operation & Testing of Medical Devices LAB		
Sub Code: 18MLL67	**No. of Credits:1=0: 0:1(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3	**Exam Marks : 50**	

Course Objectives:To enable the students to

- understand the usage of state of art equipments in the hospital
- To make the students learn troubleshooting
- Operation and Testing of Medical Devices Lab

1	Hospital visit for a minimum period 10 days to be carried out either in the beginning of the sixth semester or phased out during the semester. The report submitted should include the detailed study of equipments with respect to specification, cost & make apart from the operation and testing procedure in the following labs in the hospital: • Biochemistry lab, Pathology Lab • Opthalmology lab • Radiology lab • Dialysis lab • OT • ICU, NICU • Physiotherapy • Ventilator • Safety standards & medical ethics
2	Need for Calibration of Medical Devices. Calibrating Devices
3	Troubleshooting of X Ray machine, ECG machine
4	DC power supply, different types grounding & shielding mechanisms
5	Hands-on Workshop on Calibration & Testing of Medical Devices

Course Outcome:
On completion of the course the student will be able to
CO1: Understand the Practical use of equipments & its operating Procedures
CO2: Apply the latest trend in the technology and the state of the art technology
CO3: Develop an understanding of the global companies in the market their device specification & idea of cost of the products
CO4: Understand the safety standards and medical ethics
CO5: Understand and perform the procedures of trouble shooting & Calibration
CO6: Make effective presentation & documentation

Cos	Mapping with Pos
CO1	PO1,PO2,PO3
CO2	PO3, PO4, PO12
CO3	PO11, PO12
CO4	PO8, PO12

CO5	PO9,PO10, PO12
CO6	PO9,PO10, PO11, PO12

Sub Title: MINIPROJECT		
Sub Code: 18MLMP68	**No of Credits : 00:00:2**	**No of lecture hours/week : 2**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To enable the students to come up with their own innovative ideas and realize it.

1. PCB soldering and Testing: Learning any of the Open source PCB software
2. Practice the skills of Soldering and Testing simple circuits
3. Develop a working hardware model for any of the biomedical applications

Note:

- Mini project should be carried by a group of 3 or 4 and not more than 4 in a group.
- Evaluation should be based on the demonstration, viva-voce and final report.

COURSE OUTCOME: The students would have learnt

CO1: To build working prototype models based on their innovative ideas in the field biomedical applications
CO2: PCB designing software tools
CO3: The skills of soldering & testing
CO4: The ability to work in a group
CO5: To prepare documentation and convey their ideas through presentation

COs	Mapping with POs
CO1	PO1,PO2,PO3, PO5, PO11, PO12
CO2	PO5, PO12
CO3	PO2,PO3, PO12
CO4	PO9,PO10
CO5	PO9,PO10

NEURAL NETWORK & MACHINE LEARNING		
Sub Code: 18ML71	**No. of Credits : 3=3: 0: 0(L-T-**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: The enable the students to learn

1. The concepts of biological neuron and analogy to the artificial neuron model
2. Different neural network architecture
3. Various learning paradigms and comparisons

UNIT No	Syllabus Content	No of Hours
1	**ARTIFICIAL NEURAL NETWORK:** introduction to artificial neural network, model of a neuron, Types of activation function, neural networks viewed as directed graphs, architectural graph of a neuron with feedback, Network Architectures, Artificial intelligence and Neural Networks. **SINGLE LAYER PERCEPTION:** Introduction, Adaptive filtering problem, Unconstrained optimization techniques, Newton's method, Gauss-Newton method, Linear least square filter, Least mean square algorithm, Learning curves, Learning Rate, Annealing techniques, Perceptron, convergence theorem	7
2	MULTILAYER PERCETRON: Introduction, Some Preliminaries, Back propagation algorithm, XOR Problem, Heuristics for making the back propagation algorithm perform better, Feature detection, Hessian matrix, generalization, Cross validation, Virtues and limitations of back propagation algorithm	8
3	**Random Variables-**Binomial distribution, Poission distribution Continuous Random variables uniform density, exponential density, normal density **Introduction to pattern Recognition** **Statistical Decision Making:** Introduction, Bayes' theorem, multiple features, conditionally independent features, Decision boundaries: Two Dimensional decision boundaries **Clustering:** Introduction, Hierarchical clustering-agglomerative, single linkage, average linkage, ward's method, Partitional clustering-Forgy's,	8

4	Introduction to Deep Learning, Bayesian Learning, Decision Surfaces Linear Classifiers, Linear Machines with Hinge Loss Unsupervised Learning with Deep Network, Autoencoders Convolutional Neural Network, Building blocks of CNN, Transfer Learning Revisiting Gradient Descent, Momentum Optimizer, Effective training in Deep Net- early stopping, Dropout, Batch	**8**
5	Recent Trends in Deep Learning Architectures, Residual Network, Skip Connection Network, Fully Connected CNN etc. Classical Supervised Tasks with Deep Learning, Image Denoising, Semantic Segmentation, Object Detection etc. LSTM Networks Generative Modeling with DL, Variational Autoencoder, Generative Adversarial Network Revisiting Gradient Descent, Momentum Optimizer.	**8**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Understand the concepts neural network and different learning algorithms.
CO2: Apply perceptron and multiple perceptron for classification.
CO3: Apply the probabilistic models for data classification.
CO4: Understand the concepts of CNN
CO5: Apply Deep Learning for classification through case studies

