7. SUBJECT DETAILS

7.4 INSTRUMENTATION

7.4.1 OBJECTIVE AND RELEVANCE

Instrumentation is a science which deals with measurement and control. The knowledge of instrumentation and its practical applications is of vital importance in the modern competitive industrial environment. The most important factor in achieving quality and reliability in service of any product is its dimensional control. Due to rapid development in the field of measurements and industrial instrumentation, the student has to know the basic fundamentals and know about mechanisms and assemblies the functioning of which must meet the stringent design requirement. The course will be instrumental on achieving this objective. The student will acquire knowledge about basic principles involved in measuring instruments and the precision measurement techniques.

7.4.2 SCOPE

Instrumentation is a vast field, scope of this subject restricted to certain parameters like tempreture, pressure,torque, velocity, etc. and measurement of electrical quantities like voltage, frequency and phase. In addition to this students will also exposed to error analysis and signal transmission and reception by modulation and demodulation. Also they will get an overview of some of advanced electronic equipments like Q-meter, digital storage oscilloscope, sampling oscilloscope and wave analyzers.

7.4.3 PREREQUISITES

Requires knowledge of physics, electronic devices and electrical measurements.

7.4.4.1 JNTU SYLLABUS

UNIT-I

OBJECTIVE

Study of this unit will give idea about the types of errors in measurements, types of signals and various terminologies of measurment and how to estimate and minimize the errors in measurements and to make measurement more precise and accurate.

SYLLABUS

Characteristics of Signals: Measuring systems, Performance Characterisitics, Static characteristics, Dynamc Characteristics; Errors in Mesurement-Gross Errors, Systematic Errors, Statistical Analysis of Random Errors.

UNIT-II

OBJECTIVE

To study various standard test signals, their appications and different types of modulation and de-modulation techniques to transmit and receive the signals

SYLLABUS

Signal and their representation : standard test, periodic, aperiodic, modulated signals, sampled data, pulse modulation and pulse code modulation.

UNIT-III

OBJECTIVE

This unit gives idea to students how a CRO works, its internal circuit and types of CROs and their applications also the measurement of different parameters by various methods.

SYLLABUS

Oscilloscope: Cathode Ray oscilloscope, cathode ray tube, time base generator, horizontal and vertical amplifier, CRO probes, appliation of CRO, measurement of phase and frequency, Lissajous patterns, sampling oscilloscope, analog and digital type.

UNIT-IV

OBJECTIVE

This unit deals with types, working principle and applications of digital voltmeters, digital frequency meter and phase measurement and different errors arrised and their remedies in their measurement

SYLLABUS

Digital voltmeters, succesive approximation, ramp, dual slope integration, continuous balance type, micro processor based ramp type DVM, digital frequency meter and, digital phase angle meter.

UNIT-V

OBJECTIVE

To study how to analyze different signals at various frequencies, if at of noise on signals and cheking quality of capacitors and inductors.

SYLLABUS

Signal analyzers: Wave analysers- frequency selective analyzers, Heterodyne, application of Wave analyzers ,Harmonic analyzers, total Harmonic Distortion, spectrum analysers, Basic spectrum analysers, Spectral display, vector impedance meter, Q-meter, peak reading and RMS voltmeters.

UNIT-VI

OBJECTIVE

To get familiar with the conversion of one physcal quanity to another, principles involved in it and analysis of transducers . They will be able to measure the different parameters by different techniques and physical properties of different optical sensors which can be used for different applications viz., material handling, object detection.

SYLLABUS

Transducers: Definition of Transducers, Advantages of electrical transducers, classification of transducers, characteristics and choice of transducers, principle operation of resistor, inductor, LVDT and capacitor transducers, LVDT applications, strain gauge and its principle of operation , gauge factor, thermistors, thermocouples, synchros, peizoelectric transducers, photovoltaic, photo conductive cells, photo diodes.

UNIT-VII

OBJECTIVE

To know how to measure physical quanitities like strain, displacement, velocity, acceleration, force and torque by different mechanical, electrical and electronic methods.

SYLLABUS

Measurement of Non-Electrical Quantities-I: Measurement of strain,gauge sensitivity, displacement, velocity, angular velocity, acceleration, Forece, Torque.

UNIT-VIII

OBJECTIVE

To study Instumentation involved in process Industries in Temperature, Pressure, Flow and level by different methods.

SYLLABUS

Measurement of Non-Electrical quanities -II: Measurement of Temperature, Pressure, Vaccum, Flow Liqued level.

7.4.4.2 GATE SYLLABUS

UNIT-I

Error analysis

UNIT-II

Not included

UNIT-III

Oscilloscopes

UNIT-IV

Digital voltmeters, Frequency and Phase Meters

UNIT-V
Q-meters

UNIT-VI
Not included

UNIT-VII
Not included

UNIT-VIII
Not included

7.4.4.3 IES SYLLABUS

UNIT-I
Error analysis

UNIT-II
Not included

UNIT-III
Not included

UNIT-IV
Digital voltmeters, Frequency and Phase Meters

UNIT-V
Q-meters

UNIT-VI
Different Transducers and their Principles

UNIT-VII
Strain , Velocity and Torque measurements.

UNIT-VIII
Temperature and Pressure Measurements.

7.4.5 SUGGESTED BOOKS

TEXT BOOKS

T1 Transducers and Instrumentation, D.V.S. Murthy, PHI.
T2 Instrumentation: Devices and Systems, C.S.Rangan, G.R.Sarma and Mani, TMH.
T3 Modern Electronic Instrumentation and measurement techniques, A.D.Helfrick and W.D.Cooper, PHI.
T4 Electronic Instrumentation, H.S.Kalsi TMH, Ed.1985.

REFERENCE BOOKS

R1 Measurements Systems, Applications and Design, D.O.Doebilin, MGH
R2 Electrical and Electronic Measurements and Instrumentation, A.K.Sawhney, Dhanpatrai and Sons.
R3 Principles of Measurement and Instrumentation, A.S.Morris, PHI.
R4 Instrumentation, Measurement and Analysis, Nakra and Choudhary, PHI.

7.4.6 WEBSITES

1. www.mit.edu
2. www.gsas.harward.edu
3. www.soe.stanford.edu
4. www.eng.ufl.edu
5. www.iiid.ernet.in
6. www.bits-pilani.ac.in
7. www.iisc.ernet.in
8. www.prinston.edu
9. www.ece.umn.edu
10. www.instrumetationonline .com
11. www.instrumentationguide.com
12. www.controengg.com

7.4.7 EXPERTS' DETAILS

INTERNATIONAL

1. Dr. Shieh,
   Senior Lecturer,
   The University of Melbourne
   email : shieh@ee.unimelb.edu.au

2. Mr. Clayton R. Paul
   Professor,
   Electronics and Computer Engineering
   School of Engineering
   Mercer University,Georgia
   email : faculty.mercer.edu

3. George J. Pappas
   Professor,
   Department of Electrical and Systems Engineering
   University of Pennsylvania.
   email :pappasg@ee.upenn.edu

4. Dr. Eyad H. Abed
   Professor,
   Director of Institute for Systems Research (ISR)
   email : abed_eng.umd.edu

NATIONAL

1. Ms. Anupama .K
   Asst. prof
   Electrical and Electronics / Instrumentation Engineering Group
   BITS, Pilani
   email : anupkr@bits-pilani.ac.in

2. Ms. G. Uma, M.E.
   Lecturer,

Department of Instrumentation and Control Engineering,
National Institute of Technology,
Tiruchirappalli 620015, India
email : guma@]nitt.edu

LOCAL

1. Mr. S.K.L.V. Sai Prakash,
Lecturer, Department of ECE ,
NIT warangal,
email: sai @nitw.ernet.in

2. Dr. M. N. Avadhanulu,
KITS, Warangal,
e-mail: avadhanulu@kits.edu.in

7.4.8 JOURNALS

INTERNATIONAL

1. Instrument and Control.
2. IEEE instrumentation and Measurment.
3. IEEE control system.

NATIONAL

1. Electrical India
2. Journal of instrumentation society of India.

7.4.9 FINDINGS AND DEVEOPMENTS

1. Vibration and fluid velocity measurement by laser techniques, Prof. Enrico P. Tomasini, LAVINYA (2002-2005), thematic network dedicated to laser based equipment for vibration measurements**,** Department of Mechanics, University of Ancona, Faculty of Engineering.
2. Probe without moving parts measures flow angle Corda, Stephen NASA Tech Briefs Flow angle is computed from forces measured by use of strain gauges Dryden Flight Research Center, Edwards, California.
3. A MEMS Vertical Fringe Comb Capacitive Pressure Sensor for Biomedical Application, Technical Proceedings of the 2005 NSTI Nanotechnology Conference and Trade Show, Volume 3, K.Shah,

   H.Thumu, V. Vibhute, J.Singh and H.P. LeAffilation center of Telecommunication and Microelectronics, AU, pp. 379 – 382
4. Tactile sensor based on Piezoelectric resonance, G..Murali Krishna and K.Rajanna, IEEE Sensors Journal, vol. 4, No.5, October 2004, pp. 691 - 697.
5. Design, Fabrication and Performance study of Piezoelectric Crystal based Acoustic Sensor suitable for Aerospace application, Virupaksha D. Chitnis, M.Singaperumal, M.M.Nayak and K. Rajanna, IEEE Transactions on Sensors and Micromachines, vol.12, no.9.
6. Metrodyne Measurement Systems (HMS) for determining Phase angles, Enric O Mohns, Page No. 505,Vol. No.56, No.2, April 2007, IEEE Transactions on Instrumentation and Measurement.
7. Automated Low-Ohmic Resistance Measurements at the ì ¿/¿ level, Moutzager, Page No.407, VolNo.56,No.2, April 2007, IEEE Transactions on Instrumentation and Measurement.

8. Analysis of linearity and Frequency Response of a Novel Piezoelectric Flex tensional Actuator using a Homodyne Interferometer and J1-J4 method, Marcal, Page No.954, Vol. No.56, No.3, Jun2007, IEEE Transactions on Instrumentation and Measurement.

9. A current source for Pico Ammeter Calibration, Callegaro, Page No.1198, Vol. No. 56, No.4, August 2007, IEEE Transactions on Instrumentation and Measurement.

Sl. No.	Topics as per JNTU Syllabus	Modules and Sub-modules	Lecture No.	Suggested Books	Remarks
		UNIT-I			
1	Measuring System	Introduction to measurement	L1	T1-Ch1, T2-Ch2, R2-Ch1, R3-Ch1, R4-Ch1	GATE IES
2	Performance Characteristics	Accuracy, Precision, Resolution, Sensitivity, Linearity, Drift, Threshold and Hysteresis.	L2	T1-Ch1, T2-Ch2 R1-Ch3, R4-Ch1	GATE IES
3	Errors in Measurements, Gross Errors, Systematic Errors	Types of Errors, Sources and Remedies of Error	L3	T1-Ch1, T2-Ch2,3 R2-Ch1, R3-Ch3 R4-Ch1	GATE IES
4	Estimation of error Systematic and random errors	Systematic errors Definition Sources of systematic errors Reduction of systematic errors Random errors Introduction to statistical analysis Reduction of systematic errors	L4 L5	T1-Ch1,T2-Ch3 R3-Ch3	GATE IES
		UNIT-II			
5	Signals and their representation Standard test signals	Introduction to signals Standard test signals Step input function Ramp input function Parabolic function Unit impulse function	L6	T1-Ch2	
6	Periodic signals Aperiodic signals	Nature of signals Rectangular waveform Rectangular Pulse Train Saw tooth waveform Triangular wave form	L7	TI-Ch2,	

7	Modulated signals Sampled data	Importance of modulation Analog modulation Digital modulation Need for sampling Definition of sample Sampling process	L8	TI-Ch2,	
8	Pulse modulation	Basis of pulse modulation Applications Pulse width modulation Pulse position modulation Pulse frequency modulation	L9	TI-Ch2,	
9	Pulse code modulation	Evolution of pulse code modulation Definition of quanta Quantization Delta modulation	L10	T1-Ch.2,	
UNIT-III					
10	Cathode ray oscilloscope	Introduction to display devices Types of display devices Difference between analog and digital display devices Importance of oscilloscope Block diagram and construction Features	L11	T1-Ch10, T2-Ch21 R2-Ch7, R3-Ch7 R4-Ch7(All) R2-Ch7(All)	GATE
11	Cathode ray tube	Functional parts Principle of focusing an electron beam Electrostatic focusing Electrostatic deflection Expression for deflection sensitivity	L12	T1-Ch10, T2 –Ch2 R2-Ch7, R3-Ch7 R4-Ch6	GATE
12	Time base generator	Need for a sweep voltage Characteristics of a sweep waveform Sweep wave form generator (saw tooth generator) Various sweep generators	L13	T2-Ch21, R2-Ch21	GATE
13	Horizontal and vertical amplifier. CRO probes	Vertical amplifier features Horizontal amplifier features Need for horizontal amplifier Construction Functioning of a probe Classification of probes Direct reading probe Circuit isolation and Detector probe	L14 L15	T2-Ch21, R2-Ch21 R2-Ch21	GATE

