
**PROPOSED CURRICULA AND SYLLABI
FOR**

S.Y. B. Tech.
(Electronics & Telecommunication Engineering)

w.e.f.
Academic Year 2010-2011 onwards



SGGSIE & T, Nanded

**Department of Electronics and Telecommunication Engineering
Shri Guru Gobind Singhji Institute of Engineering & Technology
Vishnupuri, Nanded- 431606
[May 2010]**



**Shri Guru Gobind Singhji Institute of Engineering and Technology,
Vishnupuri, Nanded- 431 606**

**SYLLABUS SCHEME for
S. Y. B.Tech (Electronics and Telecommunication Engineering) 2010-11 onwards**

Sr. No.	Name of the course	Total No. of credits	Lectures/ week	Tutorials/ week	Practical/ week
Part I					
MA201	Engineering Mathematics III	4	4	-	-
EC212	Electronic Devices and Circuits - I	4	3	-	2
EC213	Digital Electronics	4	3	-	2
EC214	Data Structure and Computer Algorithms	3	3	-	-
EC215	Numerical Methods	3	3	-	-
EC216	Software Lab-I (EC214+EC215)	1	-	-	2
HU201	Communication Skills	1	-	-	2
	Sub Total	20	16	0	8
Part II					
EC221	Engineering Mathematics IV	4	4	-	-
EC222	Electronic Devices and Circuits II	4	3	-	2
EC223	Principles of Communication Engineering	4	3	-	2
EC224	Microprocessor and Microcontroller	4	3	-	2
EC225	Electronics Measurements and Instrumentation	3	3	-	-
EC226	Networks and Lines	3	3	-	-
EC227	Electronics Lab (EC225+EC226)	1	-	-	2
	Sub Total	23	19	0	8
	Total	43	35	0	16

SEMESTER I

MA201: ENGINEERING MATHEMATICS III (L-4, T-0, P-0, CR-4)

SECOND ORDER DIFFERENTIAL EQUATION:

Homogenous linear differential equations for real and complex roots. Modeling: free oscillations, Euler-Cauchy equation, Existence and Uniqueness theorem (without proof) and Wronskian, non-homogenous equations, solutions by undetermined coefficients and variation of parameter methods. Modeling: forced, oscillations, resonance and electrical circuits, system of differential equations

LAPLACE TRANSFORM (LT):

Definition, existence theorem, linearity property of LT, LT of standard functions, theorems on LT, Inverse Laplace transforms (ILT), convolution theorem, unit step function, impulse function, LT of periodic functions, applications to initial and boundary value problems

FOURIER SERIES :

Periodic functions, Fourier theorem, Fourier series, Euler's formulas for the Fourier coefficients, convergence of Fourier series, Change of interval, even and odd functions, half range Fourier Series.

PARTIAL DIFFERENTIAL EQUATIONS:

Separation of variables, Vibrations of string, One dimensional Heat Equation.

Reference Books :

1. Erwin Kreyszig , Advanced Engineering Mathematics, (Eighth Edition), Pub John Wiley & Sons.
2. Advanced Engineering Mathematics, (Second Edition) By : R. K. Jain and S. R. K. Iyengar. Pub. : Narosa Publication House.
3. Elementary Differential Equations and Boundary Value Problem By Boycs and DiPrima, Seventh Edition. Pub. : John Wiley & Sons.
4. Calculus, By Thomos and Finney, Ninth edition, Addison-Wesley Pub.

EC212: ELECTRONIC DEVICES AND CIRCUITS I (L-3, T-0, P-2, CR-4)

Review of basic devices and circuits:

Small signal equivalent circuits of diodes; Simple diode circuits, clipping, clamping, rectifier, etc; Regulated power supplies, Review of BJTs and biasing.

Amplifiers:

BJT amplifiers: DC analysis of transistor circuits; AC analysis of transistor circuits using small signal equivalent circuit of BJT (g_m - r_π model); Common emitter, common collector, common base circuit analysis; Multistage amplifier circuits.

h -parameter model and analysis: Transistor hybrid-parameter model; Analysis of transistor amplifier circuits using h -parameters; Comparison of transistor amplifier configurations, Linear analysis of transistor circuits; Miller's theorem and its dual; Cascaded transistor amplifiers; Simplified CE and CC hybrid model; High input resistance transistor circuits.