CO6: Apply software tools like MATLAB/Python

Cos	Mapping with Pos
CO1	PO1,PO2,PO4, PO6, PO7,PO12
CO2	PO2,PO3,PO4,PO6, PO7, PO12
CO3	PO2,PO3,PO4, PO6, PO7, PO12
CO4	PO2,PO3,PO4, PO6, PO7, PO12
CO5	PO2,PO3,PO4,PO6, PO7, PO12

TEXT BOOKS:

1. **An Introduction To Neural Networks,** James A. Anderson, PHI, 2nd edition ,1995.
2. **Neural Networks**, Simon Haykin Pearson Education/PHI, 2001.
3. **Neural Networks** , Satish Kumar, Tata Mcgraw-hill 2009
4. **Pattern Recognition & Image Analysis**, Earl Gose, Richard Johnsonbaugh Steve Jost, Prentice Hall of India.

REFERENCE BOOKS:

1.Deep Learning- Ian Good felllow, Yoshua Benjio, Aaron Courville, The MIT Press
2.Pattern Classification- Richard O. Duda, Peter E. Hart, David G. Stork, John Wiley & Sons Inc.

Sub Title: Medical Devices & Regulations		
Sub Code: 18ML72	**No. of Credits : 3=3: 0: 0(L-T-**	**No of lecture hours/week**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to study

1. Device types, Regulations and Standards and approval process of Medical Devices
2. Knowledge of FDA terminologies
3. Validation process for medical device hardware and software

Unit No.	Syllabus Contents	No of Hours
1	**Medical Device**: Definition, product definition process, overview of quality function deployment(QFD), QFD process, business proposal. **Reliability**: Concept of failure, various methods of CAPA. **Safety and Risk Management**: Personnel safety and hygiene, medical device safety and risk management, effectiveness/performance of medical devices, Phases in the life span of a medical device, risk management processes, shared responsibility for medical device safety and performance.	**7**
2	**The Food and Drug Administration:** Device classification, 510 (k) Process, Declaration of conformance, PMA application, Investigational Device Exemptions (IDEs), Good Laboratory Practices (GLPs), Good Manufacturing Practices (GMPs), Human Factors, Design Control. ***The European Union:*** European Directives, Conformity Assessment and Testing, European Organization for Testing and Certification, Benefits of the GHTF, Final documents from the GHTF, Global Medical Device Nomenclature (GMDN)	**8**
3	**Standards and Regulations Background** ***Standards:*** Voluntary and mandatory standards, Standards development process, Conformity assessment with standards, National and international standards systems, Identification of standards, Current trends in the use of standards in medical device regulations. The ISO 9000 Series of Standards, ISO 14000 Series of Standards. **The Medical Devices Directives:** Medical Devices Directives process, Choosing the appropriate directive, Essential requirements, Classification of the device based on conformity, Medical Devices Directives, Active Implantable Medical Devices Directives, *In-vitro* Diagnostic Medical Devices Directives. NABH, NABL, JCI, AERB , WHO guidelines on medical devices.	**8**

4	**Software and Quality System Regulation** Software as a Technology, Domestic Software Regulations, Domestic Software Standards, International Software Regulations, International Software Standards, Design controls, Document controls, Purchasing controls, Identification and traceability, Production and process controls, Acceptance activities, Non-conforming product, corrective and preventive action.	**8**
5	**Medical Device Testing** The basis and types of testing, Parsing test requirements, Test protocol, Test methodology, Purpose of the test, Failure definition, Determining sample size and test length, Types of testing. **Validation:** Hardware verification and validation, Software verification and validation,	**8**

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Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Define the medical device, its processes encompassing safety and risk management.
CO2: Identify the objectives and functions of FDA and EU.
CO3: Analyze various medical device standards and regulations
CO4: Document the procedure in software quality system regulations
CO5: Implement test protocol for medical device testing.

COs	Mapping with POs
CO1	PO1,PO4,PO6
CO2	PO1,PO6,PO7,PO8
CO3	PO1,PO5,PO6,PO7,PO8
CO4	PO1,PO5,PO12
CO5	PO1,PO2,PO11,PO12

TEXT BOOKS

1. **Reliable Design of Medical Devices**, Second Edition by Richard Fries, CRC Press, 2006.
2. **Medical Device Quality Assurance and Regulatory Compliance** , Richard C Fries, CRC Press, 1998.

REFERENCE BOOKS

1. **Medical device regulations: global overview and guiding principles** , Michael Cheng, World Health Organization.
2. **Product Safety in the European Union** , Gabor Czitan, Attila Gutassy, Ralf Wilde, TUV Rheinland Academia, 2008.

Sub Title : BIO MECHANICS		
Sub Code: 18ML73	**No of Credits :3= 3: 0: 0(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**CIE+Assignment+SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: Understand the mechanical aspects of human motion:

1. Quantitative and qualitative analysis of human motion and performance.
2. Use physical laws of motion to solve problems of human motion.
3. Understand the relationship between mechanical properties and anatomical functions.
4. Understand how biomechanical principles can be applied to examine human activities such as sport and orthopaedic rehabilitation.

