THE NATIONAL COLLEGE

Autonomous

JAYANAGAR, BENGALURU-70

PROPOSED B.Sc. [BIO MEDICAL ELECTRONICS] COURSE MATRIX
COURSE: B.Sc. [BIO MEDICAL ELECTRONICS]

Program Educational Objectives

PEO1: Graduates of Medical Electronics will build career in healthcare and allied fields.
PEO2: Graduates will adapt to the state of art technologies through lifelong learning, will effectively communicate and work a team.
PEO3: Graduates will pursue higher studies and research

Program Outcomes

PO1: An ability to apply knowledge of mathematics,science and computer fundamentals forappropriate solutions to Medical Electronics.
PO2: An ability to identify, analyze a problem, andformulate the computing Requirementsappropriate toits solution.
PO3: An ability to design, implement and evaluate anelectronic/computer-Basedsystem, process to meetdesired needs in healthcare.
PO4: An ability to design experiments, as well as toanalyze and Interpret Medical data.
PO5:An ability to use current techniques and modern toolsnecessary for computing practiceleading toimprovised health care.
PO6: An ability to understand health and safety issuesthrough Medical Electronics concepts.
PO7: An ability to understand environmentalconsiderations and sustainable Solutionsin Medical Electronics.
PO8: An ability to understand professional ethics and legalissues related to healthcaretechnologies.
PO9: An ability to function effectively as an individual anda member in diverse team.
PO10:Anability to communicate effectively with a range ofAudiences
PO11:An ability to understand management principles andapply these to manage projects and finance.
PO12:An ability to engage in continuing professionaldevelopment for lifelong learning

I SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 1	Language1	English	4	30	70	100	2
	Language2	Kan/San/Hin	4	30	70	100	2
Part 2	BBME1.1	Basic Electronics-I	4	30	70	100	5
	BBME 1.2	Mathematics-I	4	30	70	100	5
	BBME 1.3	Programming in C	4	30	70	100	4
	BBME 1.4	Digital Electronics & Verilog	4	30	70	100	4
	L1.1	Digital Electronics & Verilog	3	15	35	50	1
	L1.2	C programming	3	15	35	50	1
Part 3		Mandatory Paper	4	15	35	50	1
Total Marks and credits			**34**	**225**	**525**	**750**	**25**

II SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 1	Language1	English	4	30	70	100	2
	Language2	Kan/San/Hin	4	30	70	100	2
Part 2	BBME 2.1	Basic Electronics-II	4	30	70	100	4
	BBME 2.2	Mathematics-II	4	30	70	100	5
	BBME 2.3	Human Anatomy and Physiology	4	30	70	100	5
	BBME 2.4	8051 Microcontroller	4	30	70	100	4
	L2.1	Basic electronics Lab	3	15	35	50	1
	L2.2	8051 Microcontroller lab	3	15	35	50	1
Part 3		Mandatory Paper	4	15	35	50	1
Total Marks and credits			**34**	**225**	**525**	**750**	**25**

III SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 1	Language1	English	4	30	70	100	2
	Language2	Kan/San/Hin	4	30	70	100	2
Part 2	BBME 3.1	Biomedical signal processing	4	30	70	100	4
	BBME 3.2	Biomedical Instrumentation I	4	30	70	100	5
	BBME 3.3	Biomedical Transducers and Sensors	4	30	70	100	4
	L3.1	Signal Processing using MATLAB	3	15	35	50	1
	L3.2	Linear integrated circuitand transducers and sensors lab	3	15	35	50	1
	Project	Visit to hospitals	4	30	70	100	5
Part 3		Mandatory Paper/Open Elective	4	15	35	50	1
Total Marks and credits			**34**	**225**	**525**	**750**	**25**

IV SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 1	Language1	English	4	30	70	100	2
	Language2	Kan/San/Hin	4	30	70	100	2
Part 2	BBME 4.1	Analog and digital communication system	4	30	70	100	4
	BBME 4.2	Medical Imaging Systems	4	30	70	100	5
	BBME 4.3	Biomedical Instrumentation II	4	30	70	100	4
	L4.1	Biomedical Instrumentation lab	3	15	35	50	1
	L4.2	Communication lab	3	15	35	50	1
	Project	ARM microcontroller lab	4	30	70	100	5
Part 3		Mandatory Paper	4	15	35	50	1
Total Marks and credits			**34**	**225**	**525**	**750**	**25**

V SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 2	BBME 5.1	Data Analytics	4	30	70	100	5
	BBME 5.2	Bio Control System	4	30	70	100	5
	BBME 5.3	Latest Trends in Health care	4	30	70	100	5
	BBME 5.4	Embedded system design &RTOS	4	15	35	50	4
	L5.1	Embedded system Lab	3	15	35	50	1
	Project		4	30	70	100	5
Total Marks and credits			**23**	**150**	**350**	**500**	**25**

VI SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Project/Internship			23	150	350	500	25
Total Marks and credits			**23**	**150**	**350**	**500**	**25**

All Six Semester Matrix

Semester	Hours/week	Marks			Credit
		IA	**Exam**	**Total**	
First	**34**	**225**	**525**	**750**	**25**
Second	**34**	**225**	**525**	**750**	**25**
Third	**34**	**225**	**525**	**750**	**25**
Fourth	**34**	**225**	**525**	**750**	**25**
Fifth	**23**	**150**	**350**	**500**	**25**
Sixth	**23**	**150**	**350**	**500**	**25**
Total Marks and Credits				**4000**	**150**

SEMESTER I

I SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 1	Language1	English	4	30	70	100	2
	Language2	Kan/San/Hin	4	30	70	100	2
Part 2	BBME1.1	Basic Electronics-I	4	30	70	100	5
	BBME 1.2	Mathematics	4	30	70	100	5
	BBME 1.3	Programming in C	4	30	70	100	4
	BBME 1.4	Digital Electronics & Verilog	4	30	70	100	4
	L1.1	Digital Electronics & Verilog	3	15	35	50	1
	L1.2	C programming	3	15	35	50	1
Part 3		Mandatory Paper	4	15	35	50	1
Total Marks and credits			**34**	**225**	**525**	**750**	**25**

TITLE: BASIC ELECTRONICS-I

PAPER CODE: BBME1.1	CREDITS : 5	TOTAL NO OF HRS: 54

Course Outcomes:

After studying this paper the students will be able to

CO1:Analyze circuits in relevance to Bio Medical Electronics Applications
CO2:Analyze the circuits using Kirchhoff's laws and Networktheorems.
CO3:Analyze the Series and parallel resonantcircuits.
CO4:Analyze the basic working of pn junction diode and itsapplications
CO5:Analyze the BJT and FETcircuits.

MODULE 1	**Passive Components & AC Circuits:** **Resistors:** Specification, tolerance, rating, colour code, power dissipation, types of resistors- Fixed and variable. **Capacitors:** Specifications, colour code, energy stored in a capacitor, types of capacitors-fixed and variable, electrolytic. **Inductors:** Specifications, energy stored in an inductor, types-air core and iron core, chokes. **Transformer:** Working, classification, power losses in transformers. Fuses, switches andrelays. **(demonstration of components in classroom)** **AC Circuits :** Representation of a.c, sine wave- cycle, time period, frequency, average value, peak value (amplitude), peak to peak, r.m.s value, phase and phase difference, power factor, form factor, phasor diagram, complex number, j operator, reactance andimpedance. RL series and RC series circuits, RLC circuits: series and parallel- impedance curve, selectivity, band width Q factor- comparison between series RLC and parallel RLC circuits. Series and parallel Resonance circuits- condition for resonance, resonant frequency, half power frequencies, BW, quality factor (loaded and unloaded Q), comparison andBio Medical applications.	**12 hrs**
MODULE 2	**Transient analysis and Network Theorem:** Transient analysis of RC and RL circuits, time constant- representation, energystoredin inductors and capacitors. Network theorems (DC analysis) Current and Voltage sources: Ideal and real voltage and current sources D.C resistive circuits: Voltage divider and Current divider theorems open and short circuits, Kirchhoff's laws- mesh analysis and node voltage method. Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum	**10 hrs**

	power transfer theorem,	
MODULE 3	**Basic Semiconductor theory:** Intrinsic Semiconductor, extrinsic semiconductor-N type and P type, forward and reverse bias, energy level diagram of pn-junction. Diode symbol, the diode curve, forward bias and reverse bias characteristics,theidealdiode,practicaldiode,Breakdownindiode-zener and avalanche mechanisms, Special purpose diodes.	**08 hrs**
MODULE 4	**Rectifiers, Filters and Regulators:** Half wave, full wave and bridge rectification efficiency ' η `and ripple factor 'γ' in ease. Filters: series inductor filter and shunt capacitor filter, LC filter, л section filter performance, comparisons, clippers and clampers. Voltage regulators- block diagram of regulated power supply- zener as a line and load regulator- design.	**10 hrs**
MODULE 5	**Transistor and Biasing:** BJT: Transistor symbol, NPN/PNP- working, CB, CE and CC modes, current Gain, input and output characteristics of CB and CE Configuration, Darlington Pair. Leakage current, relation between α, β & γ, base spreading resistance. Biasing: Need for biasing, load line, operating point, thermal runaway. Voltage divider bias: design, bias stability factor (no derivation), advantages of voltage divider bias,Problems. **Field Effect Transistor (FET):** Construction and working of JFET, drain characteristics, Transconductance characteristics, FET parameters, FET approximations-Shockley's equation, comparison of FET with BJT, FET-Biasing techniques: types, self biasing design, advantages. MOSFET - working of Depletion and Enhancement types, CMOS – Construction and working, Problems.	**14 hrs**

Text Books:

1. Introductory circuit analysis, Robert L Boylstead – Pearson 12th edition.2016
2. Electronic Devices and circuit theory, Robert Boylstead and LouisNashelsky-PHI

Reference Books:

1. Basic Electronics, B. Grob,Mitchel E.Schultz-TMH 9th Edition-2005
2. Electronic Principles: A.P Malvino, David.J Bates_ Macgraw Hill 7th Edition,2010
3. Elect Basic Electronics and Linear circuits, N.N. Bhargava, D.C Kulshresta and S.C. Gupta-MacgrawHill,2012.
4. Electronic Devices: T.L.Floyd-Pearson,9th Edition,2015.
5. Measuring Instruments, W.D Cooper and A.D.Helfrick
6. Electronics text lab manual, Paul B.Zbar.

TITLE: MATHEMATICS-I

PAPER CODE: BBME1.2	CREDITS : 5	TOTAL NO OF HRS: 54

Course Outcomes:

On completion of the course, the student will be able to

CO1 :Analyze and understand big and small numbers and their different forms ofrepresentation.

CO2:Comprehend algebraic solutions to simple mathematical and businessproblems.

CO3:Solve linear and quadratic equations using multiplemethods.

CO4:Understand information organized in row and column format (matrix), and use algebraic methods to interpretthem.

CO5:Elementaryprocessedindifferentiationandintegrationandappreciatetheneedfor continuous and discrete functions.

MODULE 1	**Linear algebra** Matrices – Nomenclature, Matrix operations – Addition, Subtraction, Multiplication, Inversion. Types of matrices, Characteristics equation of a square matrix, Cayley – Hamilton theorem. Determinants – Evaluation ofa determinant, Identical rows and columns, Properties of determinants.	**15hrs**
MODULE 2	**Solution to Systems of Linear Equations** System of linear equations and criteria for unique solutions, Solution of linear equations using Cramer's rule, Elementary row operations, Gauss elimination method, Row echelon form, Iteration solutions to linear equations, Matrix method of solutions.	**15 hrs**
MODULE 3	**Differential and Integral Calculus** Limits, Continuity, Derivative, Derivatives of standard functions (results only), Derivatives of a constant, Derivative of exponential and logarithmic functions, Derivatives of sum, product and quotient of two functions, Differentiation of composite functions – Chain rule, Differentiation of parametric functions. **Integration:** Standard formulae for integration, Methods of integration – Integration by parts, Integration of substitution.	**8 hrs**
MODULE 4	**Partial differentiation:** Representation in suffix and differential form, Mixed derivatives, Partial derivatives of higher order. Homogeneous functions, Euler's theorem. Functions of two variables, Parametric representation, Chain rule for partial differentiation.	**8 hrs**
MODULE 5	**Functions, Variables, Equations, and Graphs:** Logarithm, exponential, polynomial functions, rational numbers Basic geometry and theorems, trigonometric identities, Series, sums, inequalities Graphing and plotting, Cartesian and polar coordinates, conic sections	**08 hrs**

Text Books:

1. Modern Algebra - Sharma and Vashishta, Krishna Prakashan Mandir, Meerut,U.P
2. Theory of Matrices - B S Vatsa, New Age InternationalPublishers.
3. Differential Calculus - Shanti Narayan, S. Chand & Company, NewDelhi.
4. Ordinary and Partial Differential Equations - M D Raisinghania, S. Chand and Co. Pvt. Ltd.

Reference Books:

1. A Textbook of Engineering Mathematics - N. P. Bali, N. Ch. Narayana Iyengar, Laxmi Publications

TITLE: PROGRAMMING IN C

PAPER CODE: BBME1.3	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

On completion of the course, the student will be able to

CO1:To study about algorithms, flowcharts andprograms.

CO2:To solve problems through logicalthinking.

CO3:To clearly understand the logic of theproblem.

CO4:To analyze the given problem and write the algorithm,flowchart.

CO5:To write structured C programs, this is the foundation of any programminglanguage**.**

MODULE 1	**Introduction to Programming Concepts**: Software, Classification of Software, Modular Programming, Structured Programming, Algorithms and Flowcharts with examples. Overview of C Language: History of C, Character set, C tokens, Identifiers, Keywords, Data types, Variables, Constants, Symbolic Constants , Operators in C, Hierarchy of Operators, Expressions, Type Conversions and LibraryFunctions.	**10hrs**
MODULE 2	**Managing Input and Output Operation**: Formatted and Unformatted I/O Functions, Decision making, branching and looping: Decision Making Statements - if Statement, if–else statement, nesting of if-else statements, else–if ladder, switch statement,?: operator, Looping - while, do-while, for loop, Nested loop, break, continue, and goto statements.	**10hrs**
MODULE 3	**Functions**: Function Definition, prototyping, types of functions, passing arguments to functions, Nested Functions, Recursive functions. **Arrays**: Declaring and Initializing, One Dimensional Arrays, Two Dimensional Arrays, Multi Dimensional Arrays - Passing arrays to functions. Strings: Declaring and Initializing strings, Operations on strings, Arrays of strings, passing strings to functions. Storage Classes - Automatic, External, Static and Register Variables.	**12hrs**
MODULE 4	**Structures**-Declaring and Initializing, Nested structure, Array of Structure, Passing Structures to functions, Unions, typedef, enum, Bit fields. **Pointers**: – Declarations, Pointer arithmetic, Pointers and functions, Call by value, Call by reference, Pointers and Arrays, Arrays of Pointers, Pointers and Structures. Meaning of static and dynamic memory allocation, Memory allocation functions.	**12hrs**
MODULE 5	**Files** - File modes, File functions, and File operations, Text and Binary files, Command Line arguments. C Preprocessor directives, Macros – Definition, types of Macros, Creating and implementing user defined header files.	**10hrs**

TextBooks:

1. Programming with C by Byron Gottfried., 4th Edition, 2018, McGrawhill.
2. ProgrammingInANSIC , E.Balaguruswamy,4th Edition,TMHPublications,2007.

Reference Books:

1. Let Us C ,YashwantKanetkar, 13thEdition, PHP,2013.
2. Thinking In C , Mahapatra, PHI Publications,1998.
3. C programming language , Dennis m Ritchie, 2nd Edition.
4. Programming with ANSI and Turbo C, Ashok N. Kamthane, Pearson Education,2006.

TITLE: DIGITAL ELECTRONICS & VERILOG

PAPER CODE: BBME1.4	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

After studying this paper the students will be able to

CO1:Simplify the Boolean functions using Boolean algebra and K-maptechnique.
CO2:Learn about basics ofVerilog
CO3:Realize the combinationalcircuits.
CO4:Design the Combinational and Sequential logic circuits usingVerilog.
CO5:Learn Bio medical Applications

MODULE 1	**Number System** Decimal, Binary, Octal and Hexadecimal – their inter conversion.BCD numbers (8421), Gray, Excess 3, ASCII and EBCDIC codes Arithmetic operations in Binary, Hexadecimal. BCD addition and Excess 3 addition. Sign magnitude convention, 1's and 2's Complements-2's Complement Subtraction, signed number arithmetic-addition. Positive and Negative Logic, Basic Logic gates-AND, OR and NOT gates (Logic symbols and Truth tables), Boolean algebra- Laws and Theorems, NAND and NOR gates (Logic symbols and Truth tables), De Morgan's theorems, NAND and NOR as Universal gates. Simplification of Logic Expressions using Boolean algebra, SOP and POS expressions. Karnaugh maps- K-Map techniques to solve 3 variable and 4 variable expressions.	**14hrs**
MODULE 2	**Basics of Verilog** Introduction to HDL, Structure of Verilog module, Operators, data types, simulation and synthesis Types of descriptions: Data flow descriptions, Behavioral Descriptions, Structural Descriptions, Switch – level descriptions, mixed type descriptions	**12hrs**
MODULE 3	**Modularity in Verilog** Procedure, tasks and functions, advanced HDL descriptions. Synthesis Basics: Highlights of synthesis, Synthesis information from module, mapping process and always in hardware domain.	**08 hrs**
MODULE 4	**Combinational Logic Circuits** Arithmetic Operations: Adders and subtractors, cascading full adders, Look ahead carry, Binary Comparators – 2bit and 4 bit, two bit Multiplier, Multiplexers Realization of 2:1, 4:1 and 8:1 using gates &Applications.	**10 hrs**

	Demultiplexer: – Realization of 1:2 1:4 and 1:8 using basic gates & Applications. Encoders: Binary coded decimal codes, Binary – Gray vice versa, BCD – Excess 3 Encoders: Realization and Priority Encoders, Decoders: BCD – Decimal, BCD – Seven segment, seven segments displays. **Verilog description for the above circuits.**	
MODULE 5	**Sequential Logic Circuits** Latches and Flip-Flops: SR-latch, D-latch, D flip-flop, JK flip-flop, T flip-flop Master slave FF, Edge trigger and Pulse trigger FF , Registers and Shift Registers: PISO, PIPO, SISO,SIPO, Right shift and left shift, Universal Shift register. Counters-Binary ripple counters, Synchronous binary counters, Modulo N counters – Synchronous and Asynchronous counters. **Verilog description for the above circuits.**	**10hrs**

Text Books:

1. Digital Fundamentals: T L Floyd-PEARSON 10TH EDITION,2012
2. Guide to Verilog HDL - A practical primer by J. Bhasker; Addison Wesley LongmanPub.

Reference Books:

1. Digital Logic: Jhon M Yarbrough_ Thomson Indian Edition,2002
2. Digital Design: M. Morris Mano &Michael.D Ciletti-Pearson 4th Edition,2007
3. HDL programming Fundamental: VHDL and Verilog – Botros
4. Advanced digital Design with the Verilog HDL: Michael D Ciletti_ PHI Indian Edition,2009
5. Digital Design-Principles and Practices: J.F Wakerly-PHI 4th edition ,2007

TITLE: DIGITAL ELECTRONICS & VERILOG LAB

PAPER CODE: L1.1	CREDITS : 1	NO OF HRS: 3hrs/week

Part-A(Digital Trainer Kits)

1. IC 7400-Realization of AND, OR, NOT, NOR AND X-OR gates and IC 7402-Realization of AND, OR, NOT, NAND and X-NORgates.
2. Construction of Half Adder and Half subtractor and Construction of Full Adder using IC 7486, 7402 and IC 7432.
3. Binary to Gray code and vice versa using IC7486.
4. Decimal to BCD Priority encoder and BCD to DecimalDecoder.
5. BCD to seven segment conversion using IC7447.
6. Study of Multiplexer using IC 74150 and De-Multiplexer using IC74154.
7. D/A converter using weighted resistermethod.
8. J-K Flip-flop and conversion to D and T flip flop using IC7476.

Part-B(VerilogExperiments)

1. Realization of all the Logicgates
2. Realization of Adder and Subtractor (Both Half andFull)
3. Design of Decoders, encoders andcomparators
4. Design of Multiplexer,Demultiplexer.
5. Design of 32 bitALU
6. Realization of Flip flops (SR, D, JK andT)
7. Binary and BCD counters (synchronous andasynchronous)
8. Shift register counters – ring counter and Johnsoncounter

TITLE: C PROGRAMMING LAB

PAPER CODE: L1.2	CREDITS : 1	NO OF HRS: 3hrs/week

Part-A (control statement-4. Function-2, Array-2)

1. Program to print the reverse of an integer
2. Program to print first N Prime numbers.
3. Program to input 2 numbers and perform arithmetic operation using switch statement
4. Program to find GCD and LCM of two numbers.
5. Program to print Fibonacci series upto n number of terms using function.
6. Program to find the factorial of an integer using recursion.
7. Program to multiply two given matrix
8. Program to find sum of principal diagonal matrix.

Part-B (string-2, structure-1, union-1, pointer-2. Files-2)

1. Program to find the number of vowels and consonants in a given string
2. Menu driven program to perform to find length of string, compare two strings without using built in function.
3. Program using structure to accept employee information like basic salary, calculate DA as 50%, HRA as 25%, Calculate gross, if any loan is paying by employee then deduct it and pay the net salary.
4. Program to extract individual bytes from an unsigned int using union.
5. Program to swap two numbers using function and pointers.
6. Program to print all permutations of a given string using pointers.
   Eg: ABCD given output must be ABDC, ACDB, ADBC etc…
7. Creating a file with employee details, arrange N Names in alphabetical order.
8. Creating a sequential file with three fields: empno, empname, empbasic. Print all the details in a neat format by adding 500 to their basicsalary.

SEMESTER II

II SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 1	Language1	English	4	30	70	100	2
	Language2	Kan/San/Hin	4	30	70	100	2
Part 2	BBME 2.1	Basic Electronics-II	4	30	70	100	4
	BBME 2.2	Mathematics-II	4	30	70	100	5
	BBME 2.3	Human Anatomy and Physiology	4	30	70	100	5
	BBME 2.4	8051 Microcontroller	4	30	70	100	4
	L2.1	Analog electronics Lab	3	15	35	50	1
	L2.2	8051 Microcontroller lab	3	15	35	50	1
Part 3		Mandatory Paper	4	15	35	50	1
Total Marks and credits			**34**	**225**	**525**	**750**	**25**

TITLE: BASIC ELECTRONICS-2

PAPER CODE: BBME2.1	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

After studying this paper the students will be able to

CO1:Analyze all type of amplifiers and feedback amplifiercircuits.
CO2:Analyze the oscillatorcircuits.
CO3:Analyze the Power devices including SCR andUJT.
CO4:Analyze the Operational Amplifier circuits and study theirapplications.
CO5:Study the performance of data acquisitioncircuits.

MODULE 1	**Small Signal and Large Signal Amplifiers** **Small Signal Amplifiers** Small signal voltage amplifier: Classification of amplifiers, concept of amplification. CE Amplifier: working, re-model, expression for the voltage gain, input and output impedance, frequencyresponse. Swamped amplifier, CC amplifier (Emitter follower), impedance matching, FET CS-amplifier. Multistage Amplifiers: Cascaded stages, direct coupled amplifier, two stage RC coupled amplifier-working, analysis, distortions in amplifier, Problems **Large Signal Amplifiers** Classification of large signal amplifier, ac load line, Class A single ended power amplifier- working, power dissipation, output power calculation, efficiency. Class B push pull (transformer coupled) amplifier- working, harmonic distortion, output power calculation, efficiency. Complementary-symmetry class B push-pull amplifier- working, crossover distortion and heat sinks. Tuned amplifier: Class C power amplifier- single tuned double tuned amplifier-resonant load-frequency response- power relations, efficiency-application in communication circuits, Problems.	**12hrs**
MODULE 2	**Differential amplifier** Dual input balanced and unbalanced output dc and ac analysis, input impedance, output impedance, common mode gain, differential gain, Current mirror. Problems. Operational Amplifier: Block diagram, Equivalent circuit, characteristics of	**12hrs**

	ideal and practical Op Amp, pin configuration of IC 741, electrical parameters-input bias current, input offset voltage, output offset voltage, CMRR, Slew rate, SVRR, thermal drift, frequency compensation. Open loop gain, differential gain, limitations, Problems. Feedback in amplifiers: Feedback principles, types of feedback-positive and negative, types of negative feedback-voltage series, voltage shunt, current series and current shunt (block diagram representation for each). Expression for voltage gain of an amplifier with feedback (derivation). Problems. Advantages of negative feedback: Stability, increase in input impedance, increase in bandwidth, decrease in output impedance (derivation for all), disadvantage of negative feedback. Problems. Non inverting (voltage series feedback) amplifier -gain, input and output impedances, band width, total output offset voltage with feedback, voltage follower. Problems. Inverting (Voltage shunt feedback) amplifier-virtual ground, gain, input and output impedances, bandwidth, total output offset voltage, current to voltage converter. Problems.	
MODULE 3	**Applications of Operational amplifier** Adder, Sign Changer, Scale changer, summing amplifier and Subtractor (difference amplifier, Integrator, Differentiator. Instrumentation amplifier. Comparators: Basic comparator, comparator characteristics, Schmitt trigger.Problems. Active filters: Importance of active filter, first order Butterworth low pass, high pass, band pass and band elimination filters, all pass filter. Oscillators: Basic principle of oscillator, tank circuit, Barkhausen criteria, LC oscillators-Hartley and Colpitt's using op-amp, RC oscillators-phase shift oscillator, Wein bridge oscillator. Multivibrators: Types of multivibrators-Block diagrams of astable, monostable and bistable multivibrators-Monostable and Astable Multivibrators using IC 555,Problems.	**12 hrs**
MODULE 4	**Introduction to Power Electronics** Introduction: Power Semiconductor Devices and types of Power Electronic Converters, applications, advantages and disadvantages of Power Electronics converters. **Power Semiconductor Diodes and Transistors:** Types of Power diodes, Switching Characteristics of Power diodes, Power BJTs, Power MOSFETS and Insulated Gate Bipolar Transistors (IGBT). **Thyristors:** Introduction, Principle of operation, anode-cathode characteristics, gate	**08 hrs**

	characteristics, two transistor model, switching characteristics (turn-on and turn-off). Family of Thyristors (mention only). UJT: Construction, working and Characteristics of UJT	
MODULE 5	**Data Acquisition Systems** Types of instrumentation systems, Components of analog data acquisition system, Digital data acquisition system, Use of recorders in digital systems, Digital recording systems. Data Converters: Digital to Analog Converters: Basic DAC techniques, Weighted Resistor DAC, R – 2R Ladder DAC, DAC 0800 (Data sheet: Features and description only). Analog to Digital Converters: Functional diagram of ADC, Flash ADC, Counter type ADC, Successive approximation ADC, Dual slope ADC. ADC0809(Datasheet:Features,specificationsanddescriptiononly), DAC/ADC specifications. Bio Medical Applications	**10hrs**

Text Books:

1. Electronic Devices and circuit theory: Robert L.Boylstead and Louis Nashelsky–Pearson 9th Edition,2008
2. Operational amplifiers and Linear Integrated circuits, Ramakanth Gayakwad-PHI 5th edition.
3. Power Electronics:P.S Bhimbra-Khanna Publishers,5th Edition,2014

Reference Books:

1. Electronic Principles: A.P.Malvino,D.J Bates-TMH 7thEdition,2010
2. Electronics Devices:T. Floyd-Pearson 9th Edition,2015
3. Basic Electronics and Linear circuits: N.N. Bhargava, D.C Kulshresta and D.C Gupta-MacgrawHill,2012.
4. Power electronics:Mohammad.H.Rashid-Pearson 3rd Edition,2015.
5. Electronics text lab manual: Paul B.Zbar.

TITLE: MATHEMATICS-II

PAPER CODE: BBME2.2	CREDITS : 5	TOTAL NO OF HRS: 54

Course Outcomes :

On completion of the course, the student will be able to

CO1:Analyze and understand Laplace and Fouriertransforms.

CO2:Through understanding in settheory.

CO3:Brief introduction to complexanalysis.

MODULE 1	**Laplace transforms:** Definition and basic properties Laplace transform of some common functions and Standard results –Laplace transform of periodic functions-Laplace transforms of derivatives and the integral of function- Laplace transforms,.	**8hrs**
MODULE 2	Heaviside function and Dirac-delta function-convolution theorem(no proof)-Inverse Laplace transforms-Laplace transform method ofsolvingordinarylineardifferentialequationsoffirstandsecondorder with constant coefficients	**6hrs**
MODULE 3	**Fourier Transforms:** The Fourier Integral-Complex Fourier transform-Inverse transform-Basic properties-Transforms of the derivative and the derivative of the transform. Fourier sine and cosine transforms and inverse-transforms for first and second order derivatives	**14 hrs**
MODULE 4	**Discrete Mathematical structures:** Sets, subsets, power sets, Counting techniques Methods of proofs and disproof's, proof by mathematical induction Basic data structures: stacks, queues, graphs, arrays, hash tables, trees Graph properties. Recurrence relations and equations Generating functions	**14 hrs**
MODULE 5	**Complex Analysis:** Complex numbers, the complex plane - conjugate and modulus of a complex number - the modulus-argument form - geometric representation - Equation to circle and line in the complex form.	**12 hrs**

Text Books:

1. Laplace and Fourier Transforms - M. D. Raisinghania, New Delhi, India: S. Chand and Co. Ltd.
2. Graph theory by FHarary
3. Graph theory by Dr.Chandrashekhar
4. Laplace and Fourier Transforms - M. D. Raisinghania, New Delhi, India: S. Chand and Co. Ltd.
5. Real and Complex Analysis - Walter Rudin, McGraw-Hill HigherEducation.
6. Discrete mathematics and its applications by K HRosen

Reference Books:

1. A Textbook of Engineering Mathematics - N. P. Bali, N. Ch. Narayana Iyengar, Laxmi Publications

TITLE: HUMAN ANATOMY AND PHYSIOLOGY

PAPER CODE: BBME2.3	CREDITS : 5	TOTAL NO OF HRS: 54

Course Outcomes :

CO1:To understand the internal environment of human body and homeostasismechanism

CO2:To provide the basic knowledge of different types oftissues.

CO3:To provide the knowledge of structure and functioning of nervous system, cardiovascular system, respiratory system, digestive system and musculoskeletalsystem

CO4:Toprovidetheknowledgeofphysiologicalparametersofnormalhealthandfactors affecting various physiological processes in the body**.**

MODULE 1	**Introduction:** Homeostasis, Tissue, Cartilage: The internal environment and homeostasis, survival needs of the body, movement of substances within the body, body fluids, action potential, propagation of action potential, cell-structure and functions. Epithelial tissue- simple epithelium, stratified epithelium, connective tissue- cells of connective tissue, loose connective tissue, Adipose tissue, Dense connective tissue, Lymphoid tissue, Cartilage- Hyaline cartilage, Fibro cartilage, Elastic cartilage.	**10hrs**
MODULE 2	**Nervous System:** Functional Components of nervous system, Neurons: Properties of neurons, Cell bodies, Axon and Dendrites, Types of nerves, Synapse and neurotransmitters, neuromuscular junction. Central nervous system: Meninges, ventricles of the brain and CSF. Brain: Cerebrum, functions of cerebrum, functional areas of the cerebrum, Brainstem, Cerebellum, Spinal cord- grey matter, white matter, spinal reflex, Spinal nerves (in brief list & functions), Cranial nerves (in brief list & functions), Autonomic nervous system (in brief)- functions and effects. Pituitarygland and hypothalamus.	**10hrs**
MODULE 3	**Cardiovascular System:** Introduction, Blood vessels- Arteries and Arterioles, Veins and Venules, capillaries, control of blood vessel diameter, blood supply- internal respiration, cell nutrition. Heart- position, structure- pericardium, myocardium, endocardium, interior of the heart, flow of blood through the heart, blood supply to heart, Conducting system of the heart, factors affecting heart rate, the Cardiac cycle, cardiac output, blood pressure, control of blood pressure, pulse and factors affecting the pulse rate. Circulation of the blood- pulmonary circulation, systemic circulation- aorta (different parts of aorta & their blood supply, in brief). Summary of the main blood vessels (arteries & veins, explanation with flow diagram only)	**12 hrs**

MODULE 4	**Respiratory System:** Organs of respiration, Nose and Nasal cavity- position, structure and functions, pharynx - position, structure, functions. Larynx - position, structure and functions. Trachea, bronchi, bronchioles and alveoli, lungs- position, associated structure, pleura and pleural cavity. Respiration - muscles of respiration, cycle of respiration, variables affecting respiration, lung volumes andcapacity **Digestive System:** Organs of the digestive system – mouth, tongue, teeth, salivary glands, pharynx, oesophagus, stomach, gastric juice and functions of stomach, small intestine-structure, chemical digestion in small intestine, large intestine - structure, functions of the large intestine. Pancreas and Liver. **Urinary:** Structure of Kidney and Nephron – Mechanisms of Urine formation – Regulation of Blood pressure by Urinary System – Urinary reflex	**12 hrs**
MODULE 5	**Skeletal System:** Bone, Types of bone, structure, bone cells, functions of bone. Axial skeleton- skull, sinuses, Fontanelles, vertebral column characteristics of typical vertebra, different parts of vertebral column (parts only), features of vertebral column, movements and functions of vertebral column, sternum, ribs, shoulder girdle and upper limb, pelvic girdle and lower limb. **Muscles and Joints** (Study of muscles along with joints): Muscle tissue: Skeletal muscle, Smooth muscle, Cardiac muscle, functions of muscle tissue, muscle tone and fatigue. Types of joint- Fibrous, Cartilaginous, Synovial, characteristics of synovial joints, shoulder joint, elbowjoint, radioulnar joint, wrist joint, Hip joint, Knee joint, ankle joint.	**10hrs**

Text Books:

1. Ross & Wilson's Anatomy and Physiology in Health and Illness – by Anne Waugh and Allison Grant, 9th Edition, Churchill Livingstone Publications

Reference Books:

1. Concise Medical Physiology- by Sujit K. Chaudhuri, 5th Edition, New Central Book AgencyPvt.Ltd.
2. Essentials of Medical Physiology - by K. Sembulingam and Prema Sembulingam, 3rd Edition, JaypeePublications
3. Human Physiology: From Cells to Systems – by Lauralee Sherwood, 6th Edition, Thomson India Edition, 2007.

TITLE: 8051 MICROCONTROLLER

PAPER CODE: BBME2.4	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

This course enables students to understand:

CO1:Basics of Microprocessor andMicrocontroller
CO2:8051 Microcontroller architecture and Pindescription
CO3:8051 Addressing modes and instructionset
CO4:Design and develop applications using 8051 Assembly language and Cprogram.
CO5:On-chip peripherals and program using Assembly language andC.

MODULE 1	**Introduction to microcontrollers:** Introduction, Microprocessors and Microcontrollers,. RISC & CISC CPU Architectures, Harvard & Von-Neumann CPU architecture. **The 8051 Architecture:** Introduction, 8051 Microcontroller Hardware, Input/Output Pins, Ports and Circuits External Memory, Counter and Timers, Serial Data Input / Output, Interrupts.	**10hrs**
MODULE 2	**Addressing modes and operations:** Introduction, Addressing modes, External data Moves, Code Memory, Read Only Data Moves / Indexed Addressing mode, PUSH and POP Opcodes, Data exchanges, ExamplePrograms; Byte level logical Operations, Bit level Logical Operations, Rotate and Swap Operations, Example Programs. Arithmetic Operations: Flags, Incrementing and Decrementing, Addition, Subtraction, Multiplication and Division, Decimal Arithmetic, Example Programs. **Jump and Call Instructions:** The JUMP and CALL Program range, Jumps, calls and Subroutines, Interrupts and Returns, More Detail on Interrupts, Example Problems	**12hrs**
MODULE 3	**8051 programming in C**: Data types and time delays in 8051C, I/O programming, logic operations, data conversion programs, accessing code ROM space, data serialization.	**10 hrs**
MODULE 4	**Timer / counter programming in 8051:** Programming 8051 Timers, Counter Programming, programming timers 0 and 1 in 8051 assembly level and embedded C. **Interrupts programming:** 8051 Interrupts, Programming Timer Interrupts, Programming External Hardware Interrupts, Programming the Serial Communication Interrupts, Interrupt Priority in the 8051/52, interrupt programming in assemblylevel	**12 hrs**

	and embedded C	
MODULE 5	**Memories and interfacing with 8051:** Memory Concepts- Types of semiconductor Memories, ROMs-Mask ROM, simple ROM, internal ROM structure, small and large capacity ROM, three state outputs and buses, ROM access time, application of ROM. PROMs and EPROMs- PROMs, PROM programming, EPROMs, EEPROMs IC 2516 (logic diagram and simple explanation of the IC) RAM- Static RAM cell, basic structure of static RAM, IC 74189. Dynamic RAM cell, Basic structure of a dynamic RAM, IC 4164. Magnetic Bubble Memories, Magnetic surface storage devices, special memories and applications- PLAs, FIFO memories and CCD memories. **Interfacing with 8051:** Interfacing 8051 to LCD, Keyboard, ADC, DAC, Stepper motor.	**10hrs**

Text Books:

1. The 8051 Microcontroller Architecture, Programming & Applications: Kenneth J. Ayala - Thomson Learning 3rd Edition ,2007.

Reference Books:

1. The 8051 Microcontroller and Embedded Systems – using assembly and C: Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D.McKinlay- Pearson 2nd Edition , 2009.
2. Microcontrollers- Theory andApplication: Ajay V Deshmukh-TMH,2005.
3. The 8051 Microcontrollers: Scott Mackanzie, Raphael C W-Pearson 4th Edition,2009

TITLE: ANALOG ELECTRONICS

PAPER CODE: L2.1	CREDITS : 1	NO OF HRS: 3hrs/week

PART A

1. Verification of Thevinin's and Maximum power transfertheorems.
2. Series and Parallel resonance circuit- Determination of Resonant frequency, Bandwidth and Q-factor.
3. (a) Study of V-I Characteristics of Semiconductordiode.
   (b) Half and Full wave\Bridge wave rectifier with and without shunt capacitancefilter.
4. Diode clippers andclampers.
5. Zener regulator-Line and Loadregulations.
6. Voltage divider bias-design and loadline.
7. Transistor characteristics in CEmode.
8. CEamplifier-Frequency response.

PART B

1. Non-inverting and inverting operational amplifier-Frequency response.
2. Inverting summer, Non-inverting summer.
3. Op Amp Integrator.
4. Op amp Differentiator.
5. First order Active Low-Pass and High Pass filters using OP-AMP-Frequencyresponse.
6. Phase shift oscillator/Wein bridgeoscillator.
7. Colpitt's /Hartely oscillator.(Op- ampbased)
8. Astable and monostable multivibrtor using IC555

TITLE: 8051 MICROCONTROLLER LAB

PAPER CODE: L2.1	CREDITS : 1	NO OF HRS: 3hrs/week

PART A

Assembly Language Programming:

1. Program to add and subtract two 8-bitnumbers.
2. Program to find 2's complements of an 16-bitnumber.
3. Program to find the sum of N one bytenumbers.
4. Program to multiply two 8-bitnumbers.
5. Program to solve the linear equation y = mx +c.
6. Program to find the square of a number from look-uptable.
7. Program to find largest/Smallest of Nnumbers.
8. Program to arrange the numbers in Ascending /Descendingorder.

PART B

Embedded C & Interfacing

1. Toggling ofports. Generation of square wave at a port pin
2. Program to use Timer as event Counter.
3. Program to transfer a message serially.
4. Program to receive a message serially.
5. Experiments related withinterrupts.
6. DACinterfacing.
7. Stepper motorinterfacing.
8. Keyboardinterfacing.

SEMESTER III

III SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 1	Language1	English	4	30	70	100	2
	Language2	Kan/San/Hin	4	30	70	100	2
Part 2	BBME 3.1	Biomedical signal processing	4	30	70	100	4
	BBME 3.2	Biomedical Instrumentation I	4	30	70	100	5
	BBME 3.3	Biomedical Transducers and Sensors	4	30	70	100	4
	L3.1	Signal Processing using MATLAB	3	15	35	50	1
	L3.2	Linear integrated circuitand transducers and sensors lab	3	15	35	50	1
	Project	Visit to hospitals	4	30	70	100	5
Part 3		Mandatory Paper/Open Elective	4	15	35	50	1
Total Marks and credits			**34**	**225**	**525**	**750**	**25**

TITLE:BIOMEDICAL SIGNAL PROCESSING

PAPER CODE: BBME3.1	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

After studying this course, students will be able to:

CO1:Analyze the nature of Biomedical signals and relatedconcepts

CO2:Apply filters to remove noise from biomedicalsignals.

CO3:Apply averaging technique on biomedical signals and extract the features of EEG signals.

CO4:Analyze event detection techniques for EEG and ECGsignals.

CO5:Apply signal compression techniques on biomedicalsignals.

CO6:Write simple algorithms for biomedical signalprocessing

MODULE 1	**INTRODUCTION TO BIOMEDICAL SIGNALS** Biosignal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Electrogastrogram (EGG), Electroneurogram (ENG), Event related potentials (ERPs), Phonocardiogram (PCG), Speech signal, Objectives of Biomedical signal analysis, Difficulties in Biomedical signal analysis, Computer-aided diagnosis.	**10hrs**
MODULE 2	**FILTERING FOR REMOVAL OF ARTIFACTS** Time-domain Filters - synchronized averaging, Moving Average Filters, Derivative-based operators to remove low-frequency artifacts. Frequency-domain filters - Removal of High Frequency noise, Removal of low frequency noise, Removal of periodic artifacts, optimal filter- Wiener filter, Adaptive filters for removal of interference.	**10hrs**
MODULE 3	**CARDIOVASCULAR APPLICATIONS** Noise & Artifacts, ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection, Adaptive noise canceling in ECG, improved adaptive filtering in FECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets. Computation of diagnostic signal parameters of ECG like Heart rate and QRS detection using Multivariate analysis (PCA and ICA). Segmentation of PCG, intensity patterns,Spectral modeling and analysis of PCG signals.	**10 hrs**
MODULE 4	**NEUROLOGICAL APPLICATIONS** EEG rhythms & waveforms, EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models -	**12 hrs**

	Nonlinear modeling of EEG - artifacts in EEG & their characteristics and processing – Nonparametric spectral analysis, Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis - correlation analysisofEEGchannels-coherenceanalysisofEEGchannels.Evoked potentials- noise characteristics, Noise reduction by linear filtering.	
MODULE 5	**ANALYSIS ON WAVESHAPE, SIGNAL CLASSIFICATION AND RECOGNITION** Modeling intramuscular EMG-Intramuscular signal decomposition-Fractal analysis of EMG signals. Statistical analysis of VAG signals. Analysis on amplitude and latency of MEG signals. Analysis of ERP effect. Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Analysis of EEG using Empirical mode decomposition (EMD).	**12hrs**

Text Books:

1. Rangayyan, ―Biomedical Signal Analysis", Wiley2002.
2. Semmlow, ―Biosignal and Biomedical Image Processing", Marcel Dekker,2004

Reference Books:

1. Arnon Cohen, ―Bio-Medical Signal Processing Vol I and Vol II , CRC Press Inc., Boca Rato, Florida1999.
2. D.C.Reddy,―BiomedicalSignalProcessing:Principlesandtechniques , Tata McGraw Hill, New Delhi,2005
3. Willis J Tompkins, ―Biomedical Digital Signal Processing , Prentice Hall,1993
4. Bruce, ―Biomedical Signal Processing &Signal Modeling, Wiley, 2001
5. Sörnmo, ―Bioelectrical Signal Processing in Cardiac & Neurological Applications , Elsevier2005.

TITLE: BIOMEDICAL INSTRUMENTATION I

PAPER CODE: BBME3.2	CREDITS : 5	TOTAL NO OF HRS: 54

Course Outcomes :

After studying this course, students will be able to:

CO1:Define and analyze the ECG, EEG and BPsignals.

CO2:Discuss the factors to be considered in the measurements of respiratory and audiometric signals. 3. Describe the principle and working of cardiac pacemakers, defibrillators and surgicaldevices.

CO3:Describe the principle and working of therapeutic instruments like Dialysis, heart -lung, ventilator, lithotripter and incubators.

CO4:Interpret the concepts involved with the measurement of man andinstruments.

CO5:Discuss the physiological effects from electric shocks and maintenance of medical equipment's as perstandards.

MODULE 1	**BIOELECTRIC SIGNALS AND ELECTRODES:** Sources of Biomedical Signals, Origin of Bioelectric Signals, Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Electrooculogram (EOG), Electroretinogram (ERG), Recording Electrodes–Electrode-tissue interface, Electrolyte-Skin interface, polarization, skin contact impedance, motion artifacts, Silver-Silver Chloride electrodes, Electrodes for ECG, Electrodes for EEG, Electrodes of EMG, Electrical conductivity of electrode jellies and creams, microelectrodes.	**10hrs**
MODULE 2	**Electrocardiograph,** Block Diagram Description of an Electrocardiograph, The ECG leads, Effects of Artefacts on ECG Recordings. Electroencephalograph, Block Diagram Description of an Electroencephalograph. Other Biomedical recorders. Bedside patient monitoring Systems, Measurement of Heart rate (Instantaneous heart rate meters). Measurement of Pulse rate. Blood Pressure measurement (Direct and Indirect-Korotkoff's method, Rheographic method and Oscillometric Measurement method)	**12hrs**
MODULE 3	**Pulmonary Function Measurements:-**Respiratory Volumes, Respiratory Capacities, Compliance and Related pressures, Dynamic Respiratory Parameters. Spirometry: - Basic Spirometer, Wedge Spirometer, Ultra Sonic Spirometer. Basic Audiometer: - General requirements of Audiometers. Masking in audiometer, Pure Tone and Speech Audiometer. Audiometer System (Bekesy). Evoked response AudiometrySystem. Calibration of audiometers. Hearing aids-Conventional and Digital hearing	**12 hrs**

	aid, Cochlear Implants	
MODULE 4	**Cardiac pace makers:** Need for Cardiac pace maker. Types of pace makers:-external and Implantable pacemakers. Classification codes for Pacemakers. Ventricular synchronous demand pacemaker, Programmable pacemaker. Power sources for Implantable pacemakers. Cardiac defibrillators: Need for defibrillator. DC defibrillator. Pacer-Cardioverter-defibrillator. Principle of surgical diathermy. Solid state electrosurgical machine. Safety aspects in electrosurgical units.	**10 hrs**
MODULE 5	**Hemodialysis Machine:** Function of the Kidneys. Changes in body fluids in renal disease. Artificial Kidney. Dialyzers: Parallel flow, coil, Hallow fibre type dialyzers. Performance analysis of dialyzers. Hemodialysis machine. Heart lung machine (Cardiac assist device), Lithotripsy, Ventilator, Infant incubator.	**10hrs**

Text Books:

1. Handbook of Biomedical Instrumentation: R S Khandpur-McGrawHill Education, 2nd edition, 2011.
2. "Medical Instrumentation, Application and Design", John G. Webster, 3rd Edition, John Wiley &Sons

Reference Books:

1. "Biomedical Instrumentation and Measurements:Leslie Cromwell, Fred J. Weibell,Erich A. Pfeiffer-PHI 2nd Edition, ,2001
2. Introduction to Biomedical Equipment Technology: Joseph J Carr, John M. Brown-Pearson Education ,4th Edition, 2004.
3. Introduction to Biomedical Instrumentation: Mandeep Singh-PHI 2nd Edition,2014

TITLE: BIOMEDICAL TRANSDUCERS AND MEASUREMENTS

PAPER CODE: BBME3.3	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

This course will enable the students to

CO1:Gain the knowledge of working principle and construction details of Biomedical Transducers.

CO2:Acquire the knowledge of transducer applications to access the biologicalsignals.

CO3:Access the performance of various BiomedicalTransducers.

MODULE 1	**FUNDAMENTAL CONCEPTS & BASIC TRANSDUCERS:** Introduction, Classification of Transducers, Measurement, Signals and Noise in the measurement-Measurement, signals and noise, signal to noise ratio, different types of noise. Characteristics of Measurement system-Transducer and measurement system, static characteristics, dynamic characteristics, standard and calibration, accuracy and error. Displacement, Position and Motion Transducers.	**10hrs**
MODULE 2	**PRESSURE MEASUREMENT:** Pressure Transducers-LVDT pressure transducers and Strain gauge pressure transducers. Physiological pressure ranges and measurement sites, Direct pressure measurement-catheters for pressure measurement, diaphragm displacement transducers, catheter tip pressure transducers, implantable pressure transducers and pressure telemetering capsules. Indirect pressure measurement-Indirect measurement of systolic, diastolic, and mean blood pressure, Detection of Kortokoffsounds. **FLOW MEASUREMENT**: Requirements for measurement ranges – blood flow in a single vessel, tissue blood flow, and respiratory gas flow. Electromagnetic flowmeters – principle, methods of magnetic field excitation, perivascular probes, intravascular probes. Ultrasonic blood flowmeters– propagation of ultrasound in the tissue, ultrasonic Doppler flowmeters, blood flow measurement through Doppler imaging. Indicator dilution method – principle and working, thermodilution method,Fick method, thermistor velocity probe, impedance cardiography	**14hrs**
MODULE 3	**TRANSDUCERS AND SENSORS:** Requirements for measurement ranges, Temperature transducers – Thermistors, thermocouples, wire and thin film thermo-resistive elements, P-N junction diodes and transistors, infrared radiation thermometers, infrared thermography. Clinical thermometer probes, tympanic thermometers, telemetering capsules. Photoelectric Transducers:	**10 hrs**

	photovoltaic cells and photo emissive cells.	
MODULE 4	**Biosensors** – Enzyme based biosensors, immunosensors, Microbial sensors, continuous measurement of chemical quantities –intravascular measurements, tissue measurements, Measurement - by blood drainage, Measurements by Microdialysis, Measurements by effluent fluid analysis. Transcutaneous Measurements of pO2, pCO2. Transcutaneous arterial oxygen saturation monitoring – basics of oximetry, pulse oximeter. Polymerase Chain Reaction (PCR): Principle, procedure, instrumentation& applications.SurfacePlasmonresonance(SPR):Principle,procedure, instrumentation & applications	**10 hrs**
MODULE 5	**Sensor Communication and MEMS:** Wireless zone sensing, surface acoustical wave devices, intelligent transportation system, RF-ID, Micro optics, micro-grippers, micro-probes, micro- mirrors, FEDs, communications for smart sensors - sources and standards, automotive protocols, industrial networks, office and building automation, home automation, protocols in silicon, other aspects of networkcommunications **DISPLAY AND RECORDING DEVICES:** Digital voltmeter – Multi meter – CRO – block diagram, CRT – vertical & horizontal deflection system, DSO, LCD monitor, PMMC writing systems, servo recorders, photographic recorder, magnetic tape recorder, Inkjet recorder, thermal recorder.	**10hrs**

Text Books:

1. Biomedical Transducers and Instruments – Tatsuo Togawa, Toshiyo Tamura and P. Ake Oberg, CRC Press,1997.
2. Handbook of Biomedical Instrumentation- R S Khandpur, 2nd edition, Tata McGraw Hill, 2003.
3. Understanding Smart Sensors - by Randy Frank, 2nd Edition, ArtechHouse Publications, 2000.

