Department of Technical Education

DIPLOMA COURSE IN ELECTRONICS AND COMMUNICATION ENGINEERING

Third Semester

ELECTRONIC MEASUREMENTS AND INSTRUMENTATION

Contact Hours/Week : 04 **Contact Hours/Semester : 64**

Contents	No.of Hrs.
Unit-I	
1. Fundamentals of Measurements & Instrumentation-	**09**
2. Electromechanical Indicating Instruments	**10**
Unit-II	
3. Testing Instruments	**12**
4. Transducers	**08**
Unit-III	
5. Analog Meters	**08**
6. Digital Meters	**08**
7. Instrument Maintenance & Protection	**05**
Tests and Assignments	**04**
Total	**64Hrs.**

DETAILS OF CONTENTS:

1. FUNDAMENTALS OF INSTRUMENTATION AND MEASUREMENTS

Necessity of measurements- methods, terminology, electronic measurement system, Errors – types , dynamic characteristics of an instrument, statistical analysis. Standards-different types,. Bridges-DC and AC

2. ELECTROMECHANICAL INDICATING INSTRUMENTS

Different types, PMMC meter, multi range voltmeters and ammeters . Electrodynamometer –principles-voltmeter, ammeter, wattmeter, energy meter and power factor meter.

3. TESTING INSTRUMENTS

Cathode Ray Oscilloscope, dual trace, sampling oscilloscope, Digital storage oscilloscope, CRO probes, Function generator, Standard RF signal generator, Sweep frequency generator, Distortion analyzer, Wave anlayser and Spectrum analyzer

4. TRANSDUCERS

Classification of electrical transducers, Strain guage, capacitive transducers, Hall effect type, LVDT, thermistor, thermocouple, piezoelectric, , proximity sensors, digital optical encoders

5. ANALOG METERS

Electronic voltmeters, FET input, chopper type DC amplifier voltmeter, solid state voltmeter using op-amp, AC voltmeters using half wave and full wave rectifiers, Peak responding and true RMS voltmeters. Ohmmeters series and shunt type, Calibration of meters, Q meter and RX meter.

6. DIGITAL METERS

Different types of digital voltmeters,, Automisation in DVM, Electronic counters, Digital frequency meters, Time interval measurement, Digital LCR meter, Digital phase meter, Digital multimeter, Microprocessor based instruments, IEEE 488 GPIB instruments.

7. INSTRUMENT MAINTENANCE & PROTECTION

Troubleshooting of instruments, precautions, Grounding and shielding.

RECOMMENDED BOOKS:

1. **Electronic Measurements and Instrumentation (2nd Revised Edition)** – R.K.RAJPUT
2. **Electronic Measurements and Instrumentation(3rd Edition) –** SANJAY TALBAR & AKHILESH UPADHYAYA.
3. **Electronic Measurements & Instrumentation By- K Shashidhar, Sapna Publications**
4. **Electronic Instrumentation(2 nd Edition)** – KALSI
5. **Modern Electronic Instrumentation and Measurement Techniques** – HELFRICK & COOPER

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GENERAL EDUCATIONAL OBJECTIVES:

1. **To Know the basics of measurements, methods , instruments, errors, standards & commonly used bridges in electronic measurements.**
2. **To get a fair knowledge of the working principles of commonly used indicating instruments.**
3. **To have an insight into the working principles, uses of different types of equipments in testing procedures.**
4. **To understand the working principles of commonly used transducers in electronic instrumentation**
5. **To understand the working principles of electronic meters and digital meters.**
6. **Familiarisation of general principles of equipment maintenance and protection.**

SPECIFIC INSTRUCTIONAL OBJECTIVES:

1.FUNDAMENTALS OF INSTRUMENTATION AND MEASUREMENTS

1.1 Understand the necessity of electronic measurements(1.1 of Talbar)

1.2 Block diagram description of electronic measurement system(1.2 of Talbar)

1.3 Know the different methods of measurement like direct comparison and indirect comparison.(1.3 of Talbar)

1.4 Define the terms instrument, measurement, accuracy, resolution, precision, error and sensitivity.(1.3 of Kalsi)

1.5 Discuss the types of errors in measurements like gross error, systematic error and random error , sources of errors , dynamic characteristics of an instrument(1.5.1.6 & 1.7 of kalsi /1.12.3 &.1.12.4 of Rajput)

1.6 Statistical analysis - Simple problems involving Arithmetic mean, deviation, average deviation and standard deviation. limiting errors and probable errors-simple problems (refer to 1.5,1.6 & 1.7 of Helfrick and Cooper/3.6 ,3.7 & numericals in talbar)

1.7 Know what are international, primary, secondary ,working & IEEE standards.(4.1 & 4.6 of Talbar)

1.8 List the various standards for length,mass,time,volume,frequency,current,voltage,capacitance,inductance,temperature and magnetic flux.