UNIT No	Syllabus Content	No of Hours
1	**BIO-FLUID MECHANICS:** Newton's laws, stress, strain, elasticity, Hook's-law, viscosity, Newtonian Fluid, Non-Newtonian fluid, viscoelastic fluids. Vascular tree. Relationship between diameters, velocity and pressure of blood flow, Resistance against flow	08
2	**VISCOELASTIC FLUID:** Viscoelasticity, Viscoelastic Models: Maxwell, Voigt and Kelvin Models Response to harmonic variation. Use of viscoelastic models.	08
3	**RESPIRATORY MECHANICS:** Alveoli mechanics, Interaction of blood and lung P-V curve of lung. Breathing mechanism. Airway resistance. Physics of lung diseases	08
4	**ORTHOPEDIC MECHANICS:** Mechanical properties of cartilage. Diffusion properties of articular, cartilage, Mechanical properties of bone. Kinetics and Kinematics of joints, Lubrication of joints. Fundamental concepts of Gait analysis.	08
5	Measuring principles of Cutometer, Durometer. Electrodynamometer, Microindentometer & Ballistometer.	07

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On the completion of the course the students will be able to

CO1: Understand the concepts of bio-fluids.
CO2: Understand the various viscoelastic models.
CO3: Understand the concepts of respiratory mechanics
CO4: Understand the concept of orthopaedic mechanics.
CO5: Understand the principles of various biomechanic measuring equipments.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO2,PO3,PO4
CO3	PO1,PO4, PO6, PO7
CO4	PO1,PO4,PO7
CO5	PO1,PO4,PO7

TEXT BOOKS:

1. **Biomechanics, Mechanical Properties of Living Tissues,** Y.C Fung,Springer Verlag, Edition2, 1993.
2. **Introduction to Biomechanics of Joints & Joint Replacement Mechanical Engg,** D.Dowson, V Wright publication, 1987.
3. **The Biomedical Hand Book**,Joseph.D.Bronzino ,CRC Press, 2nd Edition,2000.

Sub Title: REHABILITATION ENGINEERING		
Sub Code: 18ML742	**No. of Credits : 3=3: 0: 0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+ Assignment +SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to Study

1. Concept of Rehabilitation, Diagnosis of disability.
2. Rehabilitation team role of physiatrist.
3. Therapeutic exercise technique.
4. Principle in Management of communication.
5. Orthotic devices in Rehabilitation Engg. and to know about level of amputation.
6. Prosthetic device and mobility aids.

UNIT No	Syllabus Content	No of Hours
1	**INTRODUCTION TO REHABILITATION & REHABILITATION TEAM:** What is Rehabilitation, Epidemiology of Rehabilitation, Health, Levels of Prevention, Preventive Rehabilitation, Diagnosis of Disability, Functional Diagnosis, Importance of Physiatry in Functional diagnosis, Impairment disability handicap, Primary & secondary Disabilities, Effects of prolonged inactivity & Bed rest on body system. REHABILITATION TEAM**:** Classification of members, The Role of Physiatrist, Occupational therapist, Physical therapist, Recreation therapist, Prosthetist - Orthotist, Speech pathologist, Rehabilitation nurse, Social worker, Corrective therapist, Psychologist, Music therapist, Dance therapist & Biomedical engineer.	**12**
2	**THERAPEUTIC EXERCISE TECHNIQUE :** Co-ordination exercises, Frenkels exercises, Gait analyses-Pathological Gaits, Gait Training, Relaxation exercises-Methods for training Relaxation, Strengthening exercises-Strength training, Types of Contraction, Mobilisation exercises, Endurance exercises.	**7**
3	**PRINCIPLES IN MANAGEMENT OF COMMUNICATION:** Impairment-introduction to communication, Aphasia, Types of aphasia, Treatment of aphasic patient, Augmentative communication-general form of	**7**

	communication, types of visual aids, Hearing aids, Types of conventional hearing aid, Writing aids.	
4	**ORTHOTIC DEVICES IN REHABILITATION ENGINEERING:** General orthotics, Classification of orthotics-functional & regional, General principles of Orthosis, Biomechanics of orthoses, merits & demerits of orthotics, Material design consideration in orthotics, Calipers-FO, AFO, KAFO, HKAFO. Spinal Orthosis, Cervical, Head cervical thoracic orthosis, Thoraco lumbar sacral orthosis, Lumbo sacro orthosis, Splints-its functions & types. **AMPUTATION:** Levels of Amputation – Surgical process, Expected Outcomes, Post operative dressings – Rigid dressings, Semi rigid dressings, Soft dressings, Examination- Range of Motion, Muscle Strength, Status of Residual Limb, Status of the un involved limb, Functional status, emotional status.	**13**
5	**PROSTHETIC DEVICES:** Introduction, Partial Foot Prostheses- Foot-ankle assembly, Trans femoral Prostheses – Knee unit, Axis system, Friction Mechanisms, Extension aid, Stabilizers, Socket. Disarticulation Prostheses-Knee Disarticulation Prostheses, Hip Disarticulation Prostheses **MOBILITY AIDS:** Walking frames, Parallel bars, Rollators, Quadripods, Tripods & walking sticks, Crutches, Wheel chairs. Post cardiac operation rehab	**13**

Note1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3,4 and 5

COURSE OUTCOMES: The student will be able to

CO1: Understand the concept of rehabilitation and the role of rehabilitation team.
CO2: Implement and suggest therapeutic exercise techniques.
CO3: Understand aphasia and suggest different visual aids,hearing aids and writing aids.
CO4: Design and develop orthotic and prosthetic devices.
CO5: Differentiate between the different mobility aids.