Frequency Response of Transistor and amplifier: Amplifier frequency response, system transfer function, transistor amplifier with circuit capacitors, Low and high frequency response of transistor circuits (*excluding* high-frequency model of BJT), Transistor amplifier step response *excluding* high-frequency model of BJT).

Power Amplifiers and output stages: Power transistors; Power amplifiers; Classes of amplifiers: class-A power amplifiers, class-B power amplifiers, Class –AB push-full complementary output stages, Other power considerations.

Sinusoidal oscillators: Criterion for oscillation; Barkhausen criteria; Derivations of frequency and gain criteria of LC, RC, Wien bridge; Crystal and UJT Oscillators; Introduction to Sweep generators.

Reference Books:

1. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw-Hill.
2. Sedra/Smith, Microelectronic Circuits, Oxford University Press.
3. J. Millman and C. C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw-Hill Publishing Company.
4. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, PHI publishers.

EC213: DIGITAL ELECTRONICS (L-3, T-0, P-2, CR-4)

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates;

Boolean Algebra and Logic Gates Theorems and properties of Boolean algebra, Boolean functions, Canonicals and standard forms, other logic operations; Digital logic gates, Digital IC logic families, Logic design examples.

Simplification of Boolean Functions The K-map method, Quine McCluskey method of simplification and NAND-NOR realization.

Digital IC families: DTL, TTL, ECL, MOS, CMOS., Study of different properties of IC families.

Combinatorial circuits: arithmetic circuits, signed magnitude numbers and their arithmetic implementation, code converters, multiplexers, decoders, PROMs and PLAs.

Sequential circuits: latches and flip-flops, Sample and hold circuits, ADCs, DACs.

Counters and Shift Registers Asynchronous counters, Synchronous counters, mod-3, Counters, mod-5 counters, pre-settable counters, shift-counters, Up-down counters, Ripple counters, Shift registers, Serial in serial out, Serial in parallel out, Parallel in serial out, and Parallel in parallel out shift registers.

Semiconductor Memories Memory organization and operation, expanding memory size, classification and characteristics of memories, sequential memories, Read only memories, R/W memories, content addressable memories, CCD memories.

Introduction to VeriLog, HDL

Reference Books :

1. M. Morris Mano, Digital Logic and Computer Design, PHI Publication, New Delhi.
2. William I. Fletcher, An Engineering approach to Digital Design, PHI Publication, New Delhi.
3. Malvino and D. Leach, Digital Principles and Application, Mc Graw Hill Book Company.
4. R. P. Jain, Modern Digital Electronics, McGraw Hill Book Company.
5. Louis Nashelsky, Introduction to Digital Technology, John Wiley & Sons.
6. Williams H. Gothman, Digital Electronics, PHI Publication, New Delhi.
7. N.N. Biswas, Logic Design Theory, PHI Publication, New Delhi.
8. Samir Palnitkar, A guide to Digital Design and Synthesis, Pearson Pub.

EC214 DATA STRUCTURES AND COMPUTER ALGORITHMS(L-3, T-0, P-0, CR-3)

Object Oriented Programming Languages: Introduction and overview of C++

Algorithm Analysis and Notation: Detailed model of computer, simplified model of computer, asymptotic upper bound (big oh), lower bound (omega), theta and little oh, asymptotic analysis.

Foundational Data Structures, Data types and Abstraction: Dynamic arrays, singly linked list,

multidimensional arrays, abstract data types, design patterns.

Stacks, Queues, Deques, Ordered list, and Sorted List

Trees, Search Trees, and Heaps: Basics, n-ary trees, binary trees, tree traversals, expression trees, implementation of trees, search trees – basics, searching and implementation, heaps – basics, binary heaps.

Algorithmic Design Techniques: Brute force and greedy algorithms, backtracking algorithms, divide and conquer, dynamic programming, randomized algorithms.

