

Complementary Electronics for Physics Main

Semester 1

EL 1131-ELECTRONICS I (36 HOURS)

Unit 1 Circuit Elements and Fundamentals (10 hour)

Ohm's Law, Linear and non-linear Resistors, Resistor types-Wire wound Resistors, Carbon composition Resistors, Carbon film Resistors, Metal film Resistors, Resistor Colour code, Resistive circuits, Series and Parallel Resistor circuits, Series aiding and Series opposing Voltages, Proportional Voltage formula, Proportional Current formula, Series Voltage Dividers, 'Open' and 'Short' in Series, Parallel and Series – Parallel Circuits.

Inductor, Inductor Types- Air core inductor, Iron-core Inductor, Ferrite-core Inductor, Self Inductance, Mutual Inductance, Coefficient of Coupling, Inductors in Series or Parallel without M, series combination with M, Stray Inductance, Reactance offered by a Coil.

Capacitors, Type of Capacitors- Fixed Capacitors, Variable Capacitors, Capacitance, Capacitors in Series and Parallel, Reactance offered by the Capacitor, Cells in Series and Parallel

Unit 2 Network Theorems (6 hour)

Kirchhoff's Law, Super position theorem, Ideal constant Voltage Source, Ideal constant Current Source, Thevenin's and Norton's Theorem, Maximum Power Transfer Theorem(Proof).

Unit 3 Magnetism and A.C (8 hour)

Magnetic Field, Type of Magnets, Magnetic Shielding, Magnetic Terms and Units, Ohm's Law in Magnetism, Transformer, Transformer working, Transformer Types, Transformer Impedance.

Type of alternating waveforms, Different values of sinusoidal voltage and current, Phase and Phase difference of A.C, Non-sinusoidal waveform, Harmonics, A.C through Resistor, Inductor, Capacitor, L-R, R-C and LCR circuits, Sharpness of resonance, Q-factor, Bandwidth, Tuning of radio, Parallel LCR.

Unit 4 Transient Current (6 hour)

Rise and fall of Current in pure Resistance, Time constant of an L-R Circuit, Inductive Kick, Time constant of an R-C Circuit, Charging and Discharging of capacitor, Decreasing Time Constant, Flasher, Pulse Response of an R-C Circuit, Effect of Long and Short Time Constants.

Unit 5 Introduction to semiconductors(6 hour)

Energy Band, Valance band, Conduction Band, Classification of materials based on energy bands, Type of semiconductors-Intrinsic and Extrinsic, hole formation and its movements, Type of Extrinsic semiconductors-P-type and N-type, Drift current in Intrinsic semiconductors.

Books of Study

- a. Basic Electronics Solid State – B.L.Theraja, S.Chand & Co. Ltd.
- b. Principles of Electronics – V.K.Mehta.

Semester 2

EL1231 - Electronics II (36 hours)

Unit I Tuning circuits and filters (3 hours)

Tuned circuit – operating characteristics of a tuning circuit – series resonance – tuned transformer – double tuned transformer – parallel resonance – coupled circuits-coefficient of coupling- filters- types of filter circuits (low pass, high pass, band pass and band stop filter)- uses of filters.

Unit 2 The P-N junction (5 hours)

The P-N junction – formation of depletion layer – junction or barrier voltage – effect of temperature on barrier voltage – forward biased pn junction – forward V-I characteristics – reverse biased P-N junction – reverse saturation current reverse V-I characteristics– junction breakdown – junction capacitance – equivalent circuit of a pn junction

The ideal diode – real diode – diode circuits with dc and ac voltage sources– diode

fabrication – clippers and clampers

Unit 3 Special diodes (3 hours)

Zener diode – voltage regulation – peak clipper – meter protection – tunneling effect – tunnel diode – tunnel diode oscillator – varactor – PIN diode – Schottky diode – step recovery diode - thermistors

Unit 4 Optoelectronic devices (3 hours)

Introduction – light emitting diode(LED) – theory, construction and applications- photoemissive devices – photomultiplier tube – photovoltaic devices – bulk type photoconductive cells – photodiodes – P-N junction photodiode – PIN photodiode – avalanche photodiode.

