**7. SUBJECT DETAILS**

**7.2 ELECTRICAL MEASUREMENTS**

**7.2.1 OBJECTIVE AND RELEVANCE**

The importance of measurements in engineering and sciences cannot be overemphasized. A very large part of the measuring instruments comprise of electrical measuring instruments which measure various electrical quantities and other non electrical quantities converted into electrical variables. The study of electrical instruments, therefore is essential, particularly to electrical engineering students.

The advancement of Science and Technology is in general also related to a parallel progress in measurement techniques. The reasons for this are obvious. As Science and Technology move ahead, new phenomena and relationships are discovered and these advances make new types of measurements imperative. New discoveries are not of any practical utility unless the results are backed by actual measurements. The measurements, not only confirm the validity of a hypothesis but also add to its understanding. This result in an unending chain, which leads to new discoveries that require more, new and sophisticated measurement techniques. Hence modern Science and Technology are associated with sophisticated methods of measurement.

To know the theory, operation of PMMC and electrostatic instruments, the constructional and operational details of wattmeter, energy meter and potentiometer, the calibration of various meters like MC & MI and the applications of bridges in instrumentation and magnetic field in measurement

There are two major functions of all branches of engineering:

i. Design of equipment and processes, and
ii. Proper operation and maintenance of equipment and processes.

Both the functions require measurements. This is because proper and economical design, operation and maintenance require a feedback of information. Measurements play a significant role in achieving goals and objectives of Engineering because of the feedback information supplied by them.

**7.2.2 SCOPE**

Measurement of any electrical quantity with good accuracy is an essential requirement in maintaining power system stability and to ensure uninterrupted power flow. This necessiates the study of Electrical measurements in depth with good understanding .Since measurement of an electrical quantity without error makes the system control easier, this subject has great scope for development in order to improve system standards.

**7.2.3 PREREQUISITES**

To study this subject, the knowledge about the following subjects is required :
Engineering Mathematics – I, II and III
Basic Course in Electrical Engineering which deals with different types of machines and circuits namely Electrical Network Theory, Electro Machines – I and II.

**.2.4.1 JNTU SYLLABUS**

**UNIT-I**
**OBJECTIVE**
This unit provides the contructional details and operational concepts of measