



**COURSE OF STUDY AND SCHEME OF EXAMINATION OF  
B.TECH/B.ARCH/M.TECH/M.C.A.  
NATIONAL INSTITUTE OF TECHNOLOGY, RAIPUR**

**Branch- Biomedical Engineering  
Semester- IV**

**Course- B.Tech.(NIT Scheme)**

S. No.	Board of Studies	Sub. Code	Subject Name	Periods/Week			Examination Scheme					Total Mark	Credits L+(T+P)/2
				L	T	P	TA	FE	SE	ESE	Prac. ESE		
1	Biomedical Engg.	BM20411BM	Microbiology	3	1	-	20	15	15	70	-	120	4
2	Mathematics	MA20412BM	Numerical Analysis	3	1	-	20	15	15	70	-	120	4
3	Biomedical Engg.	BM20413BM	Biomedical signal Processing	3	1	-	20	15	15	70	-	120	4
4	Biomedical Engg.	BM20414BM	Digital Electronics	3	1	-	20	15	15	70	-	120	4
5	Biomedical Engg.	BM20415BM	Biomedical Instrumentation	3	1	-	20	15	15	70	-	120	4
6	Biomedical Engg.	BM20416BM	Analog Circuits	4	1	-	20	15	15	70	-	120	5
7	Biomedical Engg.	BM20421BM	Microbiology Lab	-	-	2	30	-	-	-	20	50	2
8	Biomedical Engg.	BM20422BM	Analog & Digital Lab	-	-	2	30	-	-	-	20	50	2
9	Biomedical Engg.	BM20423BM	Biomedical Instrumentation & Biosignal Processing Lab	-	-	2	30	-	-	-	20	50	2
10	Humanities	EN20424BM	Personality Development	-	-	2	25	-	-	-	-	25	1
11			Discipline	-	-	-	25	-	-	-	-	25	1
			Total	19	6	8	260	90	90	420	60	920	33



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Microbiology	Subject code	BM20411BM
Semester	Fourth	Board of Studies	Biomedical Engg.
Maximum Marks	75	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	Nil	4

### MODULE I Introduction of Microbiology

Microbial taxonomy; including modern approaches of taxonomy such as DNA homology; ribotyping; ribosomal RNA sequencing characteristics of primary domains and numerical taxonomy; Taxonomic nomenclature and Bergey's manual. Microscopic techniques for study of microorganisms.

### MODULE II Microbial Organism

Organization of Microbial cells: Morphology and cell structures of Prokaryotes and Eukaryotes (bacteria; fungi; algae; and viruses); comparative account of Prokaryotes and Eukaryotes cells; Different cultures techniques for cultivation; isolation; and preservation methods; effect of environment.

### MODULE III Microbial Growth

Growth; definition of growth; growth curve; mathematical expression of growth; growth culture; measurement of growth and growth yield synchronous and asynchronous; different factors affecting growth. Pure culture and isolation techniques; growth inhibitory substances; control of microorganisms; fundamentals of control; theory and practices of sterilization; physical and chemical agents and their mode of actions on microorganisms; chemotherapy; sporulation and cell differentiation.

### MODULE IV - Microbial Metabolism

Principles of microbial nutrition; Nutrition media construction of culture media ; choice of media and incubation conditions ; growth requirements including different physical conditions; Metabolic products of industrial importance; metabolic pathways-anabolic and biosynthetic.

### MODULE V - Microbiology of Food

Water Milk and Soil; Plasmids; YAC's as vectors; Transformation; conjugation and transduction processes; mutations; developments of resistance to antibiotics; microbial assays of antibiotics; brief introduction to life cycle molecular biology; microbial disease caused by bacteria and viruses tuberculosis; STD diseases; AIDS; malaria; plague etc.

### TEXT BOOKS:

1. Methods for general and Molecular Bacteriology by Gerhardt et al. (1994) ASM Press.
2. Microbiology by Pelzar, Chan and Kreig (1986) McGraw Hill.
3. Microbiology by Prescott, Harley and Klein (1996) William C. Brown Press.