Unit 5 Regulated Power Supplies (5 hours)

Unregulated and regulated power supply – steady and pulsating DC voltages – rectifiers – half wave, full wave and bridge rectifiers (working, form factor, PIV, ripple factor, efficiency)- filters- bleeder resistor – voltage regulation – zener diode shunt regulator – voltage dividers – complete power supply – voltage multipliers – half wave voltage doubler – full wave voltage doubler – troubleshooting power supplies – controlled rectification – silicon controlled rectification – SCR- pulse control of SCR – SCR controlled circuit.

Unit 6 Basic Transistor (3 hours)

BJT – transistor biasing and biasing rule – transistor currents – configurations (CB, CE and CC Configurations) – relation between transistor current gains – leakage current in a transistor – thermal runaway.

Unit 7 Transistor Characteristics and Approximations (5 hours)

Transistor static characteristics (input, output and current transfer characteristic) of CB,CE and CC configurations – different ways of drawing transistor circuits – beta rule – importance of V_{CE} cut-off and saturation points – normal DC voltage transistor indications – transistor fault location – solving universal stabilization circuit – applying

AC to a DC biased transistor – transistor AC/DC analysis.

Unit 8 Load Lines and DC Bias Circuits (5 hours)

DC load line – Q point and maximum undistorted output – need for biasing a transistor – factors affecting bias variations – stability factor – beta sensitivity- stability factor of CB and CE circuits – different methods of transistor biasing – base bias – base bias with emitter feedback - base bias with collector feedback - base bias with emitter and collector feedback – voltage divider bias – load line and output characteristics – ac load line.

Unit 9 Transistor Equivalent Circuits and Hybrid Parameters (4 hours)

DC equivalent circuit - AC equivalent circuit - CB and CE amplifier(DC and AC equivalent circuit) – effect of source resistance on voltage gain – h-parameters – h-parameter notations for transistors – h-parameters of an ideal transistor – h-parameters of ideal CB and CE transistors

Books of Study

1Basic Electronics Solid State – B.L.Theraja, S.Chand & Co. Ltd.

2Principles of Electronics – V.K.Mehta.

Semester 3

EL 1331 - ELECTRONICS III (54 Hours)

Unit 1 Single Stage Transistor Amplifiers (10 Hrs)

Amplifier Classifications - Common Base (CB), Common Emitter (CE) and Common Collector (CC) Amplifier : Gains and Characteristics - Comparison of Amplifier Configurations - Classification of Amplifiers Based on Biasing Conditions - Class A Amplifier - Transformer Coupled Class A Amplifier - Class B Amplifier - Class B Push Pull Amplifier - Cross Over Distortion - Complimentary Symmetry Push Pull Class B Amplifier - Class C Amplifier - Distortion in Amplifiers - Noise

Unit 2 Multi Stage Amplifiers (9 Hrs)

Amplifier Coupling - RC Coupled Two Stage Amplifier - Impedance Coupled Two Stage Amplifier - Transformer Coupled Two Stage Amplifier - Direct Coupled Two Stage Amplifier Using Similar Transistors - Direct Coupled Two Stage Amplifier Using Complimentary Symmetry of Two Transistors - Darlington Pair - Differential Amplifier.

Unit 3 Decibels and Frequency Response (3 Hrs)

Decibel System - Frequency Response - Cut off Frequencies - Alpha and Beta Cut off Frequencies - Gain Bandwidth Product.

Unit 4 Feedback Amplifiers (4 Hrs)

Feedback Principle - Types of Feedback - Negative Feedback and its Properties - Forms of Negative Feedback.

Unit 5 Field Effect Transistors (7 Hrs)

FET - JFET : Structure, Theory of Operation and Characteristics - JFET Parameters - MOSFET - DE MOSFET and E only MOSFET : Working and Characteristics - FET Applications.

Unit 6 Breakdown Devices (6 Hrs)

Unijunction Transistor (UJT) - UJT Relaxation Oscillator - Silicon Controlled Rectifier (SCR) - Triac - Diac - Silicon Controlled Switch.

Unit 7 Sinusoidal Oscillators (8 Hrs)

Difference between Amplifier and Oscillator - Classification of Oscillators - Types of Sinusoidal Oscillations - Oscillatory Circuit and its Frequency - Essentials of Transistor LC Oscillator - Barkhausen Criterion for Oscillator - Tuned Base Oscillator - Tuned Collector Oscillator - Hartley Oscillator - Colpitt's Oscillator - Clapp Oscillator - Phase Shift Oscillator - Wien Bridge Oscillator - Crystal Controlled Oscillators.