Reference Books:

1. Biomedical Instrumentation and Measurement – Leslie Cromwell, Fred J Weibell and Erich A. Pfeiffer, 2nd Edition, Prentice-Hall India Pvt. Ltd.,2004.
2. Transducers and Instrumentation -D. V. S. Murty Prentice Hall India Pvt ltd. 2ndEdition.
3. Biosensors - by A.E.GGass, IRL Press,1990.
4. Smart Sensors - by Paul W. Chapman, ISAPress.

TITLE: SIGNAL PROCESSING USING MATLAB

PAPER CODE: **L3.1**	**CREDITS : 1**	**NO OF HRS: 3hrs/week**

1. Introduction to basic Operations using Matlab
2. Program to Compute Linear & Circular convolution, Cross & Autocorrelation.
3. Program to Compute DFT, FFT, Power spectrum and power spectraldensity.
4. Program to Display Static and Moving ECGsignal.
5. Program to Implement 50Hz notch filter for ECG signal and displayPSD.
6. Program to Implement IIR filters for ECG(LPF,HPF,BPF).
7. Program to Implement Low-Pass FIR filter forECG.
8. Program to Implement FIR Filter using KaiserWindow.
9. Program to detect QRS complex and measure the heart rate of a given ECGsignal.
10. Program to improve the SNR using signal averagingtechnique.
11. Program to obtain the DCT & IDCT of ECGsignal.
12. Program to down sample the given ECGsignal.
13. Program to obtain Adaptive noisecancelling.
14. Program to compress the data using Turning point & FANalgorithm.

TITLE: LINEAR INTEGRATED CIRCUIT AND TRANSDUCERS AND SENSORS LAB

PAPER CODE: **L3.2**	**CREDITS : 1**	**NO OF HRS: 3hrs/week**

Part A: LINEAR INTEGRATED CIRCUIT

1. To realize Full wave Precisionrectifier
2. To realize ZCD and Positive and Negative Voltage leveldetectors
3. To design andimplement
   a. Astable Multivibrator using 555timer
   b. Mono-stable Multivibrator using 555timer
4. To realize Sample and Hold circuit using discretecomponents
5. To realize Programmable Gain Amplifier using AnalogMux
6. To design and implement 4 bit R-2R DAC using discretecomponents
7. To design and implement 8-bit DAC using IC (DAC0800)
8. To design and implement 8-bit ADC using IC (ADC0809)

Part B: TRANSDUCERS AND SENSORS

1. Measurement of displacement using LVDT& determine its sensitivity andresolution.
2. Temperature measurement using RTD, Thermistor and Thermocouple, and to find their sensitivity.
3. Measurement of unknown resistance by Wheatstone bridge & finding the sensitivity of the bridge.
4. Measurement of inductance and internal resistance of a choke by three voltmetermethod.
5. Characteristics of Load cell and Cantilever beam using Strain gauge (Quarter, Half and Full bridgeconfiguration)
6. Measurement of blood pressure using sphygmomanometer and automatic digital BP instrument. Finding the systolic and diastolic values and calculate Mean Arterial Pressure (MAP).
7. Measurement of unknown concentration of given solution/body fluid using Spectrophotometer andColorimeter
8. (a) Measurement of pH of a given solution/ body fluid using pHmeter.

   (b) Determination of Conductivity of a given unknown solution/ body fluid using conductivity meter

SEMESTER IV

IV SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 1	Language1	English	4	30	70	100	2
	Language2	Kan/San/Hin	4	30	70	100	2
Part 2	BBME 4.1	Analog and digital communication system	4	30	70	100	4
	BBME 4.2	Medical Imaging Systems	4	30	70	100	5
	BBME 4.3	Biomedical Instrumentation II	4	30	70	100	4
	L4.1	Biomedical Instrumentation lab	3	15	35	50	1
	L4.2	Communication lab	3	15	35	50	1
	Project	ARM microcontroller lab	4	30	70	100	5
Part 3		Mandatory Paper	4	15	35	50	1
Total Marks and credits			**34**	**225**	**525**	**750**	**25**

TITLE: ANALOG AND DIGITAL COMMUNICATION SYSTEM

PAPER CODE: BBME4.1	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

After studying this course, students will be able to:

CO1:Explain the basics concepts of analog modulationtechniques.
CO2:Discuss the basic concepts of digital modulationtechniques.
CO3:Describe the basic concepts of digital data and pulsecommunication.
CO4:Explain and analyze different digital modulationtechniques.
CO5:Describe different wireless area networks and theirapplications.

MODULE 1	**ANALOG COMMUNICATION** Introduction to Communication Systems - Modulation – Types - Need for Modulation. Theory of Amplitude Modulation - Evolution and Description of SSB Techniques - Vestigial Sideband Modulation, Theory of Frequency and Phase Modulation – Comparison of Analog Communication Systems (AM – FM – PM).	**10hrs**
MODULE 2	**PULSE AND DATA COMMUNICATION** Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) - Comparison of various Pulse Communication System (PAM – PTM – PCM). Data Communication: History of Data Communication - Standards Organizations for Data Communication- Data Communication Circuits - Data Communication Codes - Data communication Hardware - serial and parallel interfaces.	**10hrs**
MODULE 3	**DIGITAL COMMUNICATION** Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK)–Phase Shift Keying (PSK) – BPSK – QPSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).	**10 hrs**
MODULE 4	**SOURCE AND ERROR CONTROL CODING** Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, Error Control Coding, linear block codes, cyclic codes - ARQ Techniques.	**10 hrs**
MODULE 5	**MULTI-USER RADIO COMMUNICATION** Wireless Personal Area Networks (WPAN): Network Architecture, WPAN Components, WPAN Technologies and protocols (Bluetooth &Zigbee), WPANApplications.(WirelessWideAreaNetworks:CellularNetworks: Global System for Mobile Communications (GSM) - Code division	**14hrs**

	multiple access (CDMA) – Cellular Concept and Frequency Reuse - Channel Assignment and Handover Techniques - Overview of Multiple Access Schemes - Satellite Communication	

Text Books:

1. Electronic Communication Systems: Wayne Tomasi- Pearson Education, 5th Edition, 2009.
2. Communication Electronics: Louis E. Frenzel-TMH 3rd Edition,2004

Reference Books:

1. Electronic Communication Systems:George Kennedy,Bernard Davis,S.R.M PrasannnaMacgraw Hill,5th Edition, 2012.
2. Wireless Communications: Principles and Practice: Rappaport T.S, - Pearson Education, 2nd Edition, 2007.
3. Principles of Communication :H.Taub, D L Schilling and G Saha,-Pearson Education, 3rd Edition, 2007.
4. Modern Analog and Digital Communication Systems :B. P.Lathi and Zhi Ding -Oxford University Press,3rd Edition, 2010.
5. Electronic Communication Systems: Roy Blake- Thomson Delmar Publications,2nd Edition2005.

TITLE: MEDICAL IMAGING SYSTEMS

PAPER CODE: **BBME4.2**	**CREDITS : 5**	**TOTAL NO OF HRS: 54**

Course Outcomes :

After studying this course, students will be able to,

CO1:Define the general terminology of digital imageprocessing.
CO2:Identify the need for image transforms and their types both in spatial and frequency domain.
CO3:Identify different types of image degradation and apply restorationtechniques.
CO4:Describe image compression models and learn image compressiontechniques.
CO5:Explain and apply various methodologies for imagesegmentation.
CO6: Implement image processing and analysisalgorithms.

MODULE 1	**MEDICAL X-RAY EQUIPMENT** Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Cathode and filament currents, Focusing cup, Thermionic emission, Electromagnetic induction, Line focus principle and the heel effect, Causes of x-ray tube failure: Electron arcing/filament burn out, Failure to warm up tube, High temp due to over exposure, x-ray tube rating charts.X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography andDental x-ray unit.	**10hrs**
MODULE 2	**COMPUTED TOMOGRAPHY** Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors-Viewing systems- spiral CT scanning – Ultra fast CT scanners. Advantages of computed radiography over film screen radiography: Time, Image quality, Lower patient dose, Differences between conventional imaging equipment and digital imaging equipment: Image plate, Plate readers, Image characteristics, Image reconstruction techniques-backprojectionanditerativemethod.SpiralCT,3DImaging and its application.	**10hrs**
MODULE 3	**MAGNETIC RESONANCE IMAGING** Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system- system magnet (Permanent, Electromagnet and Super conductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), and shim coils, Electronic components, fMRI.	**10 hrs**

MODULE 4	**NUCLEAR MEDICINE TECHNIQUES** Nuclear imaging – Anger scintillation camera –Nuclear tomography – single photon emission computer tomography, positron emission tomography – Recent advances .Radionuclide imaging- Bone imaging, dynamic renal function, myocardial perfusion. Non imaging techniques- hematological measurements, Glomerular filtration rate, volume measurements, clearance measurement, whole -body counting, surface counting	**10 hrs**
MODULE 5	**RADIATION THERAPY AND RADIATION SAFETY** Radiation therapy – linear accelerator, Telegamma Machine. SRS –SRT,- Recent Techniques in radiation therapy - 3DCRT – IMRT – IGRT and Cyber knife- radiation measuring instruments- Dosimeter, film badges, Thermo Luminescent dosimeters- electronic dosimeter- Radiation protection in medicine- radiation protection principles.	**14hrs**

Text Books:

1. Steve Webb, ―The Physics of Medical Imaging", Adam Hilger, Philadelpia, 1988 (Units I, II, III &IV).
2. R.Hendee and Russell Ritenour ―Medical Imaging Physics", Fourth Edition William, Wiley-Liss,2002.