14	Applications of CRO Measurement of Phase and frequency	Introduction to lissajous patterns Phase measurement Frequency measurement	L16	T2-Ch21, R2-Ch21 R3-Ch7	GATE
15	Sampling Oscilloscope	Purpose of sampling oscilloscope Advantages Construction Working principle Importance of staircase waveform	L17	T2-Ch21, R2-Ch21	
16	Analog storage oscilloscope	Advantages of storage oscilloscopes over the ordinary oscilloscopes Analog storage methods Variable Persistence Bistable storage	L18	T2-Ch21, R2-Ch21	
17	Digital storage oscilloscope	Difference between analog storage and digital storage oscilloscopes	L19	T2-Ch21, R2-Ch21	
UNIT-IV					
18	Digital Voltmeter	Introduction Difference between analog voltmeter and digital voltmeter Classification of digital voltmeters	L20	T4-Ch5, R2-Ch6(All) R4-Ch5	GATE IES
19	Successive Approximation type	Construction Working principle Advantages and disadvantages.	L21	T4-Ch5, R4-Ch5	GATE IES
20	Ramp type Dual-slope Integration type	Construction Working principle Advantages and disadvantages.	L22	T4-Ch5, R2-Ch28	GATE IES
21	Continuous balance type Microprocessor based voltmeter	Construction Working principle Advantages and disadvantages.	L23	R4-Ch5T4-Ch5, R2-Ch28	GATE IES
22	Digital frequency meter	Construction Working principle Advantages and disadvantages High frequency measurement	L24	T4-Ch6, R4-Ch6	GATE IES
23	Digital phase meter	Construction Working principle Advantages and disadvantages.	L25	T4-Ch6, R4-Ch6	GATE IES
UNIT-V					

24	Wave analyzer, Frequency selective analyzers Heterodyne	Application of Wave analyzers, Harmonic Analyzers, Total Harmonic distortion, Spectrum analyzers, Basic spectrum analyzers, Spectra display	L26	T2-Ch23,T4-Ch9 R2-Ch9, R4-Ch9	
25	Application of wave analyzers, Harmonic distortion analyzer, Total Harmonic distortion	Importance of wave analyzers and their working	L27	T2-Ch23,T4-Ch9 R2-Ch9, R4-Ch9	
26	Vector impedance meter Q-meter	Importance of vector impedance meter Construction and working principle Q- value Construction of Q-meter and working principle	L28	T2-Ch24,R2-Ch6, R4-Ch10	GATE
27	Peak reading voltmeter	Difference between a dc instrument and an ac instrument DC voltmeter	L29	T4-Ch4,R2-Ch6 R4-Ch4	
		AC voltmeter Average responding voltmeter Peak responding voltmeter	L30	T4-Ch4,R2-Ch R4-Ch4	
28	RMS Voltmeter	Need for measuring RMS value of voltage Block diagram & working principle	L31	T4-Ch4,R4-Ch4	
UNIT-VI					
29	Classification of transducers	Definition of a transducer Introduction to sensors Difference between a transducer and a sensor Types of transducers Difference between electrical and mechanical transducers.	L32	T2-Ch2, T1-Ch1, T3-Ch11, R2-Ch11 R4-Ch13	IES
30	Advantages of electrical transducers	Electrical transducers Active Passive Examples for each. Advantages of one over the other	L33	T1-Ch6,7, T2-Ch.2 T3-Ch11, R4-Ch4	IES

31	Characteristics and Choice of transducers	Transducer selection conditions Fundamental transducer parameters Physical conditions Ambient conditions Environmental conditions Compatibility of the associated equipment	L34	T3-Ch11,R2-Ch11 R4-Ch13	IES
32	Resistive transducers	Construction and operation Classification Potentiometers Strain gauges	L35	R4-Ch4, R2-Ch4 T3-Ch11,T1-Ch6 R4-Ch13	IES
		Potentiometers. Construction Working Loaded potentiometer Loading effect Applications Problems.	L36		
33	Inductive transducers LVDT	Construction Working principle Equivalent circuit Advantages and disadvantages. Applications RVDT Construction Working principle	L37	R4-Ch4,T1-Ch6 T2-Ch4,R4-Ch13	IES
34	Synchro	Definition Control type Synchro Torque transmission type Construction and working principle of each.	L38	T2-Ch4	
35	Capacitive transducer	Construction and operation Measurement of liquid level. Frequency response	L39	T1-Ch6,T2-Ch4 R4-Ch13	IES
36	Strain Gauge	Introduction to stress and strain. Quantities involved.	L40	T3-Ch11,T2-Ch6 29, R4-Ch3	

37	Gauge factor	Construction of strain gauges Peizo resistive effect Derivation of gauge factor problems	L41	T3-Ch11,T2-Ch6 T1-Ch7, R4-Ch3	
38	Types of strain gauges	classification of strain gauges Bonded and unbounded metal strain gauges Bonded metal foil type Semiconductor type Working principle of each.	L42		
39	Thermistors and thermocouples	features construction resistance-temperature Characteristics applications	L43	R4-Ch13,R3-Ch12 T3-Ch11,T2-Ch9	
40	Piezo electric transducer	Piezo electric effect. Properties.	L44	T1-Ch7,T3-Ch11 R4-Ch3R1-Ch4	
		Construction and working principle Derivation for voltage sensitivity and Charge sensitivity. Advantages and disadvantages. problems	L45		
41	Photo voltaic cell Photo conductive cell	Construction Principle of operation Applications	L46	T1-Ch7,T3-Ch11 R4-Ch134,	

42	Photo diode Photo transistor	Construction Principle of operation Applications	L47	T1-Ch7,T3-Ch11 R4-Ch13	
UNIT-VII					
43	Measurement of strain	Strain gauge circuits Construction of strain gauges Theory of strain gauges Peizo resistive effect	L48	T3-Ch11,T2-Ch6 29,R4-Ch13	
44	Gauge sensitivity	Single strain gauge bridge Working principle Definition of gauge sensitivity Derivation for gauge sensitivity Half bridge Full bridge Problems	L49		
45	Angular velocity measurement using tachometers and digital meters	Introduction to tachometers Classification of tachometers Mechanical tachometers Electrical tachometers Stroboscopic method of measurement Digital method of measuring angular velocity.	L50	R3-Ch20,R1-Ch4	52
46	LVDT accelerometer	Basic seismic transducer LVDT accelerometer	L51	R4-Ch13,R3-Ch18 T2-Ch6,	
47	Force Measurement	Use of strain gauges in weight measurement Construction and Working principle	L52	T2-Ch10,R3-Ch21	IES

48	Torque measurement	Importance of torque measurement Torque transducers Strain gauge torque meters Inductive torque transducer digital methods	L53	T2-Ch10,R4-Ch9 R3-Ch21,R2-Ch29	
UNIT-VIII					
49	Temperature Measurement	Measurement of Temperature and Temperature Compensation	L54	T3-ch11, T2-Ch9, R2-Ch11	
50	Pressure Measurement	Classification of Pressure various methods	L55	T2-Ch7, R3-Ch13	IES
51	Vaccum Measurement	Thermocouple Vacuum Gauge, Ionization Gauge, Pirani Guage	L56	T2-Ch7, R3-Ch13	
52	Flow measurement using electromagnetic method	flow measurement Classification of flow meters electromagnetic flow meter Construction Working principle Advantages and disadvantages	L57	T1-Ch5,R3-Ch14 R4-Ch13,T2-Ch8	IES
53	Hot wire anemometer Ultrasonic type Liquid level measurement	Construction Working principle Advantages and disadvantages Level measurement capacitance method	L58	T1-Ch5,R3-Ch14 T2-Ch8	IES

45	Angular velocity measurement using tachometers and digital meters	Introduction to tachometers Classification of tachometers Mechanical tachometers Electrical tachometers Stroboscopic method of measurement Digital method of measuring angular velocity.	L50	R3-Ch20,R1-Ch4	52

46	LVDT accelerometer	Basic seismic transducer LVDT accelerometer	L51	R4-Ch13,R3-Ch18 T2-Ch6,	
47	Force Measurement	Use of strain gauges in weight measurement Construction and Working principle	L52	T2-Ch10,R3-Ch21	IES
48	Torque measurement	Importance of torque measurement Torque transducers Strain gauge torque meters Inductive torque transducer digital methods	L53	T2-Ch10,R4-Ch9 R3-Ch21,R2-Ch29	
UNIT-VIII					
49	Temperature Measurement	Measurement of Temperature and Temperature Compensation	L54	T3-ch11, T2-Ch9, R2-Ch11	
50	Pressure Measurement	Classification of Pressure various methods	L55	T2-Ch7, R3-Ch13	IES
51	Vaccum Measurement	Thermocouple Vacuum Gauge, Ionization Gauge, Pirani Guage	L56	T2-Ch7, R3-Ch13	
52	Flow measurement using electromagnetic method	flow measurement Classification of flow meters electromagnetic flow meter Construction Working principle Advantages and disadvantages	L57	T1-Ch5,R3-Ch14 R4-Ch13,T2-Ch8	IES
53	Hot wire anemometer Ultrasonic type Liquid level measurement	Construction Working principle Advantages and disadvantages Level measurement capacitance method	L58	T1-Ch5,R3-Ch14 T2-Ch8	IES

S. No	Topics scheduled	Salient topics to be discussed
1	Measuring System Performance Characteristics Errors in Measurements, Gross Errors, Systematic Errors	Introduction to measurement Accuracy, Precision, Resolution, Sensitivity, Linearity, Drift, Threshold and Hysteresis. Types of Errors, Sources and Remedies of Error

	Estimation of error Systematic and random errors	Systematic errors, Definition, Sources of systematic errors, Reduction of systematic errors, Random errors Introduction to statistical analysis, Reduction of systematic errors
2	Signals and their representation Standard test signals Periodic signals Aperiodic signals Modulated signals Sampled data Pulse modulation Pulse code modulation	Introduction to signals, Standard test signals, Step input function, Ramp input function, Parabolic function, Unit impulse function, Nature of signals, Rectangular waveform, Rectangular Pulse Train, Saw tooth waveform, Triangular wave form, Importance of modulation, Analog modulation, Digital modulation, Need for sampling, Definition of sample, Sampling process, Basis of pulse modulation, Applications, Pulse width modulation, Pulse position modulation, Pulse frequency modulation, Evolution of pulse code modulation, Definition of quanta, Quantization, Delta modulation
3	Cathode ray oscilloscope Cathode ray tube Time base generator Horizontal and vertical amplifier. CRO probes	Introduction to display devices, Types of display devices, Difference between analog and digital display devices, Importance of oscilloscope, Block diagram and construction, Features, Functional parts, Principle of focusing an electron beam, Electrostatic focusing, Electrostatic deflection, Expression for deflection sensitivity, Need for a sweep voltage, Characteristics of a sweep waveform, Sweep wave form generator (saw tooth generator), Various sweep generators, Vertical amplifier features, Horizontal amplifier features, Need for horizontal amplifier, Construction, Functioning of a probe, Classification of probes, Direct reading probe, Circuit isolation and Detector probe
4	Applications of CRO Measurement of Phase and frequency Sampling Oscilloscope Analog storage oscilloscope Digital storage oscilloscope	Introduction to lissajous patterns, Phase measurement, Frequency measurement, Purpose of sampling oscilloscope, Advantages, Construction, Working principle, Importance of staircase waveform, Advantages of storage oscilloscopes over the ordinary oscilloscopes, Analog storage methods, Variable Persistence, Bistable storage, Difference between analog storage and digital storage oscilloscopes
5	Digital Voltmeter Successive Approximation type Ramp type Dual-slope Integration type	Introduction, Difference between analog voltmeter and digital voltmeter, Classification of digital voltmeters, Construction, Working principle, Advantages and disadvantages, Construction, Working principle, Advantages and disadvantages.

6	Continuous balance type Microprocessor based voltmeter Digital frequency meter Digital phase meter	Construction Working principle Advantages and disadvantages High frequency measurement, Construction Working principle Advantages and disadvantages.
7	Wave analyzer, Frequency selective analyzers Heterodyne Application of wave analyzers, Harmonic distortion analyzer, Total Harmonic distortion Vector impedance meter Q-meter	Application of Wave analyzers, Harmonic Analyzers, Total Harmonic distortion, Spectrum analyzers, Basic spectrum analyzers, Spectra display Importance of wave analyzers and their working Importance of vector impedance meter Construction and working principle Q- value Construction of Q-meter and working principle
8	Peak reading voltmeter RMS Voltmeter	Difference between a dc instrument and an ac instrument, DC voltmeter - AC voltmeter Average responding voltmeter Peak responding voltmeter Need for measuring RMS value of voltage Block diagram & working principle
9	Classification of transducers Advantages of electrical transducers Characteristics and Choice of transducers Resistive transducers	Definition of a transducer, Introduction to sensors Difference between a transducer and a sensor Types of transducers, Difference between electrical and mechanical transducers. Electrical transducers, Active, Passive, Examples for each. Advantages of one over the other Transducer selection conditions, Fundamental transducer parameters, Physical conditions, Ambient conditions Environmental conditions, Compatibility of the associated equipment, Construction and operation Classification, Potentiometers, Strain gauges Potentiometers. Construction, Working, Loaded potentiometer, Loading effect, Applications, Problems.
10	Inductive transducers LVDT Synchro Capacitive transducer Strain Gauge	Construction, Working principle, Equivalent circuit, Advantages and disadvantages, Applications, RVDT Construction Working principle Definition, Control type Synchro, Torque transmission type, Construction and working principle of each. Construction and operation, Measurement of liquid level. Frequency response Introduction to stress and strain. Quantities involved.
11	Gauge factor Types of strain gauges	Construction of strain gauges, Peizo resistive effect, Derivation of gauge factor, problems, classification of strain gauges, Bonded and unbounded metal strain gauges, Bonded metal foil type, Semiconductor type

	Thermistors and thermocouples	Working principle of each. Features construction resistance-temperature Characteristics applications
12	Piezo electric transducer Photo voltaic cell Photo conductive cell Photo diode Photo transistor	Piezo electric effect. Properties. Construction and working principle Derivation for voltage sensitivity and Charge sensitivity. Advantages and disadvantages. Problems, Construction, Principle of operation, Applications, Construction, Principle of operation Applications
13	Measurement of strain Gauge sensitivity Angular velocity measurement using tachometers and digital meters	Strain gauge circuits, Construction of strain gauges Theory of strain gauges, Peizo resistive effect, Single strain gauge bridge, Working principle, Definition of gauge sensitivity, Derivation for gauge sensitivity, Half bridge, Full bridge, Problems, Introduction to tachometers, Classification of tachometers, Mechanical tachometers, Electrical tachometers, Stroboscopic method of measurement, Digital method of measuring angular velocity.
14	LVDT accelerometer Force Measurement Torque measurement	Basic seismic transducer LVDT accelerometer Use of strain gauges in weight measurement Construction and Working principle Importance of torque measurement Torque transducers Strain gauge torque meters Inductive torque transducer digital methods
15	Temperature Measurement Pressure Measurement	Measurement of Temperature and Temperature, Compensation, Classification of Pressure various methods, Thermocouple Vacuum Gauge, Ionization

	Vaccum Measurement Flow measurement using electromagnetic method, Hot wire anemometer Ultrasonic type, Liquid level measurement	Gauge, Pirani Guage, flow measurement, Classification of flow meters, electromagnetic flow meter, Construction, Working principle Advantages and disadvantages, level measurement, capacitance method

7.4.11 STUDENT SEMINAR TOPICS

1. Construction of Microcontroller Based Digital Voltmeter. International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Volume 3 Issue 1, January 2014 www.ijsr.net
2. Design and implement of the digital storage oscilloscope card based on VHDL , Electronic Measurement & Instruments (ICEMI), 2011 10th International Conference on (Volume:1)
3. Design of BCI Based Multi-information System to Restore Hand Motor Function for Stroke Patients, Page No.4924 - 4928 , Systems, Man, and Cybernetics (SMC), 2013 IEEE International Conference on
4. "Ink-jet printed strain sensor on polyimide substrate," Electronics Technology (ISSE),Zlebic, C.; Kisic, M.; Blaz, N.; Menicanin, A.; Kojic, S.; Zivanov, L.; Damnjanovic, M., 2013 36th International Spring Seminar on , vol., no., pp.409,414, 8-12 May 2013
5. Improvement of Lock-in Electrical Bio-Impedance Analyzer for Implantable medical devices, Mart Min,

   Page No.968, Vol. No.56, No.2, April 2007, IEEE Transactions on Instrumentation and Measurement.
6. A photonic crystal fibre sensor for pressure measurements, W. J. Bock, IEEE Transactions on Instrumentation Measurements, vol. 55, no.4, Aug 2006.
7. Dangerous effects of moisture on dielectric strength and ageing of oil paper insulation, Ashok Yadav, Electrical India Oct 2006.
8. PC based temperature recording and monitoring system, D.Das, Instrumentation Society of India, June 2006.
9. On the development of a low-cost, transformer isolated voltage probe for different measurements, Instrumentation Society of India, March 2006.
10. Analog signal processing in an AC electromagnetic flowmeter, B.J.Polo, IEEE Transactions on instrumentation and measurements, vol. 51, no.4, Aug 2002.
11. Why do we care about measurement, Kim, R. Fowler, IEEE Instrumentation and Measurement, March 2004.

7.4.12 QUESTION BANK

UNIT-I

1. i. Write short notes on Residual errors in measurement.
   ii. A voltmeter reads 109.5 V. The error taken from an error curve is -0.37 V. Determine the true voltage. **(May 12)**
2. i. What is meant by stability of a measuring system? Indicate which class of instruments are required to be more stable.
   ii. Write short notes on Environmental errors of Systematic Errors. **(April 11)**
3. What is meant by error and explain dierent types of errors? **(April 11)**

4. i. Discuss in detail about three categories of Systematic Errors.Explain with suitable examples.
   ii. Distinguish between 'range' and 'span' of an instrument. **(April 11)**

5. i. Dene the following dynamic characteristics,
      i. Bandwidth
      ii. Dynamic range
      iii. Settling time
      iv. Speed of response
      v. Measurement lag
      vi. Time constant
   ii. Determine whether the following errors are of random or systematic type. Justify your response.
   (April 11)

6. i. Explain the terms 'Sensitivity' and 'Resolution' of an instrument, with suitable example.
   ii. Define 'dynamic error' and show how it differs with the type of input signal applied to a system.
   (May 10)

7. i. What is meant by "dynamic response of an instrument"?
   ii. What do you understand by span accuracy and point accuracy? Explain. **(May 10)**

8. i. Define 'repeatability' and 'reproducibility' and discuss why instruments should possess these haracteristics.
   ii. Explain how the 'nonlinearity' of a measuring system is defined and estimated. **(May 10)**

9. What is the phenomenon of hysteresics in measurement systems? Explain the terms "threshold", "maximum input hysteresis", "maximum output hysteresis", "dead zone", and "Blacklash", with neat diagrams.
(May 10)

10. Define Systematic error and explain the types of systematic errors? (**May 09)**

11. i. Define 'Drift', 'Threshold Value' and 'Dead-band' of a measuring system, with suitable example for each.
    ii. Distinguish between 'Range' and 'Span' of an instrument. (**May 09)**

12. i. In how many stages, can any measuring process can be divided? Draw the block diagram and bring out the uniqueness of each stage, in terms of its functions.
    ii. Distinguish between 'error? and 'correction' and show how they are usually expressed for an instru ment.
    (May 09)

13. i. How are the performance characteristics of an instrument, classified?
    ii. Explain clearly the difference between Accuracy and Precision? **(May 09)**

14. Define the following **(Sep 08)**
    i. Arithmetic mean
    ii. Median
    iii. Standard deviation
    iv. Variance

15. i. How the performance characteristics of an instrument are classified? **(Sep, Apr 08)**
    ii. Explain clearly the difference between Accuracy and Precision?

16. Draw the block diagram of the measuring system and explain the each stage with their functions.
(Sep, Apr 08, 07, 06, 05)

17. i.Define Instrumentation and the importance of the Instrumentation systems **(Sep 08, Apr 07)**
   ii. Explain the role of electronic circuits in the field of modern instrumentation.
   iii. Distinguish a meter from an instrument and state the primary role of each.

18. i. What is meant by stability of a measuring system? Indicate which class of instruments are required to be more stable. **(Apr 08, 05)**
   ii. Explain how the non linearity of a measuring system is defined and estimated.

19. i. Define passive and active transducers and give an example of each.
   ii. Distinguish between static and dynamic characteristics of an instrument. **(Apr 08, 05)**

20. Define the following static characteristics with necessary examples and graph
   i. Accuracy
   ii. Dead band
   iii. Threshold
   iv. Drift **(Apr 08, 04)**

i. Describe the various sources of errors encountered in a measuring system. **(Apr 08)**
   ii. What do you understand by the terms
      a. Systematic errors
      b. Instrumental errors.

22. Distinguish the important characteristics of instrument that are totally electrical and totally electronic in nature **(Apr 07, Sep, Apr 06)**

23. Distinguish between systematic and random errors in a measurement and how they are usually minimized **(Apr 07)**

24. i. What is meant by voltmeter sensitivity? Explain its relevance in circuit applications. What is meant by loading eect? What circuit arrangement is done to avoid the same.
   ii. It is desired to measure the voltage across the 100K? resistor in the circuit given below. Two voltmeters are available for this measurement. Voltmeter 1 with a sensitivity of 1000?/V and voltmeter 2 with a sensitivity of 20,000?/V. Both meters are used on their 50V range. Calculate i) the reading of each meter ii) error in each reading, expressed as a percentage of the true value. **(Sep 06)**

25. i. How do you explain accuracy? Give examples.
   ii. A voltmeter having a sensitivity of 1,000? /V, reads 80V on its 150V scale when connected across an unknown resistor in series with a milli ammeter. When mill- ammeter reads 4mA, calculate i. apparent resistance of the unknown resistor,
   iii. actual resistance of the unknown resistor,
   iv. the error due to loading eect of the voltmeter. **(Sep 06)**

26. i. Define dynamic error and show how it differs with the type of input singal applied to the system.
   ii. Explain the term fidelity of an instruement and show how it is usually expressed. **(Apr 06)**

27. i. a. Describe the international standard of mass and length.
      b. What are atomic standards for frequency and time?

ii. What are different standard test signals for studying the dynamic response of a system? Explain them with suitable sketches. **(Jul 05)**

28\. i. Briefly explain the following transducer errors. **(Jul, Apr 05, 04)**
a. Zero error
b. Sensitivity error
c. Nonconformity error
d. Hysteresis error
ii. Briefly explain the classification of transducer based on the principle of transduction.

29\. i. Explain systematic errors clearly with the help of examples.
ii. A resistor is measured by the voltmeter and ammeter method, the voltmeter reading is 125.4V on the 250V scale and the ammeter reading is 288.5mA on 500mA scale. Both meters guaranteed to accurate within ±1 percent of full-scale reading. Calculate
a. the indicated value of the resistor
b. the limits within which you can guarantee the result. **(Apr 05)**

30\. Explain the following
i. Accuracy
ii. Error
iii. Linearity
iv. Precision
vii. Discuss main differences between accuracy and precision. **(Apr 05)**

31\. i. Explain advantages and disadvantages of electrical transducers over mechanical transducers
ii. What are the Digital Transducers explain **(Jul 04, 03)**

32\. Explain terms
i. Positioning
ii. Linearity
ii. Threshold
iv. Range as applied to measuring instruments. **(Apr 04)**

33\. i. For a transducer briefly explain the following .
a. Input characteristics
b. Output characteristics
ii. Define the following and explain
a. International standard
b. Working standard **(Apr 04)**

34\. Explain the following with examples
i. Transducer
ii. Inverse Transducer
iii. Output Transducer **(Apr 04)**

35\. i. Explain classification of Transducers. Explain general performance of systems
ii. Distinguish between static and dynamic characteristics of instruments. **(Apr 04)**

36\. i. Briefly describe the different criteria for selection of transducer for a particular application
ii. Explain the differences between Primary and secondary transducers **(Apr 04)**

37. What is meant by voltmeter sensitivity? Explain its relevance in circuit applications. What is meant by loading effect? What circuit arrangement is done to avoid the same? **(Apr 04)**

28. i. Explain systematic errors clearly with the help of examples.
ii. A resistor is measured by the voltmeter and ammeter method, the voltmeter reading is 125.4V on the 250V scale and the ammeter reading is 288.5mA on 500mA scale. Both meters guaranteed to accurate within $\pm$ 1 percent of full-scale reading. Calculate (a) the indicated value of the resistor (b) the limits within which you can guarantee the result. **(apr 04)**

39. Explain the terms:
i. precision
ii. linearity
iii. percentage error and
iv. accuracy **(Apr 03)**
Define the terms: 1 : accuracy 2: precision 3: % error

40. Explain systematic errors clearly with the help of example.

41. How are random errors analysed? Explain with examples.

42. How do you explain accuracy? Give examples.

43. Classify errors and explain them.
44. Suggest methods to minimize and eliminate different types of errors.

UNIT-II

1. i. Explain the common forms of periodic signals with their waveforms.
ii. Write the applications of PCM. **(May 12)**

2. Describe the process of obtaining discrete time signal from continuous time signal. Draw the necessary waveforms. **(April 11)**

3. Derive from fundamentals the expression representing a saw tooth wave. **(April 11)**

4. Describe pulse amplitude, pulse width and pulse position modulation techniques. **(April 11)**
5. i. Discuss in detail about Pulse Width Modulation.
ii. Write short note on sampled data. **(April 11)**

6. i. What are sidebands of a modulated signal and explain their presence in AM and FM signals.
ii. Define distortion of a periodic signal and how is it estimated? **(May 10)**

7. i. Explain the rectangular, pulse and unit impulse function with its frequency spectrum of aperiodic signal.
ii. Give the functions of rectangular wave and rectangular pulse train of periodic signal. **(May 10)**

8. Write short notes about the following spectra:
a) Continuous wave signals.
b) Amplitude modulation.
c) Frequency modulation
d) Pulse modulation. **(May 10)**
9. i. Define and distinguish between periodic and aperiodic signals with examples and necessary wave forms?
ii. Define 'Laplace' and 'Fourier' transforms and indicate the conditions under which each is applicable. **(May 10)**
10. i. What are the differences between sampling process and pulse modulation?

ii. Describe the types of test signals by which physical systems are studied and analyzed for their dynamic behavior? **(May 10)**

11. What is the process of modulation? Describe the techniques usually adopted. **(May 09)**

12 .i. Define bandwidth of a signal and explain the ways in which signals are classified according to bandwidth.

ii. Determine which of the following signals is periodic. If a signal is periodic determine its fundamental period.

i) x(t) = [sin(t-/6)]2

ii) $x(t) = e^{j(nt-1)}$ **(May 09)**

13. What is the process of modulation? Describe the techniques usually adopted. **(May 09)**

14. Derive from fundamentals the expressions representing

i. A rectangular pulse train

ii. a saw tooth wave. **(May 09)**

15. i. Explain about aperiodic signal with examples. **(Sep 08)**

ii. Compare periodic and aperiodic signals.

16. i. Write about analog and digital signals with illustrations? **(Sep 08)**

ii. Define all the standard test signals with suitable waveforms?

17. i. Explain the spectra of a periodic rectangular pulse train for the following. **(Sep, Apr 08)**

a. Amplitude

b. Phase spectra when time origin coincides with centre of pulse.

c. Phase spectra with pulse starting at t=0.

ii. Define line spectra.

18. Explain how angle modulation of a signal is done. Distinguish between angle and Phasemodulation. **(Apr 08)**

19. i. Explain the common forms of periodic signals with their waveforms. **(Apr 08)**

ii. What is complex form representation of periodic signal?

20. Describe the process of modulation and the techniques usually adopted **(Apr 08, 07, Sep 06)**

21. Derive the expression for a frequency-modulated signal and show how the number of sidebands increases with modulation index. **(Apr 08, 06)**

22. i. Briefly explain the following processes as applied to pulse code modulation

a. Quantization process

b. Encoding process

ii. Describe the following modulation processes

a. Pulse amplitude modulation

b. Pulse frequency modulation **(Apr 08, 04, 03)**

23. Define band width of a signal and explain the way signals are classified according the their band width. **(Apr 08, 05)**

24. Distinguish between analog modulation and digital modulation and explain the situations under which each is preferred. **(Apr 08, 05)**

25. Explain the types of test signals used for determination of dynamic characteristics. **(Sep 06, Apr 05)**

26. Explain the techniques of pulse-time modulation and pulse code modulation and their relative merits. **(Apr 05)**

27. Briefly explain the following systems with examples.
    i. Underdamped system
    ii. Overdamped system
    iii. Critically damped system. **(Apr 05)**

28. i. Derive the expression for time response of first order system subjected to step input.
    ii. A RC circuit consists of a capacitor of 1µ F in series with a resistor of 1KW. A DC voltage of 50V is suddenly applied across the circuit. Calculate the value of voltage after 10 mSecs. **(Apr 05)**

29. i. Distinguish between deterministic and random signals . Give suitable examples
    ii. Describe the procedure used to determine whether the sum of two periodic signals is periodic or not.
    (Apr 04, 03)

30. i. Derive the expression for time response of first order system subjected to Ramp input
    ii. A first order instrument is having time constant of 1 sec. find the response of this instrument subjected to the following inputs
    a. 2Sin(3t)
    b. 2Sin(30t). **(Apr 04)**

31. i. Explain the following types of response with suitable graphs: **(Apr 04)**
    a. Steady state response
    b. Transient response
    ii. Derive the expression for the time response of second order system subjected to step input

32. i. Derive the frequency and phase responses of second order systems subjected to sinusoidal inputs
    ii. Explain the correlation between time domain and frequency domain responses of second order systems
    (Apr 04)

33. i. Describe the process of obtaining Discrete time signal from continuous time signal. Draw the necessary plots **(Apr 03)**
    ii. What are the major classification of signals . Explain them in detail with suitable sketches

34. i. Describe the following signals with suitable plots:
    a. Continuous time periodic signals
    b. Aperiodic signals
    ii. Explain how sampling can be done using an impulse function? **(Apr 03)**

35. Write short notes on
    i. Continuous Wave Signal
    ii. Amplitude Modulation

36. Explain the significance of demodulation

37. Explain the significance of standard test signals

38. Explain significance of modulation and its types

39. i. Distinguish between periodic and a periodic signals and give examples for each
    ii. Derive from fundamentals the expression representing a rectangular wave by Fouries series

40. Distinguish between the deterministic and non-deterministic signals

UNIT-III

1. I. What is the operating voltage of a CRT arranged so that the deection plates are nearly at ground potential?
   ii. List the advantages of conventional storage oscilloscope and digital storage oscilloscope .**(May 12)**

2. Draw and explain dierent parts of a CRT. **(April 11)**

3. Explain with a neat block diagram of a horizontal and vertical deection system. **(April 11)**

4 i. With block diagram explain Delay line.
   ii. If a digitizing oscilloscope is to have a 16-bit resolution in both the horizontal and vertical axis and is to display transients at a rate of 1*10-6 sec per division for a display of 10 divisions, what is the speed required for the input of A/D converter? **(April 11)**

5. i. Explain the dierent types of graticules used in a CRO. Describe their advantages and disadvantages.
   ii. What precautions must be taken when using a sampling oscilloscope? **(April 11)**

6. Write notes on:
   i. Magnetic deflection of electron beam in a CRT.
   ii. Deflection sensitivity. **(May 10)**

7. i. What are Lissajous patterns? How can they be created? Explain.
   ii. Write the construction and working of a CRT using Halftone storage Techniques. **(May 10)**

8. i. Why is an attenuator probe used?
   ii. In a cathode ray tube the distance between the deflecting plates is 1.5cm, the length of the deflecting plates is 4.5cm and the distance of the screen from the centre of the deflecting plates is 33cm. If the accelerating voltage supply is 300volt, calculate deflecting sensitivity of the tube. **(May 10)**

9. i. Derive an expression for the vertical deflection of an electron beam in the CRT.
   ii. The deflection sensitivity of an oscilloscope is 35v/cm. If the distance from deflection plates to CRT screen is 16cm, length of the deflection plate is 2.5cm and the distance between the deflecting plates is 1.2cm. What is the acceleration anode voltage? **(May 10)**

10. What is Synchronization? What are the different methods by which it can be accomplished?**(May 09)**

11. Define deflection sensitivity and deflection factor of a cathode ray tube. **(May 09)**

12. Draw the block diagram of a general purpose CRO and explain the functions of the following controls:
    i. Intensity
    ii. Focus
    iii. Horizontal and Vertical positioning. **(May 09)**

13. Explain the operation of a CRO with a neat block diagram. **(Sep 08, Nov 04)**

14. Explain in detail about the vertical deflection system. **(Sep 08, May 04)**

15. Explain principle and operation of sampling oscilloscope with neat block diagram**(Sep 08, Apr 03)**

16. i. What do you mean by multi trace with respect to oscilloscopes
    ii. With a neat block diagram explain the each block of a dual-trace oscilloscope**(Sep 08, Apr 03)**

17. What is digital frequency meter? Explain its principle of operation, construction and working. **(Sep, Apr 08)**

18. Describe in detail the construction and working of an analog type storage oscilloscope. **(Sep 08)**

19. i. Derive an expression for electrostatic deflection sensitivity of a CRT.
    ii. What are the applications of CRO? Explain the procedure for the measurement of frequency and phase using Lissajous figures. **(Sep 08, Apr 08, 03)**

20. What are the major blocks of oscilloscope, and what does each do? **(Apr 08)**

21. What are the major components of a CRT? **(Apr 08)**

22. i. What are the operating voltages of a CRT arranged so that the deflection plates are nearly ground potential? **(Apr 08)**
    ii. What is the velcoity of electrons that have been accelerated through a potential of 2000V?

23. Discuss in detail, electrostatic deflection of the electron beam. **(Apr 08)**

24. i. Write the important specifications of CRO for instrumentation applications. What selection factors are necessary for selecting a CRO.
    ii. Calculate the velocity of an electron beam in an oscilloscope if the voltage applied to its vertical deflection plates is 2000v. Also calculate the cut off frequency if the maximum transit time is 1/4th of a cycle. The length of horizontal plates is 50mm. **(Apr 08)**

25. i. An electro statically deflected cathode ray tube has plane parallel deflecting plates which are 2.5cm long and 0.5cm apart, and the distance from their centre to the screen is 20cm. The electron beam is accelerated by a potential difference of 2500v and is projected centrally between the plates. Calculate the deflecting voltage required to cause the beam to strike a deflecting voltage and find the corresponding deflection of the screen.
    ii. What is the relationship between the period of a waveform and its frequency? How is an oscilloscope used to determine frequency? **(Apr 08, 07, 05)**

26. A lissajous pattern on the oscilloscope is stationary and has 6 vertical maximum values and five horizontal maximum values. The frequency of the horizontal input is 1500 Hz. Determine the frequency of vertical input. **(Apr 07)**

27. i.How does the digital storage oscilloscope different from the conventional storage oscilloscope using a storage cathode ray tube.
    ii. List the advantages of each. **(Sep 06)**

28. i. Why is an attenuator probe used?
    ii. In a cathode ray tube the distance between the deflecting plates is 1cm, the length of the deflecting plates is 4.5 cm and the distance of the screen from the centre of the deflecting plates is 33cm. If the accelerating voltage supply is 300 volt, calculate deflecting sensitivity of the tube. **(Sep 06)**

29. i. Define deflection sensitivity and deflection factor of a cothode ray tube.
    ii. An electrically deflected CRT has a final anode voltage of 2000v and parallel deflecting plates 1.5 cm long and 5mm apart. If the screen is 50 cm from the centre of deflecting plates, find
    a. Beam speed
    b. The deflection sensitivity
    c. The deflection factor of the tube. **(Sep 06)**

30. Derive the equation D=LIdED/2dEa with respect to the concept of electrostatic deflection of a cathode ray oscilloscope, where D=deflection of electron beam on the screen in Y direction; mtr, L=distance between screen and the centre of deflectign plates; mtrs Id =length of the deflecting plates, Ed =potential between deflecinting plates, d=distance between deflecting plates, Ea =voltage of the pre-accelerating anode. **(Sep 06)**

31. i. Derive the equations for Resistive voltage divider and capacitive voltage divider of compensated attenuator.
    ii. Explain the method of finding phase, frequency relationship of two waveforms using Lissajous figures.
    iii. What are the advantages of using an active probe. **(Sep 06)**

32. i. Explain the two types of analog storage of oscilloscopes?
    ii. What are the dierences between Digital storage oscilloscope and conventional storage oscilloscope.
    iii. A sampling oscilloscope is being used to observe a 400 MHz sine wave. A sampling pulse occurs every 3 ns. Draw five cycles of the 400 MHz signal and place a dot at the sampled point on each of the five cycles. **(Sep 06)**

33. Explain the function of each of the following CRO controls
    i. Focus
    ii. Z-Axis Modulation
    iii. Astigmatism. **(Sep 06)**

34. i. Explain the working of storage CRO.
    ii. Explain the following terms
        a. Horizontal position
        b. External horizontal input. **(Sep 06)**

35. Explain with a neat block diagram of digital storage oscilloscope **(Apr 06)**

36. i. How does the sampling oscilloscope in crease the apparaent frequency response of an oscilloscope.
    ii. Voltage E1 is applied to the horizontal input and E2 to the vertical input of a CRO. E1 and E2 have same frequency. The trace on the screen is an ellipse. The sope of major axis is negative. The maximum vertical value is 3 divisions and the point where the ellipse crosses the vertical axis is 2.6
    divisions. the ellipse is symmetrical about horizontal and vertical axis. Determine the possible phase angle E2 with respect to E1 **(Apr 06)**

37. i. Write short notes on post deflection acceler4ation with respect to oscilloscope tube
    ii. What is the minimum distance, L, that will alow full deflection of 4cm at the oscilloscope screen with a deflection factor of 100v/cm and with an accelerating potential of 2000V? **(Apr 06)**

38. i. What effect does inceasing the writing rate of an oscilloscope by increasing the accelerating potential have ont he deflection sensitivity.
    ii. How much voltage is required across two deflection plates separated by 1cm to dflect an electron beam 1 degree. If the effective length of the deflection plates is 2cm and the accelerating potential is 1000 volts? **(Apr 06)**

39. i. Compare the output voltage of the voltage divider attenuator (Compensated Attenuator) for a dc voltage and a 10 MHZ ac signal.
    ii. Write short notes on delay line construction techniques.
    iii. How do we measure voltage and time using CRO? **(Apr 06)**

40. i. Draw the neat sketch of triggered sweep circuit and explain it. Draw the trigger pulse and sweep waveforms.
    ii. Draw the block diagram of a dual beam oscilloscope and explain its working. **(Apr 06)**

41. i. Draw the neat block diagram of a general purpose oscilloscope and explain its basic operation.
    ii. Explain the following terms:
        a. Fluorescence
        b. Phosphorescence
        c. Persistence. **(Apr 06)**

42. With a neat block diagram, explain each block of a heterodyne wave analyzer. **(Apr 05)**

43. Describe the different types of phosphorous materials used in a CRO and list their applications? **(Apr 05)**

44. The input attenuator in the vertical amplifier of a general purpose CRO is generally followed by an emitter follower or cathode follower circuit. Suggest three possible reasons for using this circuit. **(Apr 05)**

45. Describe the following:
    i. Sources of Synchronisation.
    ii. Blanking circuit
    iii. Focus control **(Apr 05)**

46. Derive an expression for deflection sensitivity and deflection factor of a CRT. **(Nov 04)**

47. Explain about CRT screen. **(Nov 04)**

48. Explain the difference between the internal and external graticules. **(May 04)**

49. Write short notes on synchronization of the sweep. **(May 04)**

50. i. Draw the block diagram of a general purpose CRO and explain the function of the following control
    a. intensity
    b. focus
    c. horizontal and vertical positioning
    d. synchronization.
    ii. Explain the function of a time base generator in a CRO. **(Nov 03)**

51. i. Explain different type of graticules used in a CRO. Describe their advantage and disadvantage.
    ii. How does the sampling oscilloscope increase apparent frequency response of an oscilloscope?
    iii. What is the relationship between the period of a waveform and its frequency. How is an oscilloscope used to determine frequency? **(Nov 03)**

52. i. How much voltage is required across two deflection plates separated by 1 cm, to deflect an electron beam 1o if the effective length of the deflection plate is 2 cm and the accelerating potential is 1000 V.
    ii. What is oscilloscope probe compensation? How is this adjusted? What effect are noted when the compensation is not correctly adjusted? What are the advantage of using an active voltage probe?
    iii. State the kind of application where an x-y recorder is more suitable than the common form of single pen recorder. **(Nov 03)**

53. i. Describe the function of attenuators in CRO.
    ii. Describe the phenomen of synchronization of vertical input signal to its sweep generator.
    iii. Explain in detail the vertical and horizontal amplifiers used in CRO. **(Nov 03)**

54. i. Explain in detail the construction and working of sampling oscilloscope.
    ii. Explain the principle of secondary emission. **(Nov 03)**

55. With neat block diagram explain the working of generalpurpose oscilloscope. **(Apr 03)**

56. i. Describe the functionality of a time base generator in a CRO.
    ii. Describe the different parts of a CRT. **(Apr 03)**