Unit 8 Nonsinusoidal Oscillators (7 Hrs)

Nonsinusoidal Waveforms - Classification of Nonsinusoidal Oscillators - UJT Sawtooth Generator - Multivibrators - Astable Multivibrator - Monostable Multivibrator - Bistable Multivibrator - Schmitt Trigger - Transistor Blocking Oscillator.

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1 Basic Electronics Solid State – B.L. Theraja, S.Chand & Co. Ltd.

2 Principles of Electronics – V.K.Mehta.

Semester 4

EL1431 - Electronics IV (54 hours)

Unit 1 Modulation and Demodulation (9 Hrs)

Radio frequency spectrum – need for modulation – modulation- methods of modulation – amplitude modulation(AM) - percent modulation – upper and lower side frequencies – mathematical analysis of modulated carrier wave – power relations in AM wave –forms of amplitude modulation – methods of amplitude modulation - methods of amplitude modulation – modulating amplifier circuit - Frequency Modulation (FM) – frequency deviation and carrier swing – modulation index, deviation ratio and percent modulation –FM sidebands – modulation index and number of sidebands – Demodulation – essentials for am detection –diode detector for AM signals – transistor detector for AM signals –FM detection – frequency conversion – superheterodyne AM and FM receivers – comparison between AM and FM.

Unit 2 Integrated Circuits (7 Hrs)

Integrated circuit – advantages and drawbacks – scale of integration – classification of ICs by structure and function – linear integrated circuit – digital integrated circuit – IC terminology- fabrication of monolithic ICs – fabrication of IC

components – application of ICs –OP-AMP – ideal operational amplifier – Op-Amp applications (linear amplifier, unity follower, adder, subtractor, integrator, differentiator and comparator)

Unit 3 Number Systems (6 Hrs)

Number systems – decimal number system – binary system – binary to decimal conversion – binary fractions – Double- Dadd method – decimal to binary conversion – binary operations (addition, subtraction, multiplication and division) complement of a number – 1's complemental subtraction - 2's complemental subtraction – octal number system – octal to decimal and decimal to octal conversion – octal to binary and binary to octal conversion – advantages of octal number system – hexadecimal number system – binary to hexadecimal and hexadecimal to binary conversion.

Unit 4 Logic Gates (7 Hrs)

Positive and negative logic – the OR gate – equivalent relay circuit of an OR gate – diode OR gate – transistor OR gate – three input OR gate – Exclusive OR gate – AND gate – equivalent relay circuit of an AND gate – diode AND gate – transistor AND gate – the NOT gate – equivalent circuit for a NOT gate – Bubbled gates – the NOR gate – NOR gate is a universal gate – the NAND gate – NAND gate is a universal gate – the XNOR gate – Adders and Subtractors - Half Adder – Full Adder – parallel binary adder – Half Subtractor – Full Subtractor.

Unit 5 Boolean Algebra (3 Hrs)

Unique features of Boolean Algebra – laws of Boolean Algebra – equivalent switching circuits – De Morgan's Theorems

Unit 6 Logic Families (6 Hrs)

Important Logic Families - Saturated and Non Saturated Logic Circuits - Characteristics of Logic Families - RTL Circuit - DTL Circuit - TTL Circuit - ECL Circuit - I²L Circuit - MOS Family - PMOS, NMOS and CMOS Circuits.

Unit 7 Transducers (8 Hrs)

Transducers and its Classification - Resistive Position Transducer - Resistive Pressure Transducer - Inductive Pressure Transducer - Capacitive Pressure Transducer - LVDT - Piezoelectric Transducer - Strain Gauge - Temperature Transducers - Resistance Temperature Detectors - Thermistors - Thermocouples - Various Types of Microphones - Loudspeaker.

Unit 8 Electronic Instruments (8 Hrs)

Analog and Digital Instruments - Essentials of an Electronic Instrument - The Basic Meter Movement - Characteristics of Moving Coil Meter Movement - Conversion of Basic Meter to DC Ammeter and DC Voltmeter - Loading Effect of Voltmeter - Ohmmeter - Multimeter - Electronic Voltmeters - Direct Current VTVM - Cathode Ray Oscilloscope - Cathode Ray Tube - Deflection Sensitivity of CRT - Lissajous Figures and Frequency Determination - Applications of CRO - Q Meter.

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