Sorting Algorithms and Sorters: Basics, sorting and sorters, insertion sorting, exchange sorting – bubble sort, quick sort, selection sorting, merge sort, lower bound on sorting, distribution sorting.

Graphs and Graph Algorithms: Basics, implementing graphs, graph traversals, shortest path algorithms, minimum cost spanning trees.

Introduction to Standard Template Library (STL) of C++

Reference Books:

1. R. Preiss, Data Structures and Algorithms with Object Oriented Design Patterns in C++, John Wiley and Sons.
2. Sartaj Sahni, Data structures, Algorithms, and Applications in C++, McGraw Hill.
3. E Balagurusamy, Object Oriented Programming With C++, Tata Mcgraw Hill.
4. Jean-Paul Tremblay, Paul G. Sorenson, An Introduction to Data Structures With Applications, Mcgraw Hill Computer Science Series
5. Ashok N. Kamthane, Object Oriented Programming with ANSI & Turbo C++, Pearson Education C And Data Structure
6. Ashok N. Kamthane, C And Data Structures, Pearson Education

EC215 NUMERICAL METHODS (L-3, T-0, P-0, CR-3)

Approximations & Errors: Significant figures, accuracy & precision, Error definitions, round off errors, Truncation errors, Error Approximations, Total numerical errors, Blunders formulation errors and Data uncertainty.

Roots of Equation: Bracketing Methods: Graphical methods, Bisections method, false position method **Open Methods:** Simple one point iteration method, Newton Raphson method, secants method, multiple Roots, System of nonlinear equations, **Case Study:** Design of Electric circuit and General Engineering problems.

System of Linear algebraic equations: Gauss eliminations method, pitfalls of elimination, techniques for improving solutions. Gauss Jordan & Gauss seidal methods. Matrix inverse, error analysis and system condition and Gauss Seidal method.

Curve fitting: Least Squares regression: Linear regression, Polynomial regression, multiple linear regression, nonlinear regression. **Interpolation:** Newtons divided difference-interpolating polynomials, Lagrange interpolation polynomials and Spline Interpolation.

Numerical Differentiation & Integration: Newton cotes integration formula: trapezoidal rule, Simpson's rule, and integration with unequal segments. Integrations of equations: Romberg integration, gauss quadrature integration improper integration. Numerical Differentiation, High accuracy differentiation formula, Richardson extrapolation, Derivative of unequally spaced data, derivative and integral estimates for data with errors. **Case studies:** Cash flow analysis, determination of root mean square current by numerical Integration.

Ordinary differential equations: One step method: Euler's method, modification & improvement of Euler's method, Runge-Kutta methods, system of equation **Case Study:** Mathematical model for computer sales Projection, Simulating transient current for Electrical circuit.

Reference Books:

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1. Steven C Chapra, Numerical Methods For Engineers, McGraw-Hill.
 2. S. S. Satry, Introductory Methods of Numerical Analysis, Prentice-Hall India.
 3. V. Rajaraman, Computer Oriented Numerical Methods, Prentice-Hall India.

EC216 Software Lab (EC214+EC215) L-0, T-0, P-2, CR-1)

It should consist of study of at least Fifteen Programmes in C++ based on above two subjects i.e. EC214+EC215.

HU201: COMMUNICATION SKILLS (L-0, T-0, P-2, CR-1)

Objective: The main objective of this course is to prepare the engineering students for future career, further studies through development of listening, reading, writing and speaking skills.

Methodology: The course may be dealt with in following ways: -

1. Discussion by tutor about theoretical nature of different aspects of Communication Skill.
2. Practice of it by the students as pronunciation, public speaking and organizing meeting etc.
3. Intervention by the tutor for corrective measures.
4. Understanding and grasping and then reporting by the students.