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Numerical Analysis	Subject code	MA20412BM
Semester	Fourth	Board of Studies	Mathematics
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	Nil	4

### MODULE I - Numerical Solution of Algebraic & Transcendental Equations

Bisection Method, Regula Falsi Method, Newton- Raphson Method, Secant Method, Birge-Vieta Method, Errors in numerical computation, Error type, Analysis and Estimation, Error Propagation.

### MODULE II - System of Linear Algebraic Equations

Solution of simultaneous algebraic equations by Gauss elimination method, Gauss-Jordan method, Crout's triangularization method, iterative methods of solutions, Jacobi method, Gauss- Siedel method, relaxation method.

### MODULE III - Interpolation with Equal and Unequal Intervals

Finite difference, difference of polynomial in Factorial notation, Other difference operator, Newton's Forward and Backward interpolation formula, Central interpolation formula, Stirling's formula, Bessel's formula, Lagrange's formula and Newton's Divided difference interpolation formula

### MODULE IV - Numerical Differentiation, Integration & Curve fitting

Numerical differentiation, Numerical integration – Newton-Cote's Quadrature Formula, Trapezoidal Rule, Simpson's Rules, Weddle's Rule, Principle of least square, Curve Fitting Linear & non linear, exponential, logarithmic curve.

### MODULE V - Numerical Solution of Ordinary Differential Equation

Picard's method, Taylor's series method, Euler's methods, Euler's modified method, Runge-kutta fourth order method, Predictor-corrector method, Adams- Bashforth Method, Milne's method.

### TEXT BOOKS:

1. Jain M. K. & Iyenger R.K. "Numerical Methods for Scientific & Engg. Computation," New-Age, International Pub. 4th Edition.
2. Grewal B.S. "Numerical Methods", Khanna Pub.

### REFERENCE BOOKS

1. Burden, Richard L., Fairs, J. Douglas Fairs, "Numerical Analysis", Thomson Asia. PTE, 7<sup>th</sup> Edition.
2. Gourdin A., Boumahrat M. "Applied Numerical Method", PHI.
3. Rajasekaran, S. "Numerical Method in Science & Engineering, A Practical Approach" S.Chand & Co Ltd., II Edition



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Biomedical Signal Processing	Subject code	BM20413BM
Semester	Fourth	Board of Studies	Biomedical Engg.
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	Nil	4

### MODULE I – Fundamentals of Signal & System

Introduction to continuous and discrete time signals and systems; Signals, types of signal, singularity functions, exponential and sinusoidal signal, sinc and signum function, gate signal, manipulation and operation on signals, Energy and power signal, System and types of system, Conversion of analog signal to digital signal, review of Fourier series and Fourier transform.

### MODULE II – Introduction and application of Z- Transform & Fourier Transform

Review of Z-transform, Transfer function, Frequency Response, Convolution, correlation, Power spectral Density, Autocorrelation, DTFT, DFT, FFT, Stationary and Non stationary signal, Time frequency analysis of Biomedical signals, Short term Fourier transform, Wavelet.

### MODULE III – Filters & Bio signal analysis

Elements of Digital filtering, Active and Passive Filters, General Idea of L.P.F, H.P.F, B.P.F and N.F, First order Passive Filters (L.P.F, H.P.F, B.P.F and N.F), IIR and FIR Filters. EEG signal Characteristics and Analysis, ECG signal parameters and their estimation; Arrhythmia analysis monitoring; ECG data reduction techniques.

### MODULE IV – Noise analysis of bio signal

Noise Analysis and Cancellation for Biomedical Application: Source of noise, Types of Noise, Frequency domain temperature, Noise bandwidth, A Review of Wiener filter problem, Noise Analysis and Cancellation Using adaptive Filter, Adaptive Noise Canceller and its application, Signal Averaging.