1.9 Know the use of Wheatstone bridge in resistance measurement, equation for unknown resistance -derivation and simple problems, applications and limitations.(2.6.3 of Rajput)

1.10 Know the general form of AC bridges. (2.6.5 of Rajput)

1.11 Know the use of Maxwell's bridge in inductance measurement, equation for unknown inductance -derivation and simple problems advantages and disadvantages.(2.6.6 of Rajput)

1.12 Know the use of Schering's bridge in capacitance measurement, equation for unknown capacitance -derivation and simple problems –dissipation factor(2.6.8 of Rajput)

1.13 Know the use of Wein's bridge in frequency measurement, equation for unknown frequency -derivation and simple problems –applications of wein bridge.(2.6.9 of Rajput)

2. ELECTROMECHANICAL INDICATING INSTRUMENTS

2.1 Know about indicating, integrating and recording instruments with examples.

2.2 Know(uses, limitations) about different types of indicating instruments. like PMMC, PMMI, electrodynamometer type ,hot wire, thermocouple type, induction type, electrostatic and rectifier type instruments.(1.13.2 of Rajput)

2.3 Working principle of basic PMMC meter, defecting, controlling and damping torques. Advantages and disadvantages of PMMC(2.3.1 to 2.3.3 of Talbar)

2.4 DC ammeters and voltmeters using PMMC. Shunt and series resistors-ayrton's shunt, multi range voltmeters/ammeters and simple problems on extending range, loading effect of a voltmeter and voltmeter sensitivity.(1.13.4 & 1.13.5 of Rajput / 4.4 to 4.6 of Helfrick Cooper)

2.5 Principle of electrodynamometer type instruments- advantages and disadvantages(1.13.8 of Rajput)

2.6 Electrodynamometer as voltmeter, ammeter, wattmeter and working of electrodynamometer type watt hour meter & Power factor meter.(1.13.12 of Rajput/ 4.13to 4.15 of Helfrick- Cooper)

3. TESTING INSTRUMENTS

3.1 Block diagram description of CRO(2.5.3 of Rajput)

3.2 Explanation of working of CRT,vertical amplifier section, horizontal deflection systems, triggered sweep, trigger pulse circuit, delay line and sync selection systems.(2.5.4 , 2.5.7 to 2.5.11 of Rajput)

3.3 Typical controls of CRO(2.5.12 of Rajput)

3.4 Working principle of dual trace oscilloscope – alternate and chop methods(2.5.12 of Rajput)

3.5 Block diagram description and advantages of Sampling oscilloscope(2.5.16 of Rajput)

3.6 Block diagram description, advantages and applications of Digital storage Oscilloscope.(2.5.18 of Rajput)

3.7 Brief discussion on different types of CRO probes like direct , high impedance, active and current probes.(2.5.20.1 of Rajput)

3.8 List the applications of CRO(2.5.2 of Rajput)

3.9 Lissajous patterns – phase angle and frequency measurement.(2.5.21.4 to 2.5.21.6 of Rajput)

3.10 Block diagram descriptions of Standard signal generator, function generator and sweep frequency generators - their uses.(3.2 & 3.5 of Rajput , 11.5 of Sanjay Talabar)

3.11 Function generator using IC 8038.

3.12 Meaning of harmonic distortion, working of Fundamental suppression type Harmonic distortion analyzer, Hetero dyne type wave analyser and spectrum analysers- their uses.(4.3.1, 4.3.2, 4.2.4, 4.4.1 & 4.4.2 of Rajput)

4. TRANSDUCERS

4.1 Definition of transducer, advantages of electrical transducers, criteria for selecting a transducer(16.1 & 16.3.1 of Talbar / 13.2 & 13.3 of Kalsi)
4.2 Different types of classification like active/passive, Analog/digital, primary/secondary & transducers/inverse – their examples(7.2 & 7.3 of Rajput / 16.2 of Talbar)
4.3 Strain gauges – principle, gauge factor, brief discussion on different types of strain gauges.(7.13.1 to 7.13.2.3 of Rajput)
4.4 Load cell –definition, uses, working of strain guage load cell(Rajput 7.14.3)
4.5 Principle of operation of capacitive transducers,- advantages and disadvantages.(7.8 of Rajput)
4.6 Hall effect & Working principle of hall effect transducers(7.10.1 & 7.10.2 of Rajput)
4.7 Principle of operation of LVDT-its advantages and disadvantages(13.11 of Kalsi)
4.8 Thermistors – salient features –operating range, composition, advantages and disadvantages.(16.7.5 of Talbar & 12.2.4 of Rajput)
4.9 Thermocouples – basic principle – commonly used combinations, operating range, advantages and disadvantages.(16.7.6 of Talbar & 12.2.5 of Rajput)
4.10 Proximity sensors – applications, working principles of eddy current , capacitive and inductive proximity sensors.(7.15 of Rajput)
4.11 Piezoelectric transducers- definition of piezo –electric effect, list the different crystals, advantages, disadvantages and applications.(7.9 Rajput)
4.12 Brief account of digital optical encoders(Rajput 7.18)