COs	**Mapping with POs**
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3,PO4,PO7,PO8,PO12
CO3	PO1,PO2,PO3,PO4,PO7,PO8,PO12

TEXT BOOKS:

1. **Rehabilitation Medicine,** Dr. S. Sunder, Jaypee Medical Publications, New Delhi.

REFERENCE

1. **Physical Rehabilitation**, Susan B O'Sullivan, Thomas J Schmitz. 5th edition

Sub Title: BIOMATERIALS & ARTIFICIAL ORGANS		
Sub Code:18ML751	**No. of Credits:3=3:0:0(L-T-P)**	**No of lecture hours/week :03**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To enable the students to study

1. To know about various synthetic biomaterials.
2. To know about composite biodegradable polymeric and tissue derived material.
3. To understand the various artificial organs such as artificial heart, artificial kidney artificial lung.

UNIT No	Syllabus Content	No of Hours
1	**BIOMATERIALS:** Introduction to biomaterials, uses of biomaterials, biomaterials in organs & body systems, materials for use in the body, performance of biomaterials. **METALLIC BIOMATERIALS:** Introduction, Stainless steel, Cobalt-Chromium alloy, Titanium alloys, Titanium-Nickel alloys, Dental metals, Corrosion of metallic implants, Manufacturing of implants. **CERAMIC BIOMATERIALS:** Introduction, nonabsorbable /relatively bioinert bioceramics, biodegradable/resorbable ceramics, bioreactive ceramics, deterioration of ceramics, bioceramic-manufacturing techniques. **POLYMERIC BIOMATERIALS:**	**8**
2	**COMPOSITE BIOMATERIALS:** Structure, bounds on properties, anisotropy of composites, particulate composites, fibrous composites, porous materials, biocompatibility. **BIODEGRADABLE POLYMERIC BIOMATERIALS:** Introduction, Glycolide based biodegradable homopolymers polyesters, non-glycolide linear aliphatic polyesters, aliphatic and aromatic polycarbonates, and biodegradation properties of synthetic biodegradable polymers. **TISSUE DERIVED BIOMATERIALS:** Structure and properties of collagen and collagen-rich tissues, biotechnology of collagen, design of resorbable collagen-based medical implant. 3D Printing	**8**
3	**ARTIFICIAL ORGANS INTRODUCTION:** Substitutive medicine, outlook for organ replacement, design consideration, evaluation process.	**8**

	ARTIFICIAL HEART AND CIRCULATORY ASSIST DEVICES: Engineering design, Engg design of artificial heart and circulatory assist devices, blood interfacing implants – introduction, total artificial hearts & ventricular assist devices, vascular prostheses, Non-blood interfacing implants for soft tissues- sutures and allied augmentation devices, percutaneous and skin implants, maxillofacial implants, eye and ear implants. Cardiac Valve Prostheses: Mechanical valves, tissue valves, current types of prostheses, tissue versus mechanical, engineering concerns and hemodynamic assessment of prosthetic heart valves, implications for thrombus deposition, durability, current trends in valve design, vascular grafts-history, synthetic grafts, regional patency, thrombosis, neointimal hyperplasia, graft infections.	
4	**ARTIFICIAL KIDNEY:** Functions of the kidneys, kidney disease, renal failure, renal transplantation, artificial kidney, dialyzers, membranes for haemodialysis, haemodialysis machine, peritoneal dialysis equipment-therapy format,	**8**
5	**ARTIFICIAL LUNGS:** Gas exchange systems, Cardiopulmonary bypass (heart-lung machine)-principle, block diagram and working, artificial lung versus natural lung. Liver functions, hepatic failure, liver support systems, general replacement of liver functions.	**7**

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: Completion of this course the student will be able to

CO1: Understand the different biocompatible materials such as metallic, ceramic and polymers.

CO2: Understand the biodegradable biomaterials

CO3: Identify different artificial implants and assistive devices for cardio-vascular system

CO4:Design of artificial organs such as heart, kidney and lung.

COs	**Mapping with POs**
CO1	PO1,PO3,PO6,PO7
CO2	PO1,PO2,PO3,PO4,PO6,PO7,PO8
CO3	PO1,PO2,PO3,PO4,PO6,PO7,PO8,PO12
CO4	PO10,PO11,PO12

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TEXT BOOK:

1. **Biomedical Engineering Handbook**, J.D.Bronzino ,CRC Press ,Volume1 ,2nd Edition, 2000.
2. **Biomedical Engineering Handbook,** J.D.Bronzino ,CRC Press ,Volume2 ,2nd Edition, 2000.
3. **Handbook of Biomedical Instrumentation ,** R.S.Khandpur **,**Tata McGraw Hill, 2nd Edition , 2003.