57. i. Describe in detail the construction and working of storage oscilloscope.
    ii. Explain about direct reading probe, circuit isolation probe, detector probes. **(Apr 03)**

58. i. Derive an expression for magnetic deflection sensitivity of a CRT.
    ii. What are the materials used for CRT? Describe its characteristics. **(Apr 03)**

59. i. Draw the block diagram of a CRO and explain the function of each block.
ii. Describe the applications of a CRO. **(Apr 03)**

60. Why electronic circuits in oscilloscope causes a certain amount of time delay in transmission signal voltages to deflection plates **(Apr 03)**

61. With neat circuit diagram explain the operation of delay of vertical signal which allows horizontal sweep to start prior to vertical deflection **(Apr 03)**

62. How is vertical axis of oscilloscope deflected . How does it differ from horizontal axis **(Apr 03)**

63. How phase frequency and phase angle are measured using an oscilloscope **(Apr 03)**

64. How does Digital storage oscilloscope differ from conventional storage oscilloscope. **(Apr 03)**

65. Distinguish between dual beam and dual trace CRO'S with help of neat Block diagram. What are the advantages and disadvantages **(Apr 03)**

66. What materials used in screens of CRO'S , what are their characteristic features. **(Apr 03)**

67. Briefly explain about the characteristics of commonly used phosphors. **(Apr 03)**

68. Mention advantages of general purpose oscilloscope. **(Apr 03)**

69. How does alternate sweep compared with chopped sweep? When would one method be chosen over the other. **(Apr 03)**

70. Explain with a neat block diagram for time interval measurement and explain each block and its functionalities. **(Apr 03)**

71. Explain with a neat block diagram of a horizontal deflection system. **(Apr 03)**

72. i. Explain the following features of an analog type storage oscilloscope **(Apr 03)**
a. Bistable persistence storage
b. bistable storage
c. fast storage
ii. Discuss the advantages and disadvantages of analog and digital type of oscilloscopes

UNIT-IV

1. i. Write the general specications of digital voltmeter.
ii. With timing diagram showing voltage to time conversion, discuss Ramp type DVM. **(May 12)**

2. i. With a neat block diagram explain the working of servo balancing potentiometer type digital voltmeter.
ii. Describe the term overrange and half digit. **(April 11)**

3. Describe with the help of suitable circuit diagrams, how the following types of measurements are carried out using a digital frequency meter.
i. Single and multiple period measurements.
ii. Time interval measurements.

iii. Multiple ratio measurements. **(April 11)**

4. i. With a neat block diagram, explain the successive approximation digital voltmeter.

ii. The lowest range on a 4 1=2 digit digital voltmeter is 10 mV full scale. What is the sensitivity of this meter? **(April 11)**

5. i. How Digital voltmeters are classified? Explain.

ii. Write any four advantages and disadvantages of Linear Ramp technique. **(May 10)**

6. i. Explain working principle of Successive approximation type Digital Voltmeter?

ii. Mention advantages and disadvantages of successive approximation type DVM? **(May 10)**

7. i. Explain the Phase Meter principles employed in measuring equipment?

ii. Draw and explain Digital phase meter? **(May 10)**

8. i. Explain with a neat block diagram the working of a dual slope digital voltmeter.

ii. A dual slope integrating type A/D converter has an integrating capacitor of 0.1 microfarad and a resistance of 100 kohms. If the reference voltage is 2v, and the output of an integrator is not to exceed 10v, what is the maximum time the reference voltage can be integrated? **(May 10)**

9. Explain with neat circuit diagram the working of the linear ramp type DVM. **(May 09)**

10.. i. Explain the principle and working of peak reading voltmeter with a block diagram.

ii. Explain the two modes of operation of a vector impedance meter. **(May 09)**

11. What are the different types of Digital voltmeters? Explain them briefly with neat sketches. **(May 09)**

12. Draw and explain the circuit of a digital frequency meter. What are the different methods used for high frequency determination? **(May 09)**

13. List different types of DVM and explain any one of them with neat sketch? **(Sep 08)**

14. i. On what basis digital voltmeters are classified? **(Sep 08)**

ii. Explain with circuit diagram, the principle of operation of DVM.

15. i. Explain the basic circuit of a digital frequency meter

ii. Explain time base selector with a neat sketch **(Sep 08, 06)**

16. i. Describe the working of an integrating type voltmeter. **(Sep 08, Apr 08, 03)**

ii. A 4 1/2 digit voltmeter is used for voltage measurements.

a. Find its resolution.

b. How would 12.98 V be displayed on 10V range?

c. How would 0.6973 be displayed on 1 V range?

d. How would 0.6973 be displayed on 10 V range?

17. A 3 1/2 digit voltmeter is used for measuring voltage.

i. Find its resolution.

ii. How would a voltage of 14.53 V be displayed on 10V range?

iii. How would a reading of 14.53 V be displaced on 100V range? **(Sep 08, Apr 03)**

18. What is a digital voltmeter? Discuss about ramp type DVM with a neat diagram. **(Sep 08)**

19. Explain the basic principle of digital frequency measurement. **(Sep 08)**

20. Define deflection sensitivity and deflection factor of a cathode ray tube. **(Apr 08)**

21. On what basis digital voltmeters are classified and explain any two non-integrating type digital voltmeters. **(Apr 08)**

22. i. Explain the principle and working of peak reading voltmeter with a neat block diagram. **(Apr 08)**
ii. A coil of unknown impedance is connected in series with a capacitor of 224μF and an ammeter of negligible impedance is connected to a variable frequency of constant voltage and negligible impedance. The frequency was adjusted both above and below the resonance frequency till the reading of the ammeter was reduced to 70.7% of its value at resonance. This occurred at the frequencies of 876 and 892 kHz. Determine effective resistance, inductance and Q of the coil.

23. With a neat block diagram explain the microprocessor based ramp type digital voltmeter **(Apr 08, Sep, Apr 06)**

24. i. Explain in detail about integrating type DVM. **(Apr 08)**
ii. Explain the successive approximation conversion techniques.

25. Explain with a neat circuit diagram of a RMS voltmeter. **(Apr 07, Sep 06)**

26. i. Explain with a neat block diagram of a dual slope digital voltmeter
ii. A dual slope integrating type of A/D converter has an integrating capacitor of 0.1 microfarad and a resistance of 100k. ohms. If the referenence voltage is 2v, and the output of an integrator is not to exceed 10v, what is the maximum time the reference voltage can be integrated. **(Sep, Apr 06)**

27. i. Explain about each block of DVM and mention advantages of them.
ii. Explain the bridge type of thermocouple arrangement and mention its applications. **(Sep 06)**

28. What are the various methods of measuring distortion? With the help of neat diagrams explain the measurement techniques. **(Sep 06)**

29. Write short notes on:
i. frequency synthesizer
ii. Zero crossing detectors
iii. Frequency converters. **(Sep 06)**

30. i. Explain the working principle of a Dual slope integrator type of DVM with the help of neat block diagram.
ii. Explain the importance of thermocouples in the construction of true RMS type of voltmeter. **(Apr 05)**

31. Write short notes on:
i. Digital phase angle meter
ii. Vector impedance voltmeter **(Apr 06)**

32. i. What is digital frequency meter? Draw the basic circuit of a digital frequency meter. **(Apr 06)**
ii. What is time base? Why is it needed? Draw the circuit of a time base selector and explain.

33. i. With a neat block diagram explain the potentiometric type digital voltmeter. **(Apr 05)**
ii. The lowest range on a 4 1/2 digit digital voltmeter is 10mv full scale. What is the sensitivity of this meter

34. i. A 3 ½ digit voltmeter is used for measuring voltage.
a. Find its resolution.
b. How would a voltage of 14.53 V be displayed on 10V range?
c. How would a reading of 14.53 V be displaced on 100V range?
ii. Draw and explain the block diagram of storage oscilloscope. **(Apr 05)**

35. i. Explain the functioning of a ramp type digital voltmeter. **(Apr 05, 04)**
ii. Gating periods of 1 ms, 10 ms 100 ms 1 s and 10 s are provided on a digital counter-time-frequency meter having a 4 digit display. When a gating period is used a reading of 0095

is obtained. What is the likely value of frequency? What steps should be taken to obtain most accurate result?

36. i. Describe the working of an integrating type voltmeter.
    ii. A 4 ½ Digit voltmeter is used for voltage measurements.
    a Find its resolution.
    b. How would 12.98 V be displayed on 10V range?
    c. How would 0.6973 be displayed on 1V range?
    d. How would 0.6973 be displayed on 10 V range? **(Apr 05)**

37. Explain the different methods used for measurement of RMS values of Voltages. **(Apr 05)**

38. i. What are the different types of digital voltmeters? Explain each of them briefly. **(Apr 05)**
    ii. The lowest range on a 4 ½ digit DVM is 10 mV full scales. What is sensitivity of this meter?

39. i. Explain the principles of frequency and time measurements.
    ii. Explain the operation of a simple frequency counter together with waveforms. **(Nov 04)**

40. Draw and explain circuit of digital frequency meter . What are the different methods used for high frequency determination .Explain each of them briefly **(Apr 04)**

41. i. Expain functioning of digital phase frequency meter
    ii. Describe the working of successive approximation type DVM. **(Apr 04)**

42. i. Draw and explain vector impedance meter
    ii. Explain the principles of Peak reading and RMS voltmeter **(Apr 04)**

43. i. Explain the following terms as applied to digital displays:
    a. Resolution
    b. Difference between 3 digit and 4 digit displays
    c. Sensitivity of digital meters
    d. Accuracy specifications of digital meters.
    ii. Gating periods of 1 ms, 10 ms, 100 ms, 1 sand 10 s are provided on a digital counter-time-frequency meter having a 3 digit display. A gating period of 10 ms is selected to measure an unknown frequency and reading of 034 is obtained. What is the likely value of frequency? What steps to be taken
    a. to clock the validity of the result; b. to obtain a more accurate result? **(Apr 04)**

44. i. Explain the functioning of a potentiometer type digital voltmeter.
    ii. A 31/2 digit of DVM has an accuracy specification of:t 0.5 percent of reading +/-digit.
    a. What is the possible error in volt, when the instrument is reading 5.00 V on the 10 V range?
    b. What is the possible error in volt, when reading 0.1 V on the 10 V range? **(Apr 04)**

45. i. What are the different types of digital voltmeters? Explain each of them briefly. **(Apr 04)**
    ii. The lowest range on a 4t digit DVM is 10 mV full scales. What is sensitivity of this meter?

46. i. Describe the working of an integrating type voltmeter.
    ii. A 4 1/2 digit voltmeter is used for voltage measurements. (i) Find its resolution. (ii) How would 12.98 V be displayed on 10V range? (iii) How would 0.6973 be displayed on 1 V range? (iv) How would 0.6973 be displayed on 10 V range? **(Apr 04)**

47. i. Explain the principles of frequency and time measurements.
    ii. Explain the operation of a simple frequency counter together with waveforms. **(Apr 04)**

48. i. What are the different types of extending frequency range of a frequency counter?
    ii. Explain any two methods generally used to extend the frequency range of a frequency counter. **(Apr 04)**

49. i. Distinguish between time and phase measurements.
    ii. Explain the operation of a very low frequency comparator system? **(Apr 04)**

50. Explain the functioning of successive approximation type and potentiometric type of digital voltmeters. **(Nov 03)**

51. Explain with help of suitable diagrams the functioning of ramp type and integrating type digital voltmeter. **(Nov 03)**

52. i. Explain in detail about continuous balance type digital voltmeter.
    ii. Describe with the help of suitable block diagram how the following type of measurements are carried out time interval and low frequency measurement **(Nov 03)**

53. i. What are the design considerations of digital voltmeters.
    ii. Explain the principle of thermo couple voltmeter with diagrams **(Apr 03)**

54. i. Explain the functioning of digital phase angle meter.
    ii. Describe the working of the successive approximation type DVM. **(Apr 03)**

UNIT-V

1. i. With neat circuit diagram explain a peak reading voltmeter.
   ii. List out characteristics of frequency selective wave analyzer. **(May 12)**

2. i. With block diagram explain Harmonic distortion analyzer employing BridgeT- network.
   ii. Explain the principle and working of true RMS voltmeter with block diagram. **(April 11)**

3. Explain the principle and operation of vector impedance meter with a neat block diagram. **(April 11)**

4. i. With a neat block diagram explain the working of a heterodyne wave analyzer.
   ii. Explain the dierences between peak reading and RMS voltmeters. **(April 11)**

5. i. Explain the principle and operation of Inter Modulation Distortion analyzer with block diagram.
   ii. Explain the phase angle measurement with vector impedance meter. **(May 10)**

6. i. Explain the principle and working of peak reading voltmeter with a block diagram.
   ii. Explain the two modes of operation of a vector impedance meter. **(May 10)**

7. i. Explain the phase angle measurement with vector impedance meter.
   ii. The self capacitance of coil is measured by the Q meter. The circuit is set in to resonance at 2 MHz and the tuning capacitor is of the value 460pF. The frequency is adjusted to 4 MHz and the resonance conditions are obtained by tuning the capacitor at 100pF. Calculate the value of self capacitance of the coil. **(May 10)**

8. i. What is the spectrum of a signal? Explain with various examples.
   ii. A coil of unknown impedance is connected in series with a capacitor of 224¼F and an ammeter of negligible impedance is connected to a variable frequency of constant voltage and negligible impedance. The frequency was adjusted both above and below the resonance frequency till the reading of the ammeter was reduced to70.7% of its value at resonance. This occurred at the frequencies of 876 and 892 kHz. Determine effective resistance, inductance and Q of the coil. **(May 09)**

9. i. What is a Q-Factor? Explain hoe Q-Factor is measmed?Give the working principle of the meter.
   ii. Tests using a Q meter on a radio tuning coil to find its self capacitance gave the following results.

i. With the radio coil connected normally, the resonance was obtained at 1 MHz with tuning capaci tor set at 80 pF.

ii. With the standard inductor connected in place of the radio coil, the resonance was obtained at 3 MHz. and this condition was not altered when the radio coil was connected in parallel with the standard inductor.Calculate the self-capacitance of the radio coil. **(May 09)**

10. Explain the principle and operation of vector impedance meter with a neat block diagram. **(May 09)**

11. i. What is a wave analyzer? Mention its significance in measurement system. **(Sep 08)**
    ii. Explain the working of a Frequency selective wave analyzer with a neat block diagram.
    iii. Mention few applications of heterodyne wave analyzers.