5. ANALOG METERS

5.1 Introduction-Advantages of electronic voltmeters(2.4.1 & 2.4.2 of Rajput)
5.2 Working of FET diff. amplifier type voltmeter(2.4.5.2 of Rajput)
5.3 Working of Chopper- DC amplifier type voltmeter(2.4.5.4 of Rajput)
5.4 Working of Solid state Voltmeter using Op-amp(2.4.11 of Rajput)
5.5 AC voltmeters using HW and FW rectifiers.(2.4.7 of Rajput)
5.6 Working of peak responding type voltmeter and True RMS voltmeter using Thermocouple.(2.4.9 , 2.4.10 of Rajput)
5.7 Ohmmeters – working of series and shunt type(4.21 & 4.22 of Kalsi)
5.8 Calibration of shunt type ohmmeter and DC voltmeter(4.22.1 , 4.23 of Kalsi).
5.9 Principle of working of Q meter and Rx meter.(10.7 & 10.9 of Kalsi)

6. DIGITAL METERS

6.1 Advantages of digital instruments, analog versus digital instruments(table 1.6 of Rajput)
6.2 Principle of operation of ramp type, integrating type and SA type digital voltmeters.**(**5.4.6, 5.4.8 & 5.4.9 of Rajput)
6.3 Automisation in Digital Meters- mechanism of automatic zeroing, polarity indication and auto ranging.(6.11 of Kalsi)
6.4 Use of decade counter as an electronic counter- totalizing, frequency mode, ratio mode, period mode and time interval mode.(6.7 of Kalsi)
6.5 Working principle of digital frequency meter, time interval measurement and digital Phase meters.(6.3 , 6.4 & 6.12 of Kalsi)
6.6 Working principle of digital LCR meter and digital multimeters.(5.5 & 5.6 of Rajput /8.3.3 of Talbar)
6.7 Microprocessor based instrument – block diagram(5.7 of Rajput)
6.8 IEEE 488 GPIB instruments- block diagram of device interfacing(5.8 of Rajput)

7. INSTRUMENT MAINTENANCE & PROTECTION

7.1 Introduction to testing and troubleshooting(22.1 & 22.2.1 of Talbar)

7.2 Know the important steps(summary) in generalised trouble shooting procedure.(22.2 of Talbar)

7.3 Precautions to be taken to prevent damage to measuring instruments and other general precautions while using an instrument.(22.2.2 & 22.2.3 of Talbar)

7.4 To know about functional block diagram.(22.3 of Talbar)

7.5 Definitions of grounding and shielding, Interference – definition, its nature and causes, prevention(21.3 , 21.3.1 of Talbar)

7.6 Aspects of grounding or guarding, aspects of shielding – shielding of cabinets(21.3.2 & 21.3.3 of Talbar)

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ELECTRONIC MEASUREMENTS AND INSTRUMENTATION
Model Question Paper

Time : 3 Hours **Max . Marks: 100**

Instructions: (1) Section-I is compulsory
(2) Answer any **two** full questions from each of the remaining sections

SECTION –I

1(a) Fill in the Blanks 5 X 1 = 5

1. Wein bridge is normally used for the measurement of _____
2. An example of inverse transducer is_____.
3. _____coating is used to collect secondary electrons in CRT.
4. The standards maintained at National standard labs are called _____
5. Errors due to human mistakes are called _____.

(b) Write a note on IEEE488 GPIB interfacing. 5

SECTION-II

2 (a) Explain with a block diagram, the operation of a generalized electronic measurement system. 9

(b) Define (i) accuracy (ii) Precision (iii) Error w.r.t measurements 6

3(a) A 0-100Volt Voltmeter has an accuracy of 1% of full scale reading.If the voltage measured by this instrument is 83 volts, find the limiting error in percentage 5

(b) Explain the use of wein's bridge in frequency measurement. Derive the equation for unknown frequency. 10

4(a) Explain the operation of the basic PMMC movement . 7

(b) Explain the basic principle of Electrodynamometer . 6

© Define voltmeter sensitivity. 2

SECTION-III

5(a) With the help of a block diagram, explain the operation of Digital Storage Oscilloscope. 9

(b) What are lissajous patterns?. Explain how they can be used for phase difference measurement. 6

6(a) Explain the working of Heterodyne wave analyzer. 6

(b) list the uses of Spectrum analyzer. 3

© What are active , passive and inverse transducers? Give example for each. 6

7(a) Explain the principle of LVDT displacement transducer. 6

(b) List the advantages and disadvantages of thermistors. 4

© write a note on digital optical Encoders. 5

SECTION-IV

8(a) Explain the working of Chopper DC amplifier type voltmeter. 7

(b) Explain the operation of Q meter. 8

9(a) Explain the working of Successive approximation type DVM. 10

(b) List the advantages of digital instruments. 5

10(a) Explain the principle of digital time interval measurement. 5

(b) List the precautions to prevent instrument damage. 5

© Write a note on shielding. 5

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