Reference Books:

1. Gopal B. Saha ―Physics and Radiobiology of Nuclear Medicine"- Third edition Springer, 2006. 2. B.H.Brown, PV Lawford, R H Small wood, D R Hose, D C Barber, ―Medical physics and Biomedical Engineering", - CRC Press,1999.
2. Myer Kutz, ―Standard handbook of Biomedical Engineering and design", McGraw Hill, 2003. 4. P.Ragunathan, ―Magnetic Resonance Imaging and Spectroscopy in Medicine Concepts and Techniques",Paperback – Import,2007

TITLE: BIOMEDICAL INSTRUMENTATION II

PAPER CODE: BBME4.3	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

After studying this course, students will able to:

CO1:Analyze and interpret the types of heartabnormalities.
CO2:Describe the constructional details of equipment's used incardiology.
CO3:Explain the basic principles of ophthalmologyinstruments.
CO4:Discuss the clinical methods and surgical procedures inophthalmology.
CO5:Use few of the ophthalmological instruments for diagnosticpurpose.

MODULE 1	Catheterization Laboratory Instrumentation, Arrhythmia monitor, Exercise stress testing, Ambulatory monitoring instruments. Foetal Monitoring Instruments: Cardiotocograph, Abdominal Foetal Electrocardiogram, FoetalPhonocardiogram Oximeters: Oximetry, Ear Oximeter, Pulse Oximeter, Skin reflectance Oximeters, Intravascular Oximeter	**10hrs**
MODULE 2	Tonometry and its types, Perimetry - Peripheral Field Charting, Central Field Charting, Fundus Fluorescein Angiography, Electroretinography, Electro-oculography, Loupe & Lens Examination, Slit-Lamp Examination, Gonioscopy, Retinoscope- Principle, Procedure & Types, Refractometry, Keratometry- principle and types, subjective refraction, Ophthalmoscopy-Direct & Indirect	**10hrs**
MODULE 3	Physiology of vision, Errors of refraction and their optical correction, Aqueous humor production and drainage, Strabismus. Clinical methods: Spectacles and contact lenses, Refractive surgery, Snellen s Chart, Cover – uncover test, Maddox rod test, Maddox wing test. Cataract – list of classification only, Surgical techniques for cataract extraction – Intracapsular cataract extraction &Extracapsular cataract extraction for adulthood cataract, Phacoemulsification, Intraocular lens implantation. General considerations of Glaucoma, surgical procedures for Glaucoma, Vitreous Liquefaction, Vitreous Opacities, Vitreous Haemorrhage, Vitrectomy-typesandtechniques,LasersinOphthalmology,Cryotherapy in Ophthalmology	**12 hrs**
MODULE 4	Orthopedics and Instrumentation Pathology of Fractures and Fracture Healing: Classification, Closed and Open Fracture, Patterns of Fracture, Healing of Fractures, Repair of Tubular Bone, Repair of Cancellous Bone, Rate of Union, Fatigue or Stress Fractures, Pathological Fractures, Radiological Features – History, Clinical Examination, Addition Clinical Investigations, Radiographic and Imaging Techniques, Test of Union. Principles of Fracture Treatment: Treatment of Uncomplicated Closed Fractures – Reduction, Methods of Reduction, Methods of Immobilization, Treatment of Open Fractures, Delayed Union and Non Union, Bone	**12 hrs**

	Grafting, Mall Union	
MODULE 5	Anesthesia and Instrumentation Supply of Anesthetic Gases: Cylinders, Pin Index System, Oxygen Concentrators, Bulk store, Liquid Oxygen, Nitrous Oxide, Entonox, Medical Compressed Air, Piped Medical vacuum, Differential Pressure Flow meters, Variable – Area Constant Differential Pressure Flow meter. Vaporizers: Vaporization of Liquid Anesthetic agents, Vaporizing systems, Factors affecting vapor concentration, Boyles Vaporizer, Its problem and Practical use, Safety Features – Non Return Valve, Emergency Oxygen, Oxygen Failure warning devices. Electronics inAnestheticMachine–ControlEngineering,Newcomponents, electronically controlled Anesthetic machine, Servo controlled Anesthesia	**10hrs**

Text Books:

1. Textbook of Medical Physiology:Guyton & Hall, 11th Edition, Reed Elsevier Pvt. Ltd., 2007.
2. Handbook of Biomedical Instrumentation:R S Khandpur, 2nd edition, McGrawHill Education, 2011.

Reference Books:

1. Concise Medical Physiology: Sujith K. Chaudhuri, 5th Edition, New Central Book Agency Pvt. Ltd,2004.
2. A Text book of Anesthesia: R. D. Miller, 5th Edition, Vol-2, Churchill Livingston, 2000.
3. Outline of Orthopedics: John Crawford Adams, David Hamblen, 13th Edition, Jaypee Publication,2007.
4. Adams and Victor's Principles of Neurology: Allan H. Ropper and Robert H. Brown, 8th Edition, McGraw-Hill,2005.
5. Ward"s Anesthetic Equipment: Andrew Davey, John T. B. Moyle, Crispian S. Ward, 3rd Edition, W. B. Saunders CompanyLtd.
6. Outline of Fractures:John Crawford Adams, David Hamblen, 11th Edition, Churchill Livingstone,1999.
7. Comprehensive Ophthalmology: A. K. Khurana, 4th Edition, New Age International Ltd., 2010

TITLE: BIOMEDICAL INSTRUMENTATION LAB

PAPER CODE: **L4.1**	**CREDITS : 1**	**NO OF HRS: 3hrs/week**

1. Design and study of Instrumentation Amplifier forBiosignals
2. Study of ECG System to detect QRS complex and measure heart ratewith recording and Analysis
3. Study of EEG System and Evoked Potentialswith recording andAnalysis
4. Study of EMG Biofeedback System and Nerve Conduction Velocitywith recordingand Analysis
5. Study of Heart sounds using PCG System and ElectronicStethoscope
6. Study of EOG System to detect eyeblinks
7. Study of Pacemaker System and DefibrillatorSystem
8. Study the characteristics of optical Isolation forBiosignals
9. Measurement of pulse-rate using Phototransducer.
10. Measurement of pH andconductivity.
11. Measurement of blood pressure usingsphygmomanometer.
12. Measurement and recording of peripheral bloodflow
13. Measurement of Oxygen saturation using PulseOximeter
14. Design a PCB layout for any bio amplifier using suitable softwaretool

TITLE: COMMUNICATION LAB

PAPER CODE: L4.2	CREDITS : 1	NO OF HRS: 3hrs/week

PART A

1. Audio cross over network
2. AmplitudeModulator
3. Amplitudedemodulator.
4. Frequency modulator
5. Pre-Emphasis andDe-Emphasis.
6. Automatic GainControl.
7. Saw-tooth wave generator using IC555.
8. Voltage controlled oscillator using IC555.

PART B

1. Frequency multiplier usingtransistor.
2. FrequencyMixer.
3. PAM usingtransistor.
4. PWM and PPM usingIC-555.
5. ASK modulation and demodulation using OP-AMP ortransistor
6. FSK modulation using IC-555 or565.
7. Optical fiberExperiments
8. Communication KitExperiments
    a. Samplingtheorem
    b. QPSK.
    c. BPSK
    d. DeltaModulation

SEMESTER V

V SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Part 2	BBME 5.1	Data Analytics	4	30	70	100	5
	BBME 5.2	Bio Control System	4	30	70	100	5
	BBME 5.3	Application of Nano in Health care	4	30	70	100	5
	BBME 5.4	Embedded system design &RTOS	4	15	35	50	4
	L5.1	Embedded system Lab	3	15	35	50	1
	Project		4	30	70	100	5
Total Marks and credits			**23**	**150**	**350**	**500**	**25**

TITLE: DATA ANALYTICS

PAPER CODE: BBME5.1	CREDITS : 5	TOTAL NO OF HRS: 54

Course Outcomes :

CO1:Introduce students the concept and challenge of big data (3 V's: volume, velocity, and variety). Teach students in applying skills and tools to manage and analyze the bigdata.

MODULE 1	Preparatory: Data Science landscape, relevance and importance of data analytics, Data sources: Social data - from organizations like WHO and social sites like face book. Government data - like data.gov.in, Data from own organization, Data formats: Structured, Semi-structured, Unstructured, Excel for presentation and simple visualization of structured data. Raw and Processed Data, Components of Tidy Data, Downloading Files, Reading Local Files, Reading Excel Files, Reading XML, Reading JSON, Reading from MySQL, Reading from HDF5, Reading from The Web, Reading From APIs.	**09hrs**
MODULE 2	Data preparation / Mugging: Subsetting and Sorting, Summarizing Data, Handling missing values, Creating New Variables, Reshaping Data, Merging Data.	**09hrs**
MODULE 3	Data Exploration: Exploratory Graphs	**09hrs**
MODULE 4	Data Modelling: Data grouping, frequency, and aggregation, Handling missing data, Text manipulation and format conversion, Assertions and logical operations	**09hrs**
MODULE 5	Analysis: Mathematical functions, Sampling , Relationship between variables, Rank and percentile Time series analysis, Descriptive statistical measures, Confidence level, Analysis of variance, Correlation Covariance, Regression, Moving average	**09hrs**
MODULE 6	Visualization Comparison among items, Comparison over time, Relationship - two variables and three variables, Distribution - histogram, line chart, scatter chart, 3D area chart, Composition - static and changing over time	**09hrs**

Text Books:

1. Python Data Science Handbook: Essential Tools forWorking with Data :Jake VanderPlas, , O'Reilly,2017
2. Python for Data Analysis :W Mckinney, -O'Reilly,2013

Reference Books:

1. Getting Started with Data Science: Murtaza Haider, , IBM Press,2015
2. Introducing Data Science: Big Data, Machine Learning, andMore :Davy Cielen , Manning, 2016

TITLE: BIOCONTROL SYSTEMS

PAPER CODE: BBME5.2	CREDITS : 5	TOTAL NO OF HRS: 54

Course Outcomes :

CO1:To understand the concept behind feedback and continuum in various systems and subsystems.