Sub Title : JAVA LAB		
Sub Code: 18MLL77	**No. of Credits:2=0: 0:2(L-**	**No of lecture hours/week**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES

To enable the students learn the fundamentals of programming language Java and also develop programming skills in Java

1	Simple Java Programs to illustrate the data operators
2	Program for string reversal
3	Program for demonstration of control statements
4	Program for demonstrating constructors
5	Program for demonstrating Overloading and overriding
6	Program for demonstrating multilevel Inheritance
7	Program for exception handling (try & catch methods and nested try statement and)
8	Program for demonstration of multi threading : Implementing runnable & extends, producer-consumer problem synchronization
9	Program for demonstrating event handling
10	Developing Applet program

COURSE OUTCOME: The students would have

CO1: Acquired programming skills in Java and will be able to develop applications using Java

COs	**Mapping with POs**
CO1	PO1,PO2,PO3,PO4,PO5,PO8,PO9,PO10,PO11,PO12

Sub Title: Project Phase I		
Sub Code: 18MLP78	**No of Credits 2:00:00**	**No of lecture hours/week :**
	Exam Marks :	

COURSE OBJECTIVES: To enable the students to learn

1. Develop their own ideas
2. Interact with outside world
3. Work in a group in a collaborative and productive manner

The project topics and batch mates are decided in Project Phase 1. The project work is carried out in group of 3 or 4. Industry projects are encouraged and promoted. The Project topic and the design presented in the phase I. The students will make a presentation of the abstract and synopsis and also submit a report showing the design & implementation along with the literature survey.

COURSE OUTCOME: The students will be able to

CO1: Carry out the literature survey
CO2: Convert the ideas of their interest into a conceptual model
CO3: Interact with outside world in identifying a suitable problem
CO4: Prepare proposals and approach funding agencies

COs	**Mapping with POs**
CO1	PO2,PO3,PO4,PO5, PO6, PO7, PO12
CO2	PO3, PO6, PO12
CO3	PO9,PO10, PO12
CO4	PO10, PO11,

Sub Title: Project Phase II		
Sub Code: 18MLP81	**No of Credits 10:00:00**	**No of lecture hours/week :**
	Exam Marks : 100	

COURSE OBJECTIVES: To enable the students to Study

1. Realise their technical ideas into a working mode
2. Interact with outside world
3. Work in a group in a collaborative and productive manner

The project topics and batch mates are decided in Project Phase 1. The project work is carried out in group of 3 or 4. Industry projects are encouraged and promoted. The Project topic and the design presented in the phase I has to be implemented with the guidance of a teacher assigned to the batch. The students will finally make an oral presentation and also submit a technical report.

Course Outcome: The students will be able to

CO1: Realise innovative ideas into working models
CO2: Discuss ideas, plan and work in a peer team to develop a system
CO3: Design a cost effective model within the time
CO4: Interact with industry experts
CO5: Document and present the technical project report

Cos	**Mapping with Pos**
CO1	PO1,PO2,PO3,PO4,PO5,PO6,PO7, PO12
CO2	PO9,PO10, PO11,
CO3	PO4, PO5, PO11, PO12,
CO4	PO9, PO10,PO11, PO12
CO5	PO10, PO12

Sub Title : ANALOG ELECTRONIC CIRCUITS		
Sub Code: 18MD31	**No of Credits :3= 3: 0: 0(L-T-P)**	**No of lecture hours/week : 3**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:39**

COURSE OBJECTIVES: To make the Student understand:

1. The transistor hybrid equivalent model and frequency analysis of voltage divider configuration based on the hybrid equivalent model.
2. The frequency response of the amplifier
3. Feedback concepts and Power amplifier classification.
4. FET & MOSFET construction and characteristics.
5. MOSFET Biasing circuits

UNIT No	Syllabus Content	No of Hours
1	BJT AC Analysis : Hybrid Equivalent model, Voltage Divider Configuration **BJT Frequency Response:**, Low frequency analysis (Bode Plot excluded), low frequency response of BJT amplifier, Miller effect capacitance, High frequency response of BJT amplifiers- study of capacitors affecting frequency response,	8
2	**Feedack Amplifier:** Feedback concepts, feedback connection types **Power Amplifiers**: Definitions and amplifier types, Transformer coupled Class A amplifiers, Class B push-pull amplifier circuits Field Effect Transistor: Introduction, construction and characteristics of JFET, Transfer Characteristics	7
3	**MOSFETS:** Introduction, Device structure and physical operation - Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small VDs, Operation as VDs is increased, Derivation of the id-VDS relationship, The P- Channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the sub threshold region .	**8**

4	**Current voltage Characteristics** – Circuit symbol, id-VDS 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.	**8**
5	**Biasing in MOS amplifier circuits** - Biasing by fixing VGS, Biasing by fixing VG and connecting a resistor in the source , Biasing using a drain to gate feedback resistor, biasing using a current source. **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 gm, the T equivalent circuit model.	**8**

Note 1: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Design Hybrid equivalent model of voltage divider circuit
CO2: Determine the cut off frequencies for practical transistor amplifiers
CO3: Classify feed back amplifiers and power amplifiers
CO4: Understand the construction of FET, MOSFET
CO5: Understand the Characteristics and analyse the behaviour of MOSFET under varied voltage conditions
CO6: Design different MOSFET Biasing circuits