### MODULE V – Random Theory

Probability & Random Signal theory: set theory, introduction probability, conditional probability & statistical independence, bay's theorem, random variables, discrete random variable, continuous random variables, joint distribution, characteristics of random variables, binomial, Poisson & normal distribution, uniform & other distribution, Probability density Function and Probability Distribution Function, random processes, markov processes.

### TEXT BOOKS:

1. Oppenheim, Wilskey and Nawab "Signals and System", Prentice Hall India.
2. D.C.Reddy, " Biomedical Signal Processing", TMH.
3. Hayken & Van Veen- "Signals and System". Willey.
4. Taub & Schilling-" Principles of Communication System" , Tata McGraw-Hill.
5. Kennady & Davis –"Electronics Communication System", Tata McGraw Hill.
6. Gayakwad "Op-Amp and Integrated circuits", Prentice Hall India.



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Digital Electronic	Subject code	BM20414BM
Semester	Fourth	Board of Studies	Biomedical Engg.
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	Nil	4

### MODULE I – Number system codes & Logic gates

Number-base conversion, Binary codes, Decimal codes, Error detecting code, Reflected Code, alpha-numeric codes. NOT, OR, AND, NOR, NAND, Ex-OR, Ex-NOR gates, fundamental laws of boolean algebra and their application in simplification of Boolean functions. Realization of Boolean Functions using Gates, Universal properties of NAND and NOR Gates.

### MODULE II – Minimization techniques

Expansion of a Boolean expression to SOP & POS forms, Two, Three & Four variable K-Map, Concept of Don't Care Terms; Quine – Mc Clusky Method.

### MODULE III – Combinational circuits

Half adder, Full adder, half subtractor, Full subtractor, Parallel Binary adder, Look Ahead carry adder, Serial adder, BCD adder. Code converter, Magnitude Comparator. Decoder, Encoder, Multiplexer, Demultiplexer. Parity Generator & Checker, Diode based ROM, PAL, PLA & PLD.

### MODULE IV – Sequential circuits, Shift Register & Counters

Flip-Flops & Timing Circuit, S-R Latch; D Latch; J-K flip-Flop; T Flip-Flop, S-R Flip-Flop, D Flip-Flop, Edge-triggered Flip-Flop; Master - Slave Flip-Flop; Direct Preset and Clear Inputs. PIPO, SIPO, PISO, SISO, Bi-Directional Shift Registers; Universal Shift register. Asynchronous Counter, Synchronous Counter, Up Counter, Down Counter, Ring counter, Johnson counter, Twisted Ring Counter, Effect of propagation delay.

### MODULE V – Digital Logic Families

Introduction, Simple Diode Gating and Transistor Inverter; Basic Concepts of RTL and DTL; TTL, IIL, ECL; MOS Logic: CMOS Logic, Comparison between various logic families.

### TEXT BOOKS

1. Fundamentals of Digital Circuits: A. Anand Kumar, PHI
2. Digital Integrated Electronics: H. Taub and D. Schilling: TMH



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Biomedical Instrumentation	Subject code	BM20415BM
Semester	Fourth	Board of Studies	Biomedical Engg.
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
3	1	Nil	4

### MODULE I – Transducers

Classification, Selection, Resistive strain gauge, Gauge factor, Displacement, Capacitance, Inductance, Potentiometric transducers, velocity, photoelectric, photo magnetic and piezoelectric transducers. Temperature measurement, resistance thermometers. thermistors. Thermocouple and digital transducers.

### MODULE II – Physiological Signals

Characteristics of ECG, EMG, EEG, PCG and instrumentation for measuring these signals. Measurement of blood flow by electromagnetic Doppler and plethymographic methods.

### MODULE III –Biochemical Transducers & Amplifiers for Biomedical Application

Working Principles and characteristics of electrode, electrode–electrolyte model, half-cell potential, electrode models, microelectrodes.

Patient lead device, diode circuits, diode bridge current limiters, JEET limiter, isolated leads.

### MODULE IV - Clinical Laboratory Equipment

Medical diagnosis with chemical tests, Spectrophotometry and this type of instrument, colorimeter, spectrophotometer, Automated Biochemical Analysis System, Flame photometer, Selective ion electrodes based electrolytes analyzer.

