EC (1262)-18.08.2022

Appendix-XCV
Resolution No. 18 [18-1(18-1-5)]

UNIVERSITY OF DELHI

DEPARTMENT: Electronic Science
COURSE NAME: B.Sc. (H) Instrumentation
(SEMESTER - I)

based on

Undergraduate Curriculum Framework 2022 (UGCF)
(Effective from Academic Year 2022-23)

University of Delhi

Course name: B.Sc. (H) Instrumentation

Course Title	Nature of the Course	Total Credits	Components			Eligibility Criteria/ Prerequisite	**Contents of the course and reference is in**
			Lecture	Tutorial	Practical		
Analog Electronics	DSC	4	3	0	1	**Course Admission Eligibility**	**Annexure- I**
Basic circuit theory	DSC	4	3	0	1	**Course Admission Eligibility**	**Annexure- II**
Testing and Measurement	DSC	4	2	0	2	**Course Admission Eligibility**	**Annexure- III**
Fundamentals of Instrumentation	GE	4	3	0	1	**Physics and Mathematics in 10+2**	**Annexure-IV**
Engineering Physics	GE	4	3	0	1	**Mathematics in 10+2**	**Annexure- V**

References

1. R. L. Boylestad, L. Nashelsky, K. L. Kishore, Electronic Devices and Circuit Theory, Pearson Education (2006).
2. N Bhargava, D C Kulshreshtha and S C Gupta, Basic Electronics and linear circuits, Tata Mc Graw Hill (2007).
3. J. Millman and C. Halkias, Integrated Electronics, Tata McGraw Hill (2001).
4. David A. Bell, Electronic Devices & Circuits, Oxford University Press, Fifth edition.
5. Mottershed, Electronic Devices, PHI Publication, 1stEdition.
6. D. L. Schilling and C. Belove, Electronic Circuits: Discrete and Integrated, Tata McGraw Hill(2002).
7. J. R. C. Jaegar and T. N. Blalock, Microelectronic Circuit Design, Tata McGraw Hill(2010).
8. Donald A. Neamen, Electronic Circuit Analysis and Design, Tata McGraw Hill(2002).
9. J.Cathey, 2000 Solved Problems in Electronics, Schaum"s outline Series, Tata Mc Graw Hill (1991).
10. P. Arun, Electronics, Narosa Publishing House,2006.

Analog Electronics Lab (INDSC1AP)

Credits: 01 **Lectures: 32h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the current-voltage characteristics of semiconductor devices.
CO2 Extract important information from the graphical plots of device characteristics
CO2 Design and analyze various application-oriented circuits based on diodes and BJT
CO4 Analyze the frequency response of semiconductor devices for understanding the behavior of electronic circuits at high frequencies.
CO5 Design projects based on-device applications

Syllabus Contents

1. To study I-V characteristics of PN junction and Zener diodes in forward and reverse bias configurations.
2. To study clipping and clamping circuits.
3. To study the Half wave rectifier and full-wave rectifier.
4. To design the power supply with capacitor filter
5. To study input and output I-V characteristics of common base and common emitter transistor configurations.
6. To study Fixed Bias and Voltage divider bias configurations of BJT.
7. To design a Single Stage CE amplifier for a given gain.
8. To study the frequency response of a single stage CE Amplifier
9. To study the Colpitt"s Oscillator.
10. To study the Phase Shift Oscillator.
11. To study Class A, Class B and Class AB power amplifier

Basic Circuit theory (INDSC1B)

Credits: 03 **Lectures: 48h**

Course Learning Objectives

- To develop an understanding of the fundamental laws and elements of electric circuits.
- To learn the energy properties of electric elements and techniques to measure current and voltage.
- To develop the ability to apply circuit analysis to AC and DC circuits.
- To understand signals, waveforms and transient & steady state responses of RLC circuits.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the current-voltage characteristics of basic fundamental elements

CO2 Design and analyze the electronic circuits using various network theorems

CO3 Understand frequency response and behavior of ac circuits

CO4 Understand the concept of two port network and overall response for interconnection of two port networks

Syllabus Contents

Unit-1 **(11 Lectures)**

Basic Circuit Concepts: Voltage and Current Sources including their types, Resistors: types and color coding, Capacitor: types and color coding, Inductor: types and color coding, star-delta conversion & delta-star conversion. Sinusoidal voltage and current: Definition of instantaneous, peak to peak, average and rms value.