12. i. What is harmonic distortion? What are the types of the distortion? Discuss them. **(Sep 08)**
    ii. A capacitor of capacitance 245 μF produces resonance at angular frequency of 5 x 10^6 rad/s, while a capacitor of capacitance 50 pF produces resonance with the second harmonic of this frequency. Calculate the inductance and the self capacitance of the coil.

13. i. Explain the working of a heterodyne wave analyzer with a neat block diagram. **(Sep 08)**
    ii. Explain the principle and operation of basic spectrum analyzer with a neat block diagram.

14. i. Explain the principle and working of true RMS voltmeter with a block diagram. **(Apr 08)**
    ii. What are the differences between peak reading and RMS voltmeters.

15. i. Mention a few applications of heterodyne wave analyzers. **(Apr 08)**
    ii. Explain the principle and operation of basic spectrum analyzer with a neat block diagram.

16. i. Explain the working of a Frequency selective wave analyzer with a neat block diagram. **(Apr 08)**
    ii. What is harmonic distortion? What are the types of the distortion? Discuss them.

17. What do you mean by harmonic distortion and explain anyone method for measuring it. **(Apr 08, 05)**

18. Explain in detail about spectrum Analyzers used for High frequency. **(Apr 08, 05)**

19. Explain with an appropriate circuit for measurement of low impedance component with Q meter. **(Apr 07)**

20. For measurement of small values of capacitances, a 60Mhz signal source is to be used in a capacitance meter. What value of series resistance is required if the phase shift is to kept below 507 degrees for full scale capacitance readings of 1,10 and 100pf. **(Apr 07)**

21. i. What are the sources of error in the measurement of Q of a coil. How are they taken care of ?
    ii. A coil with a resistance of 0.1 ohm is connected in the" direct measurement" mode. Resonance occurs when the oscillator frequency is 40 MHz and the value of capacitor is 135 pF. Calculate the percentage error introduced in the calculated value of Q by the 0.02 ohm insertion resistance. **(Sep 06)**

22. i. What are the problems associated with grounding? How are they handled?
    ii. Explain how can a Q meter be used for the measurement of stray capacitance? **(May 06)**

23. i. Draw the block diagram of a spectrum analyzer of the swept-receiver design and explain it.
    ii. Discuss the applications of Spectrum analyzer. **(May 06)**

24. i. Describe the basic circuit of spectrum Analyzer. **(Jul 05)**
    ii. Explain how the spectrum of the following is displayed.
    a. continuous wave s/l
    b. AM signal
    c. FM

d. Pulse modulates signal.

25. With a neat sketch explain the operation of RF vector Impedance meter. **(Apr 05)**

26. Draw the block diagram of a spectrum analyzer of the swept-receiver design and explain it. **(Apr 05)**

27. Discuss the applications of Spectrum analyzer. **(Apr 05)**

28. Describe basic circuit of spectrum analyzer .Explain how the spectra of following are displayed .
   i. Continuous wave signals
   ii. Amplitude modulated signals
   iii. Frequency modulated signals **(Apr 04)**

29. i. Describe the engineering applications of wave analysers
   ii. Explain the different types distortions caused by amplifiers **(Apr 04)**

30. Describe the circuits and working of wave analysers used for audio frequency and megahertz ranges.
(Apr 04, 03)

31. i. Draw the circuit of a basic Q-meter and explain its principle of operation using a vector diagram
   ii. Discuss the "Direct- connection" technique of using Q-meter. **(Apr 04)**

32. Describe the basic circuit of a spectrum analyzer. Explain how the spectra of the following are displayed (a) continuous wave signals (b) amplitude modulated signals (c) Frequency modulated signal.
(Apr 04)

33. i. Describe the measurement of the following using a Q meter
   (i) Q factor (ii) inductance (iii) effective resistance (iv) self capacitance(v) bandwidth.
   ii. A circuit consisting of a coil, a resistance and a variable capacitor connected in series is tunned to resonance using a Q meter. If the frequency is 500 KHz, the resistance 0.5 Ù and the variable capacitor set to 350 PF. Calculate the effective inductance and resistance of the coil, if the Q meter indicates 90.**(Nov 03)**

4. i. Describe the circuit and working of a Q meter. Describe its application.
   ii. Describe how corrections for shunt resistance and distributed capacitance are applied when measuring Q factor of a coil with a Q meter. **(Nov 03)**

35. Explain in detail the construction and working of a spectrum analyzer. State its application. **(Nov 03)**

36. Describe with the help of a suitable block diagram, how the following type of measurements are carried out.
   i. Single and multiple period measurements.
   ii. Time interval measurements. **(Nov 03)**

37. Describe the circuits and working of wave analysers used for audio frequency and mega hertz ranges
(Apr 03)

38. Describe the circuit and working of Q meter . Describe its applications **(Apr 03)**

39. Describe the basic circuit of a spectrum analyzer. Explain how the spectra of the following are displayed
   i. Continuous wave signals
   ii. Amplitude modulated signals
   iii. Frequency modulated signal.
(Apr 03)

40. Describe the engineering applications of wave analysers. Explain various types of distortions caused by amplifier **(Apr 03)**

41. i. Explain how high impedance components can be measured using Q-meter.
    ii. Explain the working principle of Maxwell bridge circuit for the measurement of inductance. **(Apr 03)**

42. i. Explain the principle of operation of Q-meter with a block diagram.
    ii. Explain the working of distortion factor meter. **(Apr 03)**

43. i. Explain the procedure for the measurement of delay, time and phase.
    ii. Write brief notes on frequency synthesizer. **(Apr 03)**

44. i. What are the applications of spectrum analyzer.
    ii. Explain with a neat diagram the principle of storage oscilloscope. **(Apr 03)**

45. i. Explain the principle of operators of spectrum analyzer for higher frequencies.
    ii. Classify various transducers and mention the applications of each. **(Apr 03)**

46. i. Explain the principle of distortion factor meter with necessary diagram.
    ii. Explain how the distributed capacitance can be measured using Q-meter. Calculate the distributed capacitance for C1 = 460pF and C2 = 100pF at 2MHz and 4 MHz respectively in the first and second measurement. **(Apr 03)**

UNIT-VI

1. A strain gauge bridge has one arm as strain gauge with a gauge factor of 2.2. The resistance value of strain gauge and other arms is 200 . Find the bridge output voltage (with output open circuited) for a supply voltage of 3 V when the strain gauge is subjected to 600 strain. **(May 12)**

2. i. What is dierence between active and passive transducers? Explain.
   ii. What is load cell? Where is it used? **(April 11)**

3. i. With a neat sketch explain the working of Pirani gauge.
   ii. With the diagram explain ow direction measurement using double wire arrangement. **(April 11)**
4. i. What is load cell? Explain the working of a load cell strain gauge bridge.
   ii. A mild steel shaft is used to connect a motor drive to a constant load torque. A foil strain gauge having a resistance of 120 and a gauge factor 2 is mounted on a shaft with its active axis at angle of 45 degrees to the axis of the shaft. The shear modules of steel is 80 GN/m2. The shaft radius is 15 mm and the change in strain gauge resistance due to the load is 0.24 . Find load torque. **(April 11)**
5. i. Explain the working principle of potentiometric type accelerometer.
   ii. Explain the measurement of torque using strain gauge torque method. **(April 11)**
6. i. Discuss specications of LVDT.
   ii. What are the advantages of using a foil type strain gauge. **(April 11)**
7. i. With a neat schematic describe the vibrating wire force transducer.
   ii. Write short notes on strain gauges and their applications. **(April 11)**
8. Discuss in detail about.
   i. Total radiation pyrometers
   ii. Optical pyrometers. **(April 11)**

9. A resistive position transducer with a resistance of 5 k ohm and a shaft stoke of 8 cm is applied with a voltage of 5 V. When the wiper is 3 cm from the reference, what is the output voltage? **(April 11)**

10. What is meant by the distortion factor? How can this factor be measured ? Explain with the help of a block diagram. **(April 11)**

11. i. What is a self generating Transducer?
ii. What is a thermocouple? **(May 10)**

12. Describe pressure measurement using the following:
i) LVDT ii) Photoelectric transducers. iii) Oscillation transducers. **(May 10)**

13. i. What is Hystersis in a transducer? Explain.
ii. Write short notes on Errors due to
i) Noise and drift
ii) Frequency. **(May 10)**

14. i. Explain various methods of measurement of output of thermo couples.
ii. What is an LVDT? Explain its construction and operation with neat sketches. **(May 10)**

15. i. Discuss the advantages and disadvantages of the capacitive transducers.
ii. The output of an LVDT is connected to a 5V Voltmeter through an amplifier whose amplification factor is 250. An output of 2 mV appears across terminals of LVDT when the core moves through a distance of 0.5mm. Calculate the sensitivity of the LVDT and the whole set up. The millimeter scale has 100 divisions. The scale can be read to 15*th* of a division. Calculate the resolution of the instrument in mm. **(May 10)**

16. Explain the flow measurements using thermistors. **(May 10)**

17. i. What is a self generating Transducers?
ii. What is a thermocouple? **(May 09)**

18. i. Discuss in detail about strain gauge Rosettes.
ii. The strain gauge having a gauge factor of 2 is connected in a bridge circuit having an excitation voltage 8V. The resistances are equal.It is subjected to a strain of 0.006. If this output is to represent 2/3rd of full scale deflection of a recorder, what should be the gain of the amplifier. The full scale input voltage of the recorder is 1V. **(May 09)**

19. i. what do you understanding by an analog Transducer and a Digital Transducer? Give examples.
ii. What are the errors in a Transducer? **(May 09)**

20. A shaft is to transmit power up to 44kW at a constant speed of 25rps an it is proposed that the torque be sensed by a pair of torque strain gauges bonded to specially machine potion of the shaft. The gauges are to be connected pushpull in an equiarmed voltage sensitive bridge, the output of which is to be calibrated in power units. If the maximum strain value of the gauges is 0.0015, their resistance is 120 and gauge factor is 2.1, calculate
i. the diameter of the steel shaft to which they are to be bonded, if its modulus of elasticity is 200×109N/m2.
ii. the output voltage at full power if the excitation of the bridge is 6V.
iii. the sensitivity of the bridge in V/kW. **(May 09)**

21. A thermopile arrangement of a copper constantan thermocouple consists of free junction parts and has the reference junction at 2000 0C. If the output voltage is 3.3mv, determine the temperature of the detecting junction.
The calibration chart of the thermocouple is

Temp(0C)	100	200	250
Voltage (mV)	4.22	9.23	11.95

(May 09)

22. Explain about the following:
i. bonded wire strain gauges
ii. bonded metal foil strain gauges. **(May 09)**

23. i. Explain the operation of DC Tachometer generators. What are it's advantages and disadvantages.
ii. Explain Strobotran with a neat sketch. **(May 09)**

24. i. Discuss the characteristics ofmaterials used for potentiometers.

ii. A voltage dividing potentiometer is used to measure an angular displacement of 600 and the total angle travel of the potentiometer is 3550. Calculate the voltage output on open circuit if the potentiometer is excited by a 60V source. Calculate the actual value of the output voltage at this setting if a voltmeter of 1M resistance is connected across the output.The resistance of the poten- tiometer is 1K. Calculate the % error.

(May 09)

25. i. Explain shaft speed measurements using Stroboscope with a neat sketches.

ii. What are the advantages and disadvantages of moving magnet type linear velocity transducer.

(May 09)

26. i. Discuss in detail about turbine meters including their advantages and limitations.

ii. Describe pressure measurement Piezoelectric transducers with neat sketches. **(May 09)**

27. A piezoelectric transducer has a capacitance of 1000pF and a charge sensitivity of 40×10^{-3} C/m. The connecting cable has a capacitance of 300pF while the oscilloscope used for readout has an input resistance of 1M and a parallel capacitance of 50pF. **(Sep 08)**

i. what is the sensitivity of the transducer alone?

ii. (V/m) of the entire measuring system?

iii. what is the lowest frequency that can be measured with a 5% amplitude error by the entire system

iv. what is the value of external shunt capacitance that can be connected in order to extend the range of 5% error down to 10 Hz.?

v. What is the high frequency sensitivity, when the external shunt capacitance calculated in

vi. is connected in the circuit.

28. i. Explain the input and ouput characteristics of the transducers. **(Sep 08)**

ii. Discuss the materials used for potentiometers.

29. Explain the factors that influence the selection of a transducer. **(Sep, Apr 08)**

30. i. Discuss in detail about the principle of operation of a capacitive transducer

ii. What is the relation between sensitivity and area of plates **(Sep 08, 06, Apr 06,05,04)**

31. What is the frequency response of Piezo electric transducer? **(Sep, Apr 08, 06)**

32. i. Explain about photo diode and photo transistor

ii. Explain in detail about thermocouples **(Sep 08, 06, Jul, Apr 05, 04)**

33. i. Discuss in detail the operation of LVDT?

ii. What are the advantages and disadvantages of LVDT? **(Sep 08, Jul 05, Apr 04,03)**

34. i. Discuss the materials used for potentiometers. **(Apr 08)**

ii. A voltage dividing potentiometer is used to measure an angular displacement of 600 and the total angle travel of the potentiometer is 355^0. Calculate the voltage output on open circuit if the potentiometer is excited by a 60V source. Calculate the actual value of the output voltage at this setting if a voltmeter of 1M resistance is connected across the output.The resistance of the potentiometer is 1K. Calculate the % error.