Contents: What is communication- need, importance, types, and objectives. Communication process & barriers. Principles of effective communication, Personality Development, SOWT Analysis, Stress Management, Building Positive Attitude, etc

1. Modes of communication.
2. Practice of effective communication through eye contact, voice modulation, audience awareness, presentation plan and verbal & non-verbal Communication.
3. Face to face conversation with body language.
4. Understanding guidelines for telephonic conversation, making and receiving calls, telephonic messages.
5. Interviews Skills for employment – Preparing -Group Interview, Lunch / Dinner Interview, Telephonic Interview, self and reporting for sample questions on educational background, co-curricular activities, extracurricular activities, experience, and general knowledge, miscellaneous.
6. Technical Guidelines for Communication- Hyphenated words, Use of Apostrophe, Abbreviations, Units, etc.
7. Meetings: understanding role and importance of procedure, chairmanship, participation, and physical arrangements, rules for successful meeting- experience sharing and reporting.
8. Group Discussions, Seminars and Conferences- Understanding different aspects- experience sharing and reporting.
9. Practice of public speaking with use of audio – Visual and Graphic aids, experience sharing and reporting.
10. Paragraph writing – Understanding principles, general hints writing and analyzing (practising paragraph writing on 3-5 topics)
11. Understanding the principles and practice of – office drafting, circular, notices, memos, and telex/telegraph/email messages. Application resumes, sales enquiry, reply order, complaint Reports, feasibility report, analytical report, progress report, project report, inspect of damage and losses etc.
12. Preparation of notices, agenda, minutes etc.
13. Grammar – Articles, Tenses, The Preposition, Choice of Words and Phrases, Words commonly Misspelt, Confusing words and Expressions, etc.
14. Phonetics – Pronunciation, Articulation of sounds structure of syllable stress, rhythm, connected speech, intonation, clarity and pitch.
15. Use of integrated skills of communication.

Term work and Reporting:

Term work will be in the form of Report containing minimum 10-12 exercises based on separate topics as mentioned in the syllabus.

The assessment will be made by the concerned teacher or an internal examiner appointed by the Principal of the College.

Reference Books:

1. Krishna Mohan and Meera Banerji, Developing Communication Skill, McMillan Publishers.
2. Writing Correct English – Readers Digest Publication.
3. Sunita Mishra, C. Murlikrishna, Communication Skills for Engineers, Pearson Education.
4. Alok Jain, P S Bhatia & A M Shiekh, Professional Communication Skills, S. Chand, 2005.
5. Rajesh K. Lidiya, Communicative Grammar and Composition, Oxford University Press.

Note: Exercises on Chapter No. 1, 2, 3 and 7 are desirable and one each on other topic is essential.

SEMESTER II

EC221: ENGINEERING MATHEMATICS IV (L-4, T-0, P-0, CR-4)

Vector Calculus:

Vector function, limit and continuity of vector function, derivative vector function, differential geometry (tangent normal and curvature), point function, directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems. .

Complex variables:

Polar form of Complex Number, De Moivre's Theorem and its applications to roots of the equations. Circular function and Hyperbolic functions, Logarithmic of Complex Number, Limits and continuity of complex functions, derivative of Complex functions, Analytic functions, conformal mappings, bilinear transformations, Complex integration, Cauchy's integral theorem and integral formula, Taylor's and Laurent's series, Residue theorem.

Probability and Statistics:

Mean, Median, Mode and standard Deviation, moments. Sample Space, Probability axioms, combinatorics, Conditional probability and Bayes theorem, Independence of events. Random Variables, Probability Distribution of random variable, Discrete and continuous random variable. Distributions: uniform, normal, exponential, Poisson, Binomial

Reference Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig Pub. Wiley India 8th Edition
2. Calculus Monty J. Strauss, Gerald L. Bradley, Karl J. Smith Pub. Pearson Education 3rd Edition
3. Advanced Engineering Mathematics, R. K. Jain and SRK. Iyengar Pub. Narosa Publication 3rd Edition
4. Advanced Engineering Mathematics, Michael D. Greenberg Pub. Pearson Education 2nd Edition
5. An Introduction to Probability and Statistics, V. K. Rohatgi, A. K. Md. Ehsanes Saleh, 2nd ed., John Wiley & Sons, 2001.