Unit-2 **(13 Lectures)**

Concepts of Circuit Analysis: Ohms Law, Kirchhoff's Current Law (KCL), Kirchhoff's Voltage Law (KVL), Node Analysis, Mesh Analysis.

Network Theorem (DC Circuits): Principal of Duality, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Reciprocity Theorem, Millman's Theorem, Maximum Power Transfer Theorem.

Unit-3 **(15 Lectures)**

DC Transient Analysis: Time Constant, Response of RC, RL and RLC circuit to dc source(s), Response of source free RC, RL and RLC circuit.

AC Circuit Analysis: Voltage-Current relationship in Resistor, Inductor and Capacitor, Phasor, Complex Impedance. Mesh Analysis, Node Analysis and Network Theorems for AC Circuits. Frequency Response of Series and Parallel RLC Circuits, Resonance, Quality (Q) Factor and Bandwidth. Fundamentals of passive Filters: Low Pass, High Pass, Band Pass and Band Stop.

Unit-4 **(09 Lectures)**

Power in AC Circuits: Instantaneous Power, Average Power, Reactive Power, Complex Power and Power Triangle, Power Factor.

Two Port Networks: Introduction to two port networks,Impedance (Z) Parameters, Admittance (Y) Parameters, hybrid (h) parameters and Transmission (ABCD) Parameters.

References

1. S. A. Nasar, Electric Circuits, Schaum‟s outline series, Tata McGraw Hill (2004).
2. Electrical Circuits, M. Nahvi and J. Edminister, Schaum‟s Outline Series, Tata McGraw-Hill (2005).
3. Robert L. Boylestad, Essentials of Circuit Analysis, Pearson Education (2004).
4. W. H. Hayt, J. E. Kemmerly, S. M. Durbin, Engineering Circuit Analysis, Tata McGraw Hill (2005).
5. Alexander and M. Sadiku, Fundamentals of Electric Circuits, McGraw Hill (2008).

Basic Circuit theory Lab (Hardware) (INDSC1BP)

Credits: 01 **Lectures: 32h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Analyze and familiarize with active and passive components
CO2 Verify the theoretical concepts through laboratory experiments
CO3 Understand the behavior and evaluate frequency response of electronic circuits

Syllabus Contents

1. Verification of Kirchoff‟s Law.
2. Verification of Norton's Theorem.
3. Verification of Thevenin‟s Theorem.
4. Verification of Reciprocity Theorem.
5. Verification of Superposition Theorem.
6. Verification of the Maximum Power Transfer Theorem.
7. Designing of RC Integrator circuit.
8. Designing of RC differentiator circuit.
9. Designing of a RC Low Pass Filter and study of its Frequency Response.
10. Designing of a RC High Pass Filter and study of its Frequency Response.

Testing and Measurement (INDSC1C)

Credits: 02 **Lectures: 32h**

Course Learning Objective

- To describe the units of measure and the various instruments used in various measurement parameters.
- To teach the various methods in power measurement.
- To make them understand about the error in measurement systems.
- To explain the various components of a testing and calibration system.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the basic concept of measurements and calibration

CO2 Perform error measurement concepts correctly and present final values with the correct units/symbols

CO3 Analyze various standardization techniques in Production Plants

CO4 Familiarize with various testing and calibration procedures in measurement

Syllabus Contents

Unit 1 **(08 Lectures)**

Introduction to Measurement System, Significance of Measurement, Methods of measurement, Elements of a generalized measurement systems.

Performance characteristics of measurement system: Static Characteristics -Accuracy, Sensitivity, Linearity, Precision, Resolution, Threshold, Range, Hysteresis, Dead Band, Backlash, Drift, Impedance Matching and Loading.

Dynamic Characteristics- Types, Fidelity, Speed of Response, Dynamic Error.

Unit 2 **(08 Lectures)**

Measuring Instruments: Introduction to Voltmeters, Ammeters, Ohmmeters, Digital Multimeters, Clamp Meter, Lux meter, Flux Meter, Tester, Function Generator, Bolometer, B-Dot and D-Dot Sensors.

Errors in measurement systems:

Definition of Errors: Systematic Errors, Instrumental Errors, Environmental Errors, Random Errors, Loading Errors, Limiting Errors. Source of Errors in Measuring Instruments.