CO2:To analyze the systems in time and frequency domain and to understand the concept of stability

CO3:To apply mathematical modeling principles in understanding the various fundamental biologicalsystems

CO4:To analyze biological system models usingMATLAB

MODULE 1	**INTRODUCTION** Open and Closed loop Systems, Modeling and Block Diagrams, Block diagram and signal flow graph representation of systems, reduction of block diagram and signal flow graph, Introduction to Physiological control systems-Illustration,Linearmodelsofphysiologicalsystems,Difference between engineering and physiological control system	**12hrs**
MODULE 2	**TIME RESPONSE ANALYSIS** Step and impulse responses of first order and second order systems, time domain specifications of first and second order systems, steady state error constants, Definition of stability, Routh- Hurwitz criteria of stability, root locus technique, construction of root locus and study of stability.	**10hrs**
MODULE 3	**FREQUENCY RESPONSE ANALYSIS** Frequency domain specifications - Polar plots, Bode plots, Nyquist plot, Nyquist stability criterion, closed loop stability, Constant M and N circles, Nichol's chart.	**12 hrs**
MODULE 4	**BIOLOGICAL SYSTEM MODELS** Distributed parameter versus lumped parameter models, Model development of Cardiovascular system- Heart model-circulatory model, Pulmonary mechanics- Lung tissue visco-elastance-chest wall- airways, Interaction of Pulmonary and Cardiovascular models, Static analysis of physiological systems – Regulation of cardiac output, Regulation of ventilation.	**10 hrs**
MODULE 5	**BIOLOGICAL CONTROL SYSTEM ANALYSIS** Simple models of muscle stretch reflex action, Study of steady state analysis of muscle stretch reflex action, Study of transient response analysis of neuromuscular reflex model action, Study of frequency response of circulatory control model, Stability analysis of Pupillary light reflex	**10hrs**

Text Books:

1. Control Systems Engineering :I.J. Nagarath and M. Gopal -5th Edition, Anshan Publishers,2008.
2. Physiological Control Systems :Michael C K Khoo-IEEE Press, Prentice Hall of India, 2005

Reference Books:

1. Automatic Control Systems :Benjamin C. Kuo- PHI,1995.
2. Introduction to Biomedical Engineering: John Enderle Susan Blanchard, Joseph Bronzino-2nd edition, Academic Press,2005.
3. Modern control systems :Richard C. Dorf, Robert H. Bishop-Pearson,2004.

TITLE: LATEST TRENDS IN HEALTH CARE

PAPER CODE: BBME5.3	CREDITS : 5	TOTAL NO OF HRS: 54

Course Outcomes :

CO1:To provide a broad view of the nascent field of nanoscience and nanotechnology to undergraduates

CO2:To explore the basics of nanomaterial synthesis andcharacterization.

CO3:To introduce the applications of nanotechnology

MODULE 1	Introduction to Nanotechnology, Basic Structure of Nanoparticles- Kinetics in Nanostructure Materials- Zero dimensional, size and shape of nanoparticles; one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors,bionano-particles. Fabrication And Characterization Of Nanomaterials Gas, liquid, and solid –phase synthesis of nanomaterials; Lithography techniques (Photolithography, Dip-pen and Electron beam lithography); Thin film deposition; Electrospinning. Bio-synthesis of nanomaterials.	**12hrs**
MODULE 2	Polymeric Materials: Polypeptides, Liposomes, Dendrimers, Miscelles, Conjugation, Fabrication,Advantages and Issues	**10hrs**
MODULE 3	Nano particles:Quantum Dots, Metal Nanoparticles, Magnetic Nanoparticles, Conjugation, Fabrication, Advantages and Issues Nanofibers: Electrospun Fibers, Self Assembled Fibers,Conjugation, Fabrication, Advantages and Issues	**12 hrs**
MODULE 4	Applications of Nanotechnology in Biomedical Electronics: Drug Delivery, Imaging and Diagnostics, Cancer Detection, Tissue Regeneration	**10 hrs**
MODULE 5	APPLICATIONS of Robotics in Biomedical Electronics – Bio Engineering Biologically Inspired Robots, Neural Engineering, Application in Rehabilitation – Interactive Therapy, Bionic Arm, Clinical and Surgical – Gynecology, Orthopedics, Neurosurgery	**10hrs**

Text Books:

1. Springer Handbook of Nanotechnology by Bharat Bhushan 2004.(Unit I –V)
2. Encyclopedia of Nanotechnology - Hari Singh Nalwa 2004. (Unit I –V)

ReferenceBooks:

1. Nanomaterials, Nanotechnologies and Design: an Introduction to Engineers andArchitects, D. Michael Ashby, Paulo Ferreira, Daniel L. Schodek, Butterworth-Heinemann, 2009.
2. Handbook of Nanophase and Nanostructured Materials (in four volumes), Eds: Z.L.Wang, Y. Liu, Z. Zhang, Kluwer Academic/Plenum Publishers, 2003.
3. Handbook of Nanoceramics and their Based Nanodevices (Vol. 2) Edited byTseung-Yuen Tseng and Hari Singh Nalwa, American Scientific Publishers.

TITLE: EMBEDDED SYSTEM DESIGN &RTOS

PAPER CODE: BBME5.4	CREDITS : 4	TOTAL NO OF HRS: 54

Course Outcomes :

CO1:To understand the aspects of Real Time Embeddedconcepts
CO2:To learn the Essentials of Open Source RTOS and theirusage
CO3:To select the proper technique to design a Real-TimeSystem
CO4:To understand VxWorks RTOS and real time application programming withit
CO5:To build the device driver and kernel internal for Embedded OS and RTOSearn and apply the knowledge of Memorysystems

MODULE 1	**EMBEDDED OS INTERNALS** Linux internals: Process Management, File Management, Memory Management, I/O Management. Overview of POSIX APIs, Threads – Creation, Cancellation, POSIX Threads Inter Process Communication – Semaphore, Pipes, FIFO, Shared Memory Kernel: Structure, Kernel Module Programming Schedulers and types of scheduling. Interfacing: Serial,ParallelInterruptHandlingLinuxDeviceDrivers:Character,USB, Block & Network.	**12hrs**
MODULE 2	**OPEN SOURCE RTOS** Basics of RTOS: Real-time concepts, Hard Real time and Soft Real-time, Differences between General Purpose OS & RTOS, Basic architecture of an RTOS, Scheduling Systems, Inter-process communication, Performance Matric in scheduling models, Interrupt management in RTOS environment, Memory management, File systems, I/O Systems, Advantage and disadvantage of RTOS. POSIX standards, RTOS Issues – Selecting aReal-Time Operating System, RTOS comparative study.	**12hrs**
MODULE 3	**REAL TIME KERNEL BASICS** Converting a normal Linux kernel to real time kernel, Xenomai basics. Overview of Open source RTOS for Embedded systems (Free RTOS/ ChibiosRT) and application development. Real Time Operating Systems: Event based, process based and graph based models, Petrinet models. Real time languages, real time kernel, OS tasks, task states, task scheduling, interrupt processing, clocking, communication and Synchronization. Control blocks, memory requirements and control, kernel services, basic design using RTOS.	**10 hrs**
MODULE 4	**VXWORKS / FREE RTOS** VxWorks/ Free RTOS Scheduling and Task Management – Realtime scheduling, Task Creation, Intertask Communication, Pipes, Semaphore, Message Queue, Signals, Sockets, Interrupts I/O Systems – General	**10 hrs**

	Architecture, Device Driver Studies, Driver Module explanation, Implementation of Device Driver for aperipheral.	
MODULE 5	**CASE STUDY** Software Development and Tools: Simulators, debuggers, cross compilers, in circuit emulators for the microcontrollers. Interface Issues Related to Embedded Systems: A/D, D/A converters, FPGA, ASIC, diagnostic port. Cross compilers, debugging Techniques, Creation of binaries & porting stages for Embedded Development board (Beagle Bone Black, Rpi or similar), Porting an Embedded OS/ RTOS to a target board ().Testing a real-time application on the board.	**10 hrs**

Text Books:

1. Essential Linux Device Drivers :Venkateswaran Sreekrishnan- 1st Kindle edition, Prentice Hall,2008
2. WritingLinuxDeviceDrivers:AGuidewithExercises :JerryCooperstein,-J. Cooperstein publishers ,2009

Reference Books:

1. Real Time Concepts for Embedded Systems :Qing Li and CarolynYao,-Qing Li, Elsevier ISBN:1578201241 CMP Books ©2003
3. Embedded Systems Architecture Programming and Design :Raj Kamal,- Tata McGraw Hill, 2011
4. Embedded/Real Time Systems Concepts, Design and Programming Black Book : KVK Prasad, - Wiley India,2003
5. Real-Time Systems Design and Analysis:Tools for the Practitioner":Seppo J. Ovaska Phillip A. Laplante,", 4th Edition,2013.
6. Structured Development for Real - Time Systems v1, v2,V3 : Implementation ModelingTechniques :Ward, Paul T & Mellor, Stephen- PHI,2015.
7. Embedded Software Primer: David E. Simon-Addison-Wesley Professional ,2000.

TITLE: EMBEDDED SYSTEM LAB

PAPER CODE: L5.1	CREDITS : 1	NO OF HRS: 3hrs/week

TEXAS INSTRUMENTS INNOVATIVE LAB

VI SEMESTER							
Part	**Paper**		**Hours/week**	**Marks**			**Credit**
	Code	**Title**		**IA**	**Exam**	**Total**	
Project/Internship			23	150	350	500	25
Total Marks and credits			**23**	**150**	**350**	**500**	**25**