EC222: ELECTRONIC DEVICES AND CIRCUITS II (L-3, T-0, P-2, CR-4)

Transistor at High Frequency Hybrid π common emitter transistor model, Hybrid π conductance and capacitance, Variation of hybrid π parameters, CE short-circuit current gain, Single stage CE transistor amplifier response, Gain bandwidth product, Emitter follower at high frequency. Multi stage amplifier: classification, distortion, frequency response, step response; Band pass of cascaded stage, RC coupled amplifier, Low frequency response of RC coupled amplifier, Effect of an emitter bypass capacitor on low-frequency response, High frequency response of two cascaded CE transistor stages, Multi stage CE amplifier cascade at high frequency.

Feedback Amplifier and Amplifier Design Classification of amplifiers, Feedback concept, Transfer gain with feedback, General characteristics of negative feedback amplifier, Input and output resistance, Method of analysis of feedback amplifier, Voltage - series, current - series, voltage - shunt, current-shunt amplifiers. Design of feedback amplifier, emitter follower, cascaded amplifier, and Darlington emitter follower.

MOS Field Effect Transistor Operating modes, Ideal and nonideal current-voltage characteristics, DC circuit analysis, basic applications such as: switch, digital logic gate, amplifier. Amplifier configurations such as: common source, common gate, source follower. DC analysis and small signal analysis. Biasing and bias stability of FET amplifiers

Multivibrators Astable, bistable, and monostable multivibrators; Communicating capacitors, Triggering methods, Schmitt trigger, Gate width, Temperature effect on gate width, Astable time periods,

Recovery at collector, Gated astable multivibrator, Sweep Generators. Function, Signal generators and waveshaping circuits, 555 Timers.

Introduction to differential amplifier using BJT & MOSFET and Op-Amp.

Reference Books:

1. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw-Hill.
2. Sedra/Smith, Microelectronic Circuits, Oxford University Press.
3. J. Millman and C. C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Tata McGraw-Hill Publishing Company.
4. Robert L. Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory, PHI publishers.

EC223 : PRINCIPLES OF COMMUNICATION ENGINEERING(L-3, T-0, P-2, CR-4)

Communications: Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density. Fundamentals of information theory and channel capacity theorem.

Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions.

Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), digital modulation schemes: amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwidth consideration and probability of error calculations for these schemes.

Basics of TDMA, FDMA and CDMA and GSM.

Reference Books

1. A. Bruce Carlson, etal : Communication systems, 4/e, McGraw Hill, 2001
2. H. Taub, D. Schilling, Principles of Communication systems, TMH, 2nd Ed.
3. Simon Haykin, Communication systems, 4/e. John Wiley, 2001
4. G. Kennedy, Electronic Communication Systems, McGraw Hill.
5. D. Roddy and J. Coolen, Electronic Communication, PHI Publication.

EC224: MICROPROCESSOR AND MICROCONTROLLER (L-3, T-0, P-2, CR-4)

Introduction: 8085 Architecture and Microcomputer System, 8085 Assembly Language Programming, Counters and Time delays, Stack and Subroutines, Interrupts structure of 8085, Applications of interrupts in 8085.

Memory and I/O Device interfacing: various decoding schemes such as Partial, Fully exhaustive, Memory mapped I/O, I/O mapped I/O. Interfacing I/O devices,

Introduction microcontrollers : Architecture of 8051. Comparison of 8051 with microprocessor 8085, Registers, Flag bits and PSW register. Parallel I/O ports.

Interfacing of I/O devices and Memory with 8051.

Study of I/O Peripherals : PPI 8255and PTC 8253 interfacing with 8085, 8 bit ADC and DAC ICs and applications, interfacing of key board, stepper motor, LCD display with 8085 and 8051.

Reference Books:

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1. R. S. Gaonkar, Microprocessor Architecture1 Programming and Application with the 8085/8080A.
 2. A. P. Mathur, Introduction to Microprocessor
 3. Muhammad Ali Mazidi and Janice Gillispe, The 8051 Microcontroller and embedded systems, Pearson Education Asia, Indian reprint 2002.
 4. Kenneth J. Ayala, The 8051 Micro-controller– Architecture, Programming & Applications, Second Edition, Penram International & Thomson Asia.