Unit 3 **(07 Lectures)**

Introduction to Testing, Fault, Types of Faults, Methods used for localizing faults, Methods used for ground and short circuit faults, Murray loop test, Varley loop test, location of open circuit faults in cable, types of Probes and Connectors.

Unit 4 **(09 Lectures)**

Standardization and Calibration Modelling: Standardization in Production Plants and manufacturing houses, Reliability studies and inspection, Product Standardization techniques, Calibration: Calibration of measuring instruments, Theory and Principles (absolute and secondary or comparison method), Setup, Modelling.
Various Testing and Calibration Systems: Sensor calibration and testing, Analytical methods in calibrating, Automated test and calibration systems.

References:

1. Electrical measurement and measuring Instruments by Golding and Widdis.
2. Electrical and Electronic measurements and Instruments By A.K.Sawhney.
3. Electrical measurements and Measuring instruments By Rajendra Prasad.

Testing and Measurement Lab (INDSC1CP)

Credits: 02 **Lectures: 64h**

Syllabus Contents

1. Testing of Active and Passive Components.
2. Testing of all basic components.
3. Calculation and verification of Resistance.
4. Calculation and verification of Voltage and Current.
5. Testing of Faulty equipment.
6. Fault diagnosis of Lab. Instruments.
7. Measurement of Temperature.
8. Measurement of Pressure.
9. Measurement of Power.
10. Measurement of Energy using Energy meter.
11. Study of Electrical and Mechanical parameters standards used in testing and calibration.
12. Calibration of Instruments.
13. Testing of Electrical Components.
14. Testing of Various Instruments.
15. Murray Loop test
16. Varley loop test
17. B-Dot sensor, D-Dot sensor
18. Lux meter
19. Flux meter
20. Multimeter
21. Error measurement

Fundamentals of Instrumentation (INGE1A)

Credits: 03 **Lectures: 48h**

Course Learning Objectives

- To learn about basic concepts of Instrumentation.
- To understand the basic concept of errors and study different types of errors present in measurement systems.
- To study different characteristics of measurement systems.
- To study different types of transducers – resistive, capacitive and inductive
- To study signal conditioning.

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Understand the basics of concepts of Instrumentation and measurement systems

CO2 Identify and comprehend various sensors used in the real-life applications and paraphrase their importance

CO3 Classify and explain with examples of transducers, including those for measurement of temperature, strain, motion, and light

CO4 Be conversant in construction and working of signal conditioning circuits

Syllabus Contents

Unit-1 **(12 Lectures)**

Basic concepts of Instrumentation: Generalized instrumentation systems block diagram representation, Error in measurement- Gross Errors, Systematic Errors and Random Errors. Statistical analysis of error in measurement-Arithmetic mean, Deviation, standard deviation

Unit -2 **(10 Lectures)**

Measurement systems: static characteristics (accuracy, sensitivity, linearity, precision, resolution, threshold, range, hysteresis, dead band, backlash, drift), dynamic characteristics (types, fidelity, speed of response, dynamic error)

Unit- 3 **(15 Lectures)**

Transducers: Classification, Active and Passive. Principle and working of following types: Resistive (Strain Gauge) Capacitive, Inductive (LVDT), Piezoelectric, Light (LDR), Temperature (RTD, Thermocouple, Thermistor)

Unit- 4 **(11 Lectures)**

Signal Conditioning: Introduction to Op-Amp, Basic Instrumentation Amplifier, Application of Instrumentation Amplifiers

References

1. Doeblin&Manek, Measurement Systems, McGraw Hill, New York, 1992, 5th edition.
2. Nakra& Choudhary, Instrumentation Measurements and Analysis, Tata McGraw-Hill, 2nd edition.

3. A.K. Sawhney, Electrical & Electronic Measurements & Instrumentation, 19th revised edition.
4. Rangan, Sarma, and Mani, Instrumentation- Devices and Systems, Tata-McGraw Hill, 2nd edition.
5. H.S Kalsi, Electronic Instrumentation, McGraw Hill, 4th edition.
6. DVS Murthy, Measurement & Instrumentation, PHI, 2nd edition.
7. D. Patranabis, Sensors and Transducers, PHI, 2nd edition.
8. A Course in Electrical and Electronic Measurements and Instrumentation, (2005), A.K. Sawhney, DhanpatRai& Co.
9. Mechanical and Industrial Measurements, 3rd Edition, Tenth Edition (1996), R.K. Jain, Khanna Publishers.