Blood gas analyzer Acid –base balance, Blood Ph measurement of blood PCO<sub>2</sub>, blood PO<sub>2</sub>, Intra –arterial Blood Gas Analyzers ,Blood cell counters Types of Blood cells, Methods of cell counting, coulter counter, Automatic recognition and differential blood cell counting.

### MODULE V – Neonatal Instrument, Respiratory Measurements & Electrical Hazards

Incubator, Principal and techniques of impedance pneumography and pneumotachography, Apnea monitor, study of mechanical ventilators, Nebulizers & Humidifiers, Anesthesia machine, capnograph. Safety code standards Micro and macro shock and its physiological effects. Leakage currents and protection by use of isolation transformers, equipotential grounding and earth free monitoring.

### TEXT BOOKS

1. Joseph Dubovy: Introduction to Biomedical Electronics. McGraw Hill book Company, I 978
2. John G. Webster: Medical Instrumentation Application & Design Haughton Mifflin, Co. Boston. USA, I 978
3. Weikowisty Etal: Biomedical Instruments – Theory and Design. Academic press. 1976,
4. R.S. Khandpur: Hand Book of Biomedical Instrumentation. Tata McGraw Hill, 1975.
5. L.A. Gedders & L.E. Baker: Principles of Applied Medical Instrumentation. John Wiley & Sons. NY. USA. 1978



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Analog Circuit	Subject code	BM20416BM
Semester	Fourth	Board of Studies	Biomedical Engg.
Maximum Marks	70	Minimum Marks	25
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
4	1	Nil	5

### MODULE I – Transistor at low frequency

Graphical analysis CE configuration, Two Port device and their hybrid model, Transistor hybrid model, h parameter, Conversion formula for the parameters of three transistor configuration, Analysis of transistor amplifier circuit using h parameter, Emitter follower, Comparison of transistor amplifier configuration, Linear Analysis of transistor circuits, Miller's theorem and its Dual, Simplified CE hybrid model, Simplified calculation for CC configuration, Common emitter amplifier with emitter resistance, High input resistance transistor circuits

### MODULE II - Transistor at high frequencies

The hybrid-pi p common emitter transistor model, Hybrid-II conductance the Hybrid-II capacitance, Validity of Hybrid-p Parameter, The CE short circuit current gain, Current gain with resistive load, Single stage CE transistor amplifier response, The gain-bandwidth product, Emitter follower at high frequencies.

### MODULE III – Multistage Amplifier

Classification of amplifier, distortion in amplifiers, Frequency response of an amplifier, Step response of an amplifier, Band pass of cascade stages, RC coupled Amplifier, Low Frequency response of RC coupled stage, Effect of emitter by pass capacitor on low frequency response, High frequency response of two cascade CE transistor stages, Multistage CE amplifier cascade at high frequencies.

### MODULE IV – Feedback Amplifier and Oscillator

Feedback Concept, General Characteristics of Negative feedback amplifier, Voltage Series feedback and voltage series feedback pair, Current Series feedback, Voltage shunt feedback.  
Sinusoidal Oscillator, Phase Shift Oscillator, Resonant circuit Oscillator, General term of Oscillator Circuit, Wein Bridge Oscillator, Crystal Oscillator, Frequency Stability.

### MODULE V – Power Circuit and System

Classification of amplifiers, Class A large signal amplifier, Second Harmonic Distortion, Higher Order harmonic distortion, Transformer coupled audio power amplifier, Puss-pull amplifier, Class B amplifier, Class AB Operation.

### TEXT BOOKS

1. J. Miliman & C. Halkias Integrated electronics. Tata Mc Graw Hill. 1991.
2. Albert Paul Malvino, "Electronics Principle", Tata Mc Graw Hill.
3. Bernard & Grob, "Basic Electronics", Mc Graw Hill.
4. Milliman & Gabrel, "Micro Electronics", Tata Mc Grow Hill



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Microbiology	Subject code	BM20421BM
Semester	Fourth	Board of Studies	Biomedical Engg.
Maximum Marks		Minimum Marks	
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
Nil	Nil	2	2

Experiment No. 1: Pure culture of Bacteria.