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4
CO2	PO1,PO2,PO3,PO4
CO3	PO1,PO2,PO3,PO4
CO4	PO1,PO2,PO3,
CO5	PO1,PO2,PO3
CO6	PO1,PO2,PO3

TEXT BOOK:

1. **Electronic Devices and Circuit Theory,** Robert L. Boylestad and Louis Nashelsky, PHI/Pearson Education, 9th Edition.
2. **Microelectronic Circuits Theory and Applications,** Adel S Sedra and Kenneth C Smith Oxford International Student edition, 6th edition

REFERENCE BOOKS:

1. **Integrated Electronics,** Jacob Milman & Christos C. Halkias, Tata - McGraw Hill, 1991 Edition.
2. **Electronic Devices and Circuits,** David A. Bell, PHI, 4th Edition, 2004.

Sub Title : LOGIC DESIGN and VHDL		
Sub Code: 18MD32	**No of Credits : 3=2:2:0(L-T-P)**	**No of lecture hours/week : 4**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: To make the Student understand

1. Principles of combinational and sequential logic.
2. Different Boolean expression reduction techniques.
3. The design and analysis of combinational circuits.
4. The integrated circuit technologies.
5. Different flip flops and its applications.
6. Sequential circuit models

UNIT No	Syllabus Content	No of Hours	Tutorials
1	**Principles of combinational logic-1:** Definition of combinational logic, Canonical forms, Generation of switching equations from truth tables, Karnaugh maps-3, 4 and 5 variables, Incompletely specified functions (Don't Care terms), Simplifying Max term equations. **Principles of combinational Logic-2:** Quine-McCluskey minimization technique-Quine-McCluskey using don't care terms, Reduced Prime Implicant Tables. **Introduction to VHDL:** Structure of VHDL Module, Operators, Data types, Types of Descriptions, simulation and synthesis. Data flow description, behavioral description and structural description.	8	4
2	**Analysis and design of combinational logic - I:** General approach, Decoders-BCD decoders, Encoders. **Analysis and design of combinational logic - II:** Digital multiplexers- Using multiplexers as Boolean function generators. Adders and subtractors-Cascading full adders, Binary comparators. **VHDL Implementation: D**ecoder, Encoder, Comparator, Adder/Subtractor	**8**	**4**
3	**Sequential Circuits – 1:** Basic Bistable Element, Latches, SR Latch, Application of SR Latch, A Switch Debouncer, The $\overline{S}\,\overline{R}$ Latch, The gated SR Latch, The gated D Latch, Master-Slave SR Flip-Flops, The Master-Slave JK Flip-Flop,T Flip Flop,D Flip flop. V**HDL Implementation** – Sequential Circuits: Flip Flops	**8**	**4**
4	**Sequential Circuits – 2:** Characteristic Equations, Registers, Counters - Binary Ripple Counters, Asynchronous counters, Synchronous Binary counters, Counters based on Shift Registers, Design of a Synchronous counters using JK Flip-Flop, D Flip-Flop, T Flip-Flop.	8	-
5	**Sequential Design - I:** Introduction, Mealy and Moore Models, State Machine Notation, Synchronous Sequential Circuit Analysis. **Sequential Design – II:** Construction of state diagrams, counter design.	**8**	-

Note 1: Assignment-1 Comparative study of different logic families
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: On completion of the course the student will be able to

CO1: Simplify the Boolean equation and build logical circuits.
CO2: Design combinational circuits
CO3: Design shift registers, synchronous/ asynchronous counters
CO4: Draw state diagram for Melay & Moore Models
CO5: Write & simulate VHDL programs using the software tool Xilinx-ISE

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5
CO2	PO1,PO2,PO3,PO4,PO7
CO3	PO1,PO2,PO3,PO4,PO5,PO7
CO4	PO3,PO4,PO6,
CO5	PO3,PO5,PO6,PO12

TEXT BOOKS:

1. **Digital Logic Applications and Design**, John M Yarbrough, Thomson Learning, 2001.
2. **Digital Principles and Design,** Donald D Givone, Tata McGraw Hill Edition, 2002.
3. **Fundamentals of Logic Design:** C H Roth, Thomas Learning, 5th Edition.

REFERENCE BOOKS:

1. **Fundamentals of logic design,** Charles H Roth, Jr, Thomson Learning, 2004.
2. **Logic and computer design Fundamentals,** Mono and Kim, Pearson, Second edition, 2001.

Sub Title : ANALOG ELECTRONIC CIRCUITS LAB		
Sub Code: 18MDL37	**No of Credits:1=0:0:1(L-T-P)**	**No of lecture hours/week :2**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To wire up and understand the working of the following circuits

1. Diode circuits such as rectifiers, clipping and clamping circuits
2. Design of RC coupled amplifiers
3. RC phase shift oscillators
4. Power Amplifiers
5. Verify the Network theorems.