35. Explain the operation of Control type synchro system. **(Apr 08)**

36. i. Show and explain the capacitive transducer arrangement to measure angular velocity and what are its limitations?

ii. What are the disadvantages of capacitive transducers?

iii. What are the uses of capacitive transducers? **(Apr 08, Sep 06)**

37. Explain in detail the applications of photodevices? **(Apr 07)**

38. i.What are the various types of inductive transducers? **(Apr 07, 06)**
    ii. Explain in detail the working of inductive transducers operating on the principle of eddy currents?

39. i. Where are piezoelectric transducers mainly used and why?
    ii. Give the equivalent circuit of a crystal and explain how a crystal is used as a transducer?
    iii. Explain the construction and working of strain gauge. **(Sep, May 06)**

40. i. Show with an example, how the capacitive transducer has excellent frequency response?
    ii. What is temperature co-ecient of resistor? Explain in detail. **(Sep 06)**

41. i. Explain the working of a piezoelectric transducer with suitable equations and sketches.
    ii. Derive an expression for gauge factor for a strain gauge. **(Sep 06)**

42. Explain the following with suitable examples:
    i. Transducer
    ii. Inverse transducer
    iii. Output transducer **(Jul 06, Apr 05)**

43. i. Define gauge factor for a transducer?
    ii. Derive an expression for this factor for a strain gauge?
    iii. What is the main factor desirable for a strain gauge?
    iv. How will you achieve it? **(May 06)**

44. i. What are the advantages and disadvantages of a capacitive transducer?
    ii. A barium titanate pick up has the dimensions of 5mmx5mmx1.25mm.The force acting on it is 5N.The charge sensitivity of barium titanate is 150 PC/N and its permittivity is 12.5x10-9 F/M. The force acting on it is 5N. If the modulus of elasticity of barium titanate is 12x106 N/M2.Calculate the strain, he charge and the capacitance. **(Apr 06, 05)**

45. i. What are the advantages and disadvantages of a capacitive transducer?
    ii. A barium titanate pick up has the dimensions of 5mm x 5mm x 1.25mm. The force acting on it is 5N. The charge sensitivity of barium titanate is 150 PC/N and its permittivity is 12.5 x 10-9 F/M. The force acting on it is 5N. If the modulus of elasticity of barium titanate is 12 x 106 N/M2. Calculate the strain, he charge and the capacitance. **(Jul 05 Apr 03)**

46. What are the crystalline materials used as transducers. What are their merits and demerits? Derive an expression for finding the voltage developed across a crystal. Explain how temperature affects it?**(Apr 05)**

47. Name some common types of strain gauges? What characteristics determine the size of the strain gauge? Explain the functioning of a foil type strain gauge. **(Apr 05)**

48. i. What are the modes of operation of piezo electric crystals? Explain in detail.
    ii. Draw the equivalent circuit of piezo electric transducer.
    iii. Explain the properties of piezo electric crystals. **(Apr 05)**

49. i. What is Rosettes? Explain with neat sketches the different forms of it.
    ii. Explain semiconductor strain gauges. **(Apr 05)**

50. Describe the working of LVDT with a neat sketch. **(Nov 04)**

51. i. What is piezo resistive effect

ii. Explain about semiconductor strain gauges
iii. What are the advantages and disadvantages of semiconductor straingauges **(Apr 04)**

52. i. Explain advantages and disadvantages of electrical transducers over mechanical transducers
ii. What are the digital transducers . Give examples **(Apr 04)**

53. What are the different types of inductance transducers?Explain their basic principle of operation.**(Apr 04)**

54. Describe the construction and working of the following types of accelerometers and state its advantage and disadvantage (a) LVDT type (b) Potentiometer type. **(Nov 03)**

55. i. Briefly describe the different criteria for selection of transducer for a particular application
ii. Explain the differences between Primary and Secondary transducers. **(Apr 03)**

56. i. Explain gauge sensitivity in case of a strain gauge. Derive an expression for the output voltage of a wheat stone bridge when one of the arms is a strain gauge.
ii. A strain gauge bridge has one arm as strain gauge with a gauge factor of 2.2. the resist ance value of strain gauge and other arms is 120 . Find the bridge output voltage (with output open circuited) for a supply voltage of 3V when the strain gauge is subjected to 600 micro strain. **(Apr 03)**

57. i. What is the gauge sensitivity? Explain with a neat sketch to find the sensitivity of a half bridge.
ii. Two electrical strain gauges are bonded to a duralumin cantilever and connected a bridge as adjacent arms. Each gauge has a resistance of 100 and a gauge factor of 2.1. the input voltage is 4V. The stress is 200MN/m2. Find the current through the detector if its resistance is 400 . Modulus of elasticity of duralumin is 70 GN/ m2. **(Apr 03)**

58. Discuss the characteristic and choice of transducers.

59. Explain the constructiona and working principle of resistive transducers.

60. Explain the construction and working princple of synchros.

61. State and explain active type of transducers.

UNIT-VII

1. Explain the measurement of angular velocity using D.C tachometer generator. **(May 12)**

2. i. What are the specications of potentiometers? What are its merits and demerits?
ii. What is gauge factor and poission's ratio. **(May 12)**

3. Explain with a neat block diagram for time interval measurement and explain each block and its functionalities.
(April 11)

4. i. Explain shaft speed measurements using Stroboscope with a neat sketches.
ii. What are the advantages and disadvantages of moving magnet type linear velocity transducer?
(May 10)

5. i. Explain the construction and working of seismic accelerometer. Discuss its characteristics.
ii. An accelerometer has a seismic mass of 0.05kg and a spring constant of $3x10^3$ N/M. Maximum mass displacement is 0.02*m*± (before the mass hits the stop). Determine maximum measurable acceleration and natural frequency of the system. **(May 10)**

6. i. Discuss briefly about piezoelectric accelerometers.
   ii. A piezoelectric accelerometer has a transfer function 61mV/g and a natural frequency of 4500Hz. In a vibration test at 110Hz, a reading of 3.6V peak is obtained. Find the vibration peak displacement. **(May 10)**

7. i. Describe the construction and functioning of electromagnetic tachometers.
   ii. A disc mounted on the shaft of the machine has 12 pattern points. The number of flashes projected on the disc by stroboscope is 6000 in a minute.
      i) Find the speed of the machine if the disc appears stationary and has single image of 12 points.
      ii) Find the speed, if the disc appears to move forward in the direction of rotation. **(May 10)**

8. Explain about magneto-strictive torque transducers. **(May 09)**

9. Discuss the principle of operation , advantages and disadvantages of drag cup type tachogenerator. **(Sep 08)**

10. i. Define gauge sensitivity and derive expression for it. **(Sep 08)**
    ii. In order to measure strain in a cantilever beam a single strain gauge of resistance 1 K and gauge factor 2 and temperature coefficient of 10 x 10^{-6}/0C is mounted on one beam and connected in one arm of the bridge circuit. The other three arms of the bridge have resistances of 100 " each. The bridge detector resistance is 100 and it • fs sensitivity is 10mm/μA
    a. Calculate deflector'fs defletion for 0.1% strain
    b. Calculate the change in effective strain indicated when the room temperature increases by 10^0C.
    iii. Mention few devices that are used for the measurement of Rotary displacement.

11. i. Describe the following methods of temperature compensation for strain gauges **(Sep 08)**
    a. use of dummy gauge
    b. half bridge method.
    ii. A single electrical resistance strain gauge of resistance 120and having a gauge factor of 2 is bonded to steel having elastic limit stress of 400MN/m^2. and modulus of elasticity 200GN/m2.Calculate the change in resistance due to
    a. change in stress equal to 1/10^{th} of the elastic range
    b. change of temperature of 20 ^{0}C if the material is advanced alloy. The resistance temperature coefficient of alloy is 20 × 10^{-6}/ ^{0}C.
    c. Calculate the strain due to the differential expansion of the guage metal and steel, if coefficient of linear expansion of the steel is 12 × 10^{-6}/ ^{0}C and that of the advanced alloy is 16 × 10^{-6}/ ^{0}C.

12. i. Discuss briefly about piezoelectric accelerometers. **(Sep 08)**
    ii. A piezoelectric accelerometer has a transfer function 61mV/g and a natural frequency of 4500Hz. In a vibration test at 110Hz, a reading of 3.6V peak is obtained. Find the vibration peak displacement.

13. Draw the neat sketch of different strain guages. **(Sep 08)**

14. i. What is a load cell? Explain the working of a load cell strain gauge bridge.
    ii. A load cell consists of a solid cylinder of steel 40mm in diameter with fours train gauges bonded to it and connected in to the four arms of a voltage sensitive bridge. The gauges are mounted to have Poisson's arrangement. The gauge factor is 2.1 and each gauge has 1000 ohms resistance. The bridge excitation voltage is 6v. Determine the sensitivity of the cell in V/KN modulus of elasticity for steel is 200GN/m2 and Poisson ratio is 0.29. **(Sep, Apr 08, 06, 03, July 05)**

15. i. What is the gauge sensitivity? Explain with a neat sketch to find the sensitivity of a half bridge.
    ii. Two electrical strain gauges are bonded to a duralumin cantilever and connected a bridge as adjacent arms. Each gauge has a resistance of 100 and a gauge factor of 2.1. the input voltage is e stress is 200MN/m2. Find the current through the detector if its resistance is 400. Modulus of elasticity of duralumin is 70GN/m2. **(Sep, Apr 08, Jul, Apr 05)**

16. i. Explain the method of adjacent arm compensating gauge for temperature compensation in strain gauge with a neat circuit.
    ii. A single electrical resistance strain gauge of resistance 120 and having a gauge factor of 2 is bonded to steel having an elastic limit stress of 400MN/m2 and modulus of elasticity 200 GN/m2 . calculate the change in resistance due to a change of temperature of 200C. co-efficient of linear expansion of steel is 12x10-6/0C. **(Sep 08, Apr 08, 03)**

17. What is ionization chamber? Explain its special features. **(Apr 08, May 04)**

18. i. Explain the operation of DC Tachometer generators. What are it's advantages and disadvantages.
    ii. Explain Strobotran with a neat sketch. **(Apr 08)**

19. i. Discuss the principle of operation of strain gauge. What is gauge factor? Compare some of the important characteristics of metallic and semiconductor type strain gauges.
    ii. A resistive strain gauge with a gauge factor of 2 is fastened to a member which is subjected to a strain of 1 x 10-6 . If the original value of gauges is 130 ohms, calculate change in resistance.**(Apr 08, Jul 05)**

20. i. Explain in detail the application of RVDT.
    ii. Discuss in detail the operation of a synchros **(Apr 08, 06, 04, 03)**

21. i. Discuss in detail about strain gauge Rosettes. **(Apr 08)**
    ii. The strain gauge having a gauge factor of 2 is connected in a bridge circuit having an excitation voltage 8V. The resistances are equal.It is subjected to a strain of 0.006. If this output is to represent 2/3rd of full scale deflection of a recorder, what should be the gain of the amplifier. The full scale input voltage of the recorder is 1V.

22. i. Explain the method of measurement of linear displacement using potentiometer
    ii. A helipot is provided with 40 turns/mm. The gearing arrangement is such that the motion of the main shaft by one revolution causes 5 revolutions of the potentiometer shaft. Calculate the resolution of the Potentiometer? **(Sep Apr 06, 03)**

23. i. A single strain gauge is mounted to measure the axial strain in a simple tensile member If the recorded strain is 380 micro strain . what is the axial stress.
    a. if member is steel
    b. if member is alluminium
    ii. What are the advantages of electrical transducers **(Sep 06, Apr 04, 03)**

24. i. Explain in general, the measurement of torque using digital technique compare the merits of multi toothed flange over single toothed flange. Give the necessary sketch.
    ii. Explain the measurement of torque using strain gauge torque method. Also give the advantages of this method. **(Sep 06, Jul 05)**

25. i. Explain the principle and measurement a torque using magneto-strictive transducer
    ii. A mild steer shaft is used to connect a motor drive to a constant load torque. A foil strain gauge having a resistance of 120 ohms and a gauge factor 2 is mounted on a shaft with its active axis at angle of 45 degrees to the axis of the shaft. The shear modules of steel is 80GN/m2, the shaft radius is 15mm and the change in strain gauge resistance due to the load 0.24ohms. Find the load torque.

(Sep, Apr 06, 04)

26. i. Describe the construction and working of LVDT accelerometer with a neat sketch
    ii. An LVDT is used in an accelerometer to measure seismic mass displacement. The LVDT and signal conditioning outputs are 0.31mv/mm with a± 20mm core displacement. The spring constant is 240N/m and the core mass is 0.05kg. Find
    a. relation between acceleration in m/s2 and the output voltage **(Sep 06, Apr 05)**
    b. natural frequency and
    c. maximum acceleration measurable

27. i. Explain how a load cell is employed to measure static and dynamic forces.
    ii. Derive the expression for gauge factor for a strain guage. **(Sep 06)**

28. i. Name some common types of strain gauges?
    ii. What characteristics determine the size of the strain gauge?
    iii. Explain the functioning of a foil type strain gauge. **(Sep 06)**

29. i. Discuss the specifications of LVDT
    ii. A copper constantan thermocouple with a= 3.75*10-2 and b=4.5*10-5 mv/oC . If T1= 100oC and cold junction compensation T2 is kept in ice , compute resulting emf **(Apr 06, 04)**

30. i. What are the applications of LVDT? **(Jul 05)**
    ii. A steel cantilever is 0.25mm long, 20mm wide and 4mm thick.
    a. Calculate the value of deflection at the free end for the cantilever when a force of 25N is applied at the end. The modulus of elasticity for steel is 200 GN/M2. An LVDT with a sensitivity of 0.5/mm is used. The voltage is read on a 10V voltmeter having 100 divisions. Two lengths of a division can be read with certainty
    b. Calculate the minimum and maximum value of force that can be measured with this arrangement?