Fundamentals of Instrumentation (Hardware) (INGE1AP)

Credits: 01 **Lectures: 32h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Identify different types of transducers
CO2 Understand the principles of the conversion of measured quantities into electric signal
CO3 Interpret the output and its relation with the input

Syllabus Contents

1. Measurement of strain using strain gauge/load cells.
2. Measuring change in resistance using LDR
3. Measurement of displacement using LVDT.
4. Measurement using capacitive transducer.
5. Measurement of Temperature using Temperature Sensors.
6. Design and study basic circuit of Op-Amp.

Engineering Physics (INGE1B)

Credits: 03 **Lectures: 48h**

Course Learning Objectives

- To develop an intuitive understanding of semiconductor physics
- To provide the students a thorough understanding of the fundamentals of optics
- To introduce fundamental aspects of photonics

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Gain in-depth knowledge about basic concepts of semiconductor physics
CO2 Understand the physics behind various phenomena in optics
CO3 Understand the photonics

Syllabus Contents

Unit-1 **(12 Lectures)**

Semiconductor physics: Energy bands in semiconductors, Types of semiconductors, Charge carriers, Intrinsic and extrinsic materials. Carrier concentration: Fermi Level, Electron and hole concentration equilibrium, the temperature dependence of carrier concentration, Compensation, and charge neutrality. Conductivity and mobility, Effect of temperature, Doping, and high electric field.

Unit-2 **(12 Lectures)**

Interference: Interference of light, Fringe formation, interference in thin films, wedge-shaped film, Newton's rings, Michelson interferometer.
Diffraction - Single, Double & N- Slit, Diffraction grating, grating spectra, Rayleigh's criterion, and resolving power of grating.

Unit-3 **(12 Lectures)**

Polarization: Phenomena of double refraction, Nicol prism, Production and analysis of plane, circular and elliptical polarized light, Fresnel's theory of optical activity, Polarimeters.
Laser: Basic principle, Spontaneous and stimulated emission of radiation, Einstein's Coefficients, Laser applications.

Unit-4 **(12 lecture)**

Photonics: Light Emitting Diodes, Construction, materials, and operation, Photodetectors: Photomultiplier tube. Phototransistors and Photodiodes (p-i-n, avalanche).
LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays.
Fiber optics: Principles and applications

References

1. B. G. Streetman and S. Banerjee "Solid-state electronics devices", 5th Edition, PHI.

2. Donald A Neaman, "Semiconductor Physics and Devices Basic Principles" 3rd Ed TMH India.
3. Alok Dutta, "Semiconductor Devices and circuits", Oxford University Press.
4. Robert F. Pierret, Semiconductor Device Fundamentals, Pearson Education (2006)
5. AjoyGhatak –Optics, Fourth Edition, McGraw-Hill (2008).
6. Arthur Beiser -Concepts of Modern Physics, 6th Edition, Mc-Graw Hill.
7. S. O. Kasap, Optoelectronics, and Photonics: Principles and Practices, Pearson Education (2009)
8. Ghatak A.K. and Thyagarajan K., Introduction to fiber optics, Cambridge Univ. Press. (1998)

Engineering Physics Lab (INGE1BP)

Credits:01 **Lectures: 32h**

Course Learning Outcomes

At the end of this course, students will be able to

CO1 Gain practical knowledge about semiconductor technology

CO2 Perform experiments based on the phenomenon of light/photons.

CO3 Learn the usage of various optical instruments for measurement of the wavelength of light and refractive index, dispersive power of material

CO4 Prepare the technical report on the experiments carried out.

Syllabus Contents

1. To determine the type (n or p) and mobility of semiconductor material using Hall-effect
2. To determine the refractive index of a prism using a spectrometer
3. To determine the dispersive power of prism using spectrometer and mercury source.
4. To determine the wavelength of sodium light by Newton's Ring.
5. To determine the wavelength of sodium light using Michelson's Interferometer.
6. To determine the resolving power of diffraction grating
7. To determine the specific rotation of cane sugar using a polarimeter.
8. To find the wavelength of He-Ne Laser using a transmission diffraction grating.
9. To determine characteristics of LEDs and Photodetector.
10. To measure the numerical aperture of an optical fibre.