UNIT No	Syllabus Content
1	Rectifiers: Half wave, Full wave and Bridge Rectifier circuits.
2	Clipping Circuits: Single & Double ended with and without bias voltages
3	Clamping circuits: Positive clamping & Negative clamping.
4	RC Coupled Amplifier: BJT & FET
5	BJT Oscillators-RC Phase shift Oscillator
6	BJT/ FET Oscillators – Hartley & Colpitts Oscillators
7	Power Amplifiers : Push Pull Amplifiers
8	Open Ended experiment

COURSE OUTCOMES: The student will be able to

CO1: To design and test Recifiers Circuits

CO2: To design clipping and clamping circuits to generate

CO3: To design Oscillators

CO4: To Test the working of power amplifiers

CO5: To design & develop a system based on analog circuits

Cos	Mapping with Pos
CO1	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO2	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO3	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO4	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO5	PO12

Sub Title : LOGIC DESIGN LAB		
Sub Code: 18MDL38	**No of Credits:1=0:0:1(L-T-P)**	**No of lecture hours/week : 2**
Exam Duration: 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To design and Implement the following digital circuits:

1. Basic Gates, and simple logic circuits
2. Typical Combinational circuits
3. All types of flip flops
4. Typical Sequential circuits

UNIT No	Syllabus Content
1	Design of Half/Full adder and Half/Full Subtractors using logic gates.
2	(i) Realization of parallel adder/Subtractors using 7483 chip (ii) BCD to Excess-3 code conversion and vice versa.
3	Design of Binary to Gray code convertors and vice versa.
4	Study of 74153 IC(MUX) and designing different combinational circuits based on 74153.
5	Designing of One/Two bit comparator and study of 7485 magnitude comparator.
6	i)Design a decoder circuit for seven segment LED display ii) Study of Priority encoder
7	Implementation of given flip flops both at gate and IC level.
8	Designing of 3 bit counters and MOD – N counter (7476, 7490)
9	Design of Universal shift register using 74LS95.
10	Design sequence generator using Ring counter/Johnson counter.

COURSE OUTCOMES: The student will be able to
CO1: Design and Verify basic combinational and sequential circuits.
CO2: Design any given combinational and sequential circuits using logic gates and standard ICs.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5,PO7,PO8,PO9,PO10
CO2	PO9,PO10,PO11,PO12

Sub Title: BIOMEDICAL INSTRUMENTATION		
Sub Code: 18MD44	**No. of Credits : 4=4: 0: 0(L-T-P)**	**No of lecture hours/week :04**
Exam Duration : 3 hours	**CIE+ Assignment+ SEE =45+5+50=100**	**Total no of contact hours:52**

COURSE OBJECTIVES: Is to make the student understand

1. The human physiology, anatomy and evolution of bio signals.
2. The concepts of bio signal transducers and measurement.
3. The working of all major biomedical equipments.
4. The safety of biomedical devices.

Unit No.	Syllabus Content	No. of Hours
1	**FUNDAMENTAL CONCEPTS:** Sources of biomedical signals, Basic medical instrumentation system, performance requirements of medical instrumentation systems, General constraints in design of medical instrumentation systems. **Bioelectric Signals and Electrodes**: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrodes for ECG, Electrodes for EEG, Electrodes of EMG. EOG, EGG.	**10**
2	**BIO POTENTIAL AMPLIFIERS**: Need for bio amplifier- single ended bio amplifier-right leg driven ECG amplifier, Transient protection, Common-Mode and Other Interference -Reduction Circuits, Amplifiers for other bio potential signals, Band Pass filtering, isolation amplifiers-transformer and optical isolation- isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference.	**10**
3	**BIOMEDICAL RECORDERS:** Electrocardiograph-block diagram description, ECG leads, artefacts, Vector cardiograph, Phonocardiograph, Electroencephalograph, Electromyograph, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiratory rate.	**12**
4	**OXIMETERS:** Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter. **Cardiac Output Measurement:** Indicator-Dilution Method- Continuous infusion, Rapid injection. **Blood Flow Meters:** Electromagnetic blood flow meters, Ultrasonic blood flow meters, NMR blood flow meters, Photoplethysmography.	**10**
5	**CARDIAC PACEMAKERS AND DEFIBRILLATORS:** Need for cardiac pacemaker, External pacemaker, Implantable pacemaker, Types of Implantable	**10**

	pacemakers, Programmable pacemaker, Rate-responsive pacemakers. DC defibrillator, Implantable defibrillators. **PATIENT SAFETY:** Physiological effects of electrical currents on humans. Electric shock hazards, Leakage currents, macro shock, micro shock hazards and preventions, Electrical safety analyzer & precautions. Electrical safety codes standards.	