31. i. Compare the advantages and disadvantages of DC tachometer generation and AC tachometer generator.
    ii. A variable reluctance type tachometer has 60 rotor teeth. The counter records 3600 counts per second. Determine the speed in rpm. **(Jul 05)**

32. i. What are the primary detectors? Explain in detail?
    ii. A torque bar of 30 mm diameter is used for measurement of a torque of 100 NM. Calculate the angel of twist if shear modulus of mild steel is 80 x 109 N/M2 **(Jul 05, Apr 04)**

33. i. What is dynamic compensations? Explain the compensation adjustment scheme in a hot wire anemometer using squire wave current source.
    ii. Explain how torque can be measured using an Inductive transducer. Give the sketch for arrangement of inductive transducers with respect to shaft. **(Jul 05)**

34. i. Explain the method of measurement of linear displacement using potentiometer
    ii. A heliport is provided with 40 turns/mm. The gearing arrangement is such that the motion of the main shaft by one revolution causes 5 revolutions of the potentiometer shaft. Calculate the resolution of the Potentiometer? **(Apr 05)**

35. i. A round steel bar of .03mm in diameter is .5m long and is subjected to a tensile force of 40kg where E = 3 X 106 kg/m2. Find the elongation in meters
    ii. Write short notes on strain gauges and their applications **(Apr 05)**

36. i. Explain the measurement of torque of rotating shaft using multi toothed wheel.
    ii. A digital meter is used to determine the torque in a rotating shaft using single toothed flanges and inductive pickups. Static calibration show that the flange twist by an angle of

one degree for an applied torque of 1000Nm. In a test with the shaft rotating at 500rpm, the torque calculated from the timer readings is 1200Nm. What is the maximum possible error of final digit on the timer display represents units of 10-5 s, and accuracy of instrument specified 0.05% of the reading ±1 in the final digit. **(Apr 05)**

37\. i. What is a full bridge. Derive an expression for gauge sensitivity of a full bridge.

ii. A bridge circuit has two fixed resistances and two strain gauges all of which have a value of 1200. The gauge factor is 2.04 and the strain applied to twin strain gauges one in tension and the other in compression is 0.000165. If the battery current in the initial balanced condition of the bridge is 50mA determine. a. voltage o/p of the bridge b. The sensitivity in volt per unit strain **(Apr 05)**

38\. What is a strain gauge? What is its principle of operation? Derive an expression for the gauge factor of a strain gauge. **(Nov 04)**

39\. i. What are primary detectors. Explain in detail

ii. A torque bar of 30mm diameter is used for measurement of a torque of 100 NM .Calculate the angle of twist is shear modulus of mild steel is 80 * 10(9) N/m2 **(Apr 04)**

50\. An LVDT with a secondary voltage of 5.2 V has a range of ±1.5 cm determine 1. the output voltage when the core is -1.0 cm from center 2, the plot of output vs core position for a core movement going from 0.8cm to 0.1 cm **(Apr 04)**

51\. i. A round steel bar of 0.03 mm in diameter is 0.5m long and is subjected to a tensile force of 40kg where E= 3x10(6) Kg/m2 . Find the elongation in meters

ii. Write short notes on strain gauges and their applications **(Apr 04)**

52\. i. A round steel bar of .03mm in diameter is .5m long and is subjected to a tensile force of 40kg where E = 3 x 106 kg/m2. Find the elongation in meters.

ii. Write short notes on strain gauges and their applications. **(Apr 04)**

53\. i. A strain bridge comprises of two fixed resistors each of value 120 ohms one active gauge and an un strained temperature compensation gauge. The two gauges are of unstrained resistance 120 ohms and gauge factor 2.2. Find the bridge output voltage for a supply voltage of 3V when the active gauge is subjected to 600 micro strain

ii. A single strain gauge having resistance of 120 1: is mounted on a steel cantilever beam at a distance of 0.15m from the free end. An unknown force F applied to the free end produces a deflection of 12.7 mm of the free end. The change in gauge resistance is found to be 0.152 LThe beam is 0.25m long with a width of 20 mm and a depth of 3mm.The young's modulus for steel is 200GN/M2.Calculate the gauge factor? **(Apr 04)**

54\. i. Give the advantage of digital methods in measuring angular velocity over electromechanical methods.

ii. Explain the measurement of angular velocity using photo electric tachometer .Also give advantage and disadvantage of the method **(Apr 04)**

55\. i. Explain in general the measurement of torque using digital technique. Compare the merits of multi toothed flange over single toothed flange .Give the necessary sketch.

ii. Explain the measurement of torque using strain gauge torque method . Also give advantages of this method. **(Apr 04)**

56\. i. Explain with a neat sketch the measurement of angular velocity using toothed rotor variable reluctance

tachometer. Give the advantage and disadvantage of this method.

ii. An inductive pick off operating from a 120 tooth wheel is used with a digital frequency meter to measure the speed of rotation of the shaft on which the wheel is mounted. The gating period is set to 0.01 see and a reading of 0030 is obtained on the four digit display. What shaft speed does this in r.p.s. If the available gating periods are 102,103,104,105,106 and 107micro seconds respectively, what would be the optimum setting of gating period for making this measurement. **(Apr 04)**

57. i. What is a torsion bar and how is it used for torque measurement
ii. What is the principle of ultra sonic flow meter with heat sink **(Apr 03)**

58. i. Explain the measurement of torque of rotating shaft using multi toothed wheel.
ii. Explain principle and measurement of torque using magneto strictive transducer **(Apr 03)**

UNIT-VIII

1. What is the principle of ultrasonic ow meter? Explain the operation of ultrasonic ow meter with neat sketch. **(May 12)**
2. i. Explain the principle of thermocouple vacuum gauge.
ii. With neat diagram explain determination of liquid level employing variable permeability method. **(April 11)**
3. i. Explain the ow direction measurement using hot wire anemometer. Give a neat sketch.
ii. Explain the constant current method of measurement of ow. **(April 11)**

4. Classify the various types of pressure measuring instruments. **(Ma y 10)**

5. Explain the principles and operation of ultrasonic flow meters. **(Ma y 10)**

6. i. Mention various types of instruments used for temperature measurement.
ii. Describe the temperature measurement with resistance thermometers. **(May 09)**

7. i. Mention various types of instruments used for temperature measurement. **(Sep 08)**
ii. Describe the temperature measurement with resistance thermometers.

8. i. Explain the principle of solid rod thermometer. **(Sep 08)**
ii. The hot junction of a chromel- alumel thermocouple is connected to a potentiometer terminals is at 24^{0}C. The potentiometer whose terminals are at 24 ^{0}C reads 27.6mV. What is the temperature of the thermocouple junction. The calibration chart of the thermocouple is
Temp(^{0}C) 20 24 28 .... 480 488 493
Voltage(mV) 0.8 0.95 1.12 .... 26.25 26.72 26.04

9. i. Describe the principle and operation of Knudsen gauge with a neat sketch. **(Sep, Apr 08)**
ii. Describe the operation of Ionization gauges for pressure measurement.

10. i. What is a Radiation pyrometer? Explain the principles used for radiation temperature measuring devices.
ii. Explain the black body conditions.
iii. Write a short notes on quartz crystal thermometer. **(Sep 08)**

11. i. Explain with a neat sketch the measurement of angular velocity using toothed rotor variable reluctance tachometer, Give the advantage and disadvantage of this method.
ii. An inductive pick off operating from a 120 tooth wheel is used with a digital frequency meter to measure the speed of rotation of the shaft on which the wheel is mounted. The gating peirod is set to 0.01 sec and a reading of 0030 is obtained on the four digit display. what shaft speed does this in r.p.s If the available gating periods are 102, 103, 104, 105,

106 and 107 micro seconds respectively, what would be the optimum setting of gating period for making this measurement. **(Sep 08, Apr 06)**

12. i. Discuss in detail about turbine meters including their advantages and limitations. **(Apr 08)**
    ii. Describe pressure measurement Piezoelectric transducers with neat sketches.

13. Write a short notes on the following: **(Apr 08)**
    i. Electromagnetic flow meter
    ii. Inductive method of liquid level measurement
    iii. thermocouples.

14. i. Discuss about the radiation receiving elements used in Radiation pyrometers. **(Apr 08)**
    ii. The emitted radiant energy from a piece of metal measured and the temperature is found to be 1065 ^{0}C assuming surface emissivity of 0.82. It was later found that the true emissivity is 0.75. Calculate the error in the temperature measurement.

15. Discuss the merits and demerits of constant temperature method over constant current method of measurement of flow using hot wire Anemometer. **(Apr 08, 07)**

16. i. Compare advantages and disadvantages of dc tachometer generator and ac tachometer generator
    ii. A variable reluctance type tachometer has 60 rotor teeth . The counter speed records 3600 counts per second . Determine the speed in rpm. **(Apr 08, 04, Sep 06)**

17. With a neat sketch explain the measurement by constant temperature Anemometer. **(Apr 07)**

18. i. Explain the operation of a thermocouple for the measurement of temperature?
    ii. Explain in detail about photo voltaic and photo conductive cells? **(Sep 06,Jul 05, Apr 03)**

19. i. Discuss the list of various transducers that are used as secondary transducers in pressure measurement
    ii. Explain pressure measurement using resistive transducer **(Sep 06, Apr 04)**

20. i. Explain principle of thermocouple vaccum gauge
    ii. Explain measurement of vaccum using pirani gauge **(Sep 06, Apr 03)**

21. Explain the equivalent circuit of piezoelectric crystal under conditions of load. What are the uses of piezoelectric transducers? Draw the experimental set up measuring force using piezoelectric crystal. **(Apr 05)**

22. What are the main characteristics of a high vacuum gauge? How are they used for measurement? Enumerate the principles behind an inductive transducer. **(Apr 05)**

23. Explain the principle of thermistor ? And state the applications? **(Apr 05)**

24. What is the principle of ultrasonic flow meter. Explain the operation of ultrasonic flow meter with neat sketch. **(Apr 05)**

25. i. Explain the measurement of pressure using piezo-electric transducer **(Apr 05)**
    ii. Design a column type load cell using Nickel steel as the member and strain.

26. Describe the working of a Hot wire anemometer with a neat sketch. **(Nov 04)**

27. Explain in detail about any 2 transducers used for the temperature measurement. **(Nov 04)**

28. Explain different forms of construction of thermistors. **(Apr 04)**

29. i. Explain measurement of pressure using capacitive transducer.
    ii. Design a column type load cell using nickel steel as the member and strain gauge at "advance" material to measure the stress developed, with temperature compensation for variations in young's modulus in the range 25°c to 100°c. **(Apr 04)**

30. i. Explain the differential pressure measurement using inductive transducer in combination with a bridge. Derive an expression for the output voltage of the bridge.
    ii. Explain how load cells are used in weight measurement with a suitable sketch. **(Apr 04)**

31. i. Explain the measurement of differential pressure using capacitive transducer.
    ii. Explain how pressure can be measured using photoelectric transducer. Give the necessary diagrams.
    (Apr 04)

32. i. Explain the working of a oscillation transducer in the measurement of pressure.
    ii. Explain the measurement of pressure using piezo-electric transducer. **(Apr 04)**

33. Describe with a neat sketch the principle and construction details of resistance thermometer and thermistor. Draw its characteristics curve and state its merits and demerits. **(Nov 03)**

34. i. With suitable diagram, explain a method for force measurement.
    ii. Explain the principle of capacitive transducer and show how it can be used for displacement measurement.
    iii. Under what condition a dummy strain gauge used and what is the function of that gauge. **(Nov 03)**

35. i. Describe the working and theory of an ultrasonic flow meter. List its advantage.
    ii. Explain with suitable diagram a method by which velocity measurement can be done. **(Nov 03)**

36. i. Expain measurement of pressure using capacitive transducer gauge at advance material to measure stress developed , with temperature compensation the range 25^0 C to 100^0 C for variations in youngs modulus in **(Apr 03)**

37. i. Explain differential pressure measurement using inductive transducers in combination with a bridge. Derive an expression for output voltage of bridge.
    ii. Explain how load cells are used in weight measurement with a suitable sketch **(Apr 03)**

38. i. Describe the measurement of liquid level using capacitive transducer in case of insulating and conducting liquids.
    ii. Explain how the capacitance transducers are used in measurement of non-electrical quantities? Give neat sketch. **(Apr 03)**

39. i. Explain the principle of operation of electromagnetic flow meter. Describe how flow is measured with a neat sketch.
    ii. Give the block diagram and explain the operation of a servo-operated electromagnetic flow meter to measure flow rate. **(Apr 03)**

40. i. Discuss the merits demerits of constant temperature method over constant current method of measurement at flow using hot wire anemometer. **(Apr 03)**
    ii. With a neat sketch explain the measurement by constant - temperature anemometer.

41. Explain the various electrical pressure transducers. **(Apr 03)**

42. i. Explain with relevant circuit the ultrasonic measurement of fluid velocity.
    ii. Derive an expression for gage factor of strain gauge. **(Apr 03)**

43. Explain the working principle of hot wire anemometer

44. Is thermometer a temperature transducer? Justify your answer.

45. State and explain the temperature transducer based on negative coefficient of temperature materials.