Experiment No. 2: Pure culture of fungi.

Experiment No. 3: Isolation & identification of bacteria.

Experiment No. 4: Isolation & identification of fungi.

Experiment No. 5: Permanent slide identification of bacteria & fungi.

Experiment No. 6: Growth curve study of bacteria.

Experiment No. 7: Growth curve of fungi.

Experiment No. 8: Thermal Death point (TDP).

Experiment No. 9: Thermal death time (TDT).



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Analog and Digital	Subject code	BM20422BM
Semester	Fourth	Board of Studies	Biomedical Engg.
Maximum Marks		Minimum Marks	
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
Nil	Nil	2	2

Experiment No. 1: To verify the Truth Table of all Basic, Universal and Special gates.

Experiment No. 2: To make all Basic gates and EX-OR and EX-NOR using NAND and NOR gate.

Experiment No. 3: To design Half Adder using EX-OR, AND and NOT gate verify the Truth Table.

Experiment No. 4: To study Full Adder and Subtractor and verify the Truth Table.

Experiment No. 5: To design RS, JK, D and T Flip-Flop and verify the Truth Table.

Experiment No. 6: To study and verify the Truth Table of Universal Shift Register.

Experiment No. 7: To design Binary to Gray and Gray to Binary Code Converters and verify the Truth Table.

Experiment No. 8: To study and design Multiplexer and Demultiplexer.

Experiment No. 9: To study and design Asynchronous Mod-n Counter.

Experiment No. 10: To design RTL, DTL, TTL circuits.

Experiment No. 11: To study the static input and output characteristics of CB, CC and CE transistor.

Experiment No. 12: To study the drain and Transfer Characteristics of JFET.

Experiment No. 13: To study Wien Bridge Oscillator.

Experiment No. 14: To determine the frequency of RC phase shift oscillator.

Experiment No. 15: To study the Darlington Pair amplifier using transistor.



## DEPARTMENT OF BIOMEDICAL ENGINEERING SYLLABUS

Name of the subject	Biomedical Instrumentation & BioSignal Processing Lab	Subject code	BM20423BM
Semester	Third	Board of Studies	Biomedical Engg.
Maximum Marks		Minimum Marks	
Lecture Periods/Week	Tutorial Periods/Week	Practical Periods/Week	Credits
Nil	Nil	2	2

- Experiment No. 1: To study and measure Blood pressure using analog and digital sphygmomanometer.
- Experiment No. 2: To study EMG waveform generated by built-in EMG Simulator as well as subject (Human Body).
- Experiment No. 3: To study LEAD I, LEAD II & LEAD III of standard Bipolar lead configuration.
- Experiment No. 4: To study AVR, AVF & AVL lead of standard augmented Uni-polar leads configuration.
- Experiment No. 5: To study chest lead of standard Uni-polar leads configuration.
- Experiment No. 6: To measure heart rate of subject and study the heart abnormalities (Tachycardia, Bradycardia).
- Experiment No. 7: To measure and observe the normal and abnormal respiratory signal waveform
- Experiment No. 8: To study EEG trainer in unipolar and average recording mode.
- Experiment No. 9: To observe PCG signal and hear the PCG signal sound.
- Experiment No. 10: To study and measure the intensity of light by spectrophotometer.
- Experiment No. 11: To study Coulter counter instrument for counting cells.
- Experiment No. 12: To study Differential Blood Cell Counter used in hematology for classification and counting white blood cells.
- Experiment No. 13: To study incubator used in cell culture.
- Experiment No. 14: To study Ventilator, Anesthesia machine, Capnograph and Nebulizer.
- Experiment No. 15: To measuring airflow and the corresponding changes in lung volume by pneumotachometer.
- Experiment No. 16: To study working of Plethysmograph.
- Experiment No. 17: To determine characteristics of thermistor.