Note2: Assignment-1 from unit 1 and 2.
Asssignment-2 from unit 3, 4 and 5

COURSE OUTCOMES: By the completion of this course the student will be able to

CO1: Understand the generation of bio electric signals, identify the basic components of a measuring system
CO2: Understand the working of electrical amplifiers & filters for acquiring and measuring the physiological parameters
CO3: Record ECG according to 5/12 lead standard system
CO4: Understand the principle of measurement of blood pressure, blood flow , body temperature and pulse rate
CO5: Understand the working and also the application of cardiac pacemakers & defibrillators
CO6: Understand the patient safety standards

COs	Mapping with POs
CO1	PO1,PO2,PO3
CO2	PO1,PO3,PO4,PO6
CO3	PO1,PO3, PO4,PO6
CO4	PO3, PO4,PO6,PO7,
CO5	PO3, PO4,PO6,PO7,
CO6	PO8

TEXT BOOK:

1. **Handbook of Biomedical Instrumentation**, R.S.Khandpur, Tata McGraw Hill, 2nd Edition, 2003.
2. **Medical Instrumentation Application and Design, John G WebsterJohn Wiley and Sons, New York 2004**

REFERENCE BOOK:

1. **BIOMEDICAL TRANSDUCERS AND INSTRUMENTS**, Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press, 1997.
2. **Biomedical Instrumentation and Measurement**, Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, Prentice-Hall India Pvt. Ltd.
3. **Introduction to Biomedical Equipment Technology**, Joseph J Carr and John M Brown Pearson Education ,4th Edition , 2001 .
4. **The Biomedical Engineering Handbook**, Ed.Joseph Bronzino, Boca Raton: CRC Press LLC, 2000.

Sub Title: OOPs AND DATA STRUCTURE LAB		
Sub Code: 18MDL46	**No of Credits :1= 0:0:1(L-T-P)**	**No of lecture hours/week : 2**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To enable the students to write programs

1. To access/store different data
2. Making use of functions
3. To Sort/Search an element
4. For Dynamic memory allocation

UNIT NO	Contents: Write Programs for the following problems
1	Read and display student information by structure variable initialization.
2	Find the largest number.
3	Swap two numbers using functions(pass by value, pass by reference)
4	Store student details using array of objects.
5	Sort an array of elements in ascending/descending order.
6	Search a given element in an array.(Binary search)
7	Display the memory address of an object.
8	Perform the stack operation using static/dynamic memory allocation.
9	Perform the queue operation using static/dynamic memory allocation.
10	Perform the circular queue operation.
11	Illustrate single, double linked list.
12	Implement binary tree.

COURSE OUT COMES: The student will be able to

CO1**:** Write Programs using structures ; C02: Write Programs using functions
CO3: Write Program implementing data Structure

COs	Mapping with POs
CO1, CO2, CO3	PO3,PO4,PO5,PO8,PO9,PO10, PO12

Sub Title : MICROCONTROLLER LAB		
Sub Code: 18MDL47	**No of Credits:1=0:0:1(L-T-P)**	**No of lecture hours/week : 2**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: To make the student proficient in

1. The complete instruction set.
2. Writing and executing Standard programming examples like sorting, code conversion etc.
3. Writing and execution of certain interfacing programs.
4. Working with a programming tool such as Keil.

UNIT No	Syllabus Content
	I. PROGRAMMING for 8051
1.	Familiarisation of Addressing modes
2.	Write programs for all kinds of data manipulations.
3.	Write programs for implementing ALU for given specifications.
4.	Write programs to count different events.
5.	Implementation of subroutines
6.	Write programs to implement standard code convertors.
7.	Programs to generate delay, Programs using serial port and on-Chip timer / counter.
	II. INTERFACING:
8.	Alphanumeric LCD panel, LED and Hex keypad input interface
9.	Generate different waveforms Sine, Square, Triangular, Ramp etc. using DAC interface
10.	Stepper and DC motor control interface

COURSE OUTCOMES: On the completion of the course the students will be able to

CO1: Write program based on 8051.
CO2: Interface typical external hardware to 8051
CO3: Handle versatile tool: Keil IDE.

COs	Mapping with POs
CO1	PO1,PO2,PO3,PO4,PO5
CO2	PO2,PO3,PO4,PO5,PO9,PO10
CO3	PO3,PO6,PO11,PO12

Sub Title: LINEAR INTEGRATED CIRCUITS LAB		
Sub Code: 18MDL48	**No of Credits:1=0:0:1(L-T-P)**	**No of lecture hours/week :02**
Exam Duration : 3 hours	**Exam Marks : 50**	

COURSE OBJECTIVES: The student will learn

1. To rig up ,test and verify the BASIC linear integrated circuits .
2. The application circuits such as filters, waveform generators, multivibrators.

Unit No	Syllabus Content
1.	Study of Opamp characteristics.
2.	Design of Inverting and non-inverting amplifier.
3.	Design of various application circuits of Opamp: i)Adder and Subtractor ii)Integrator iii)Differentiator.
4.	Design Waveform generator using Schmitt trigger.
5.	Design of active first order filter: Low pass, High Pass, Band pass, Band elimination.
6.	Design of active second order filter: Low pass, High Pass, Band pass, Band elimination
7.	Design of multivibrator using 555 timer.: i) Astable ii) Bistable
8	Building of PAM, PWM and PPM
9	Experiments on TI board
Open end experiment based on Telemedicine concepts.	

COURSE OUTCOME: The students will be able to

CO1: Design & Testing of linear circuits using opamp IC 741
CO2: Design & test Digital Communication Circuits Using 555
CO3: Build & test applications of 555 Timer IC
CO4: Realise different modules using Industry standard TI Board and develop application circuits

COs	**Mapping with Pos**
CO1	PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12
CO2	PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12
CO3	PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12
CO4	PO2,PO3,PO4,PO5,PO7,PO9,PO10,P12