EC 225: ELECTRONICS MEASUREMENTS AND INSTRUMENTATION **(L-3, T-0, P-0, CR-3)**

Measurement and error: Generalized Measurement System, Accuracy and Precision, Significant Figures, Types of Errors, Statistical Analysis, Probability of Errors, Limiting Errors, etc.

Primary sensing elements and transducers: Definition and Classification of Transducers, Characteristics and Choice of Transducers, Potentiometer, Strain Gauges, RTD, Thermister, Thermocouple, LVDT, RVDT, Capacitive Transducer, Piezo-Electric Transducer, Hall Effect Transducers, Photo Emissive Cell, Photoconductive Cell, Photovoltaic Cell, Photo Diode, Photo Transistor, Microphone, Loud Speaker and their Applications.

Electronic Instruments for Measurement of Basic Parameters: DC Meter, AC Voltmeter Using Rectifiers, True Rms Responding Volt-Meter, Electronic Multi-Meter, DVM, etc.

Bridge Measurement: Wheatstone Bridge, Kelvin Bridge, Maxwell Bridge, Hay Bridge, Schering Bridge, Wien Bridge, etc.

Oscilloscopes: Block Diagram of General Purpose Oscilloscope, Vertical Deflection System, Horizontal Deflection System, Probes, Dual Beam Oscilloscope, Dual Trace Oscilloscope, Lissajous Patterns, Storage Oscilloscope, etc.

Reference Books :

1. Alan S. Morris, “Principles of Measurements & Instrumentation”, PHI.
2. A.D. Helfrick & W.D. Cooper, “Modern Electronic Instrumentation & Measurement Techniques”, PHI.
3. Oliver Cage, “Electronic Measurement”, McGraw Hills.
4. Clyde F. Coombs, “Electronic Instruments Handbook”, McGraw Hills.
5. Hewlett Packard, Tektronics, Advantest, Aplab, “Application Notes on Measurement”.
6. A.K. Sawhney, “A course in Electrical and Electronic measurements and Instrumentation”, Dhanpat Rai and Company.

EC226: NETWORK AND LINES (L-3, T-0, P-0, CR-3)

Network Transformations Network definitions, Mesh and node circuit analysis, Principle of duality, Conversion between T and π networks and sections; Network theorems: Superposition, reciprocity, Thevenin’s, Norton’s, compensation, and maximum power transfer; Driving point impedance, Transfer impedance.

Resonance Definition of Q factor, Series resonance, Bandwidth of series resonance circuit, Parallel resonance, Conditions for maximum impedance, Impedance variation with frequency, Bandwidth of parallel resonance circuit, Reactance curves.

Impedance Transformation and Coupled Circuit Coupled circuit, Singly and doubly tuned air core transformers, Dot conventions.

Filters Neper and decibel, Properties of symmetrical networks, Filter fundamentals, Filters: Low pass,

high pass, band pass, band stop, k -derived, m -derived, composite, crystal, and crossover; Equalizers and attenuators.

Transmission Line (TL) Parameters TL, TL equation, Infinite line, Propagation constant, Attenuation constant, Phase constant, Group velocity, Characteristic impedance; Open and short-circuited lines: reflected incident wave, standing wave in open and short circuit lines, impedance of OC and SC lines, secondary line constant, impedance as a function of line length; Line with any termination, Distortion less and lossless lines.

Low Frequency Lines (Power Lines) Losses and efficiency in power lines, Effect of length, Calculation of inductance and capacitance.

Radio Frequency Lines Standing wave ratio, Reflection coefficient, Location of maxima and minima, Impedance circle diagram, Smith chart, Properties and applications of Smith chart, Impedance matching devices, Quarter wave and half wave transformers, Single and double stub matching, Stub matching problems using Smith chart.

Reference Books:

1. John D. Ryder, Network, Lines and Fields, PHI Publication.
2. Van Valkenburg, Network Analysis, PHI Publication.
3. Umesh Sinha, Transmission Lines and Networks, Satya Prakashan, New Delhi.

EC 227: ELECTRONIC LAB (EC225+EC226) (L-0, T-0, P-2, C_r-1)

It should consist of study of at least Ten hardware circuits based on above two subjects i.e. EC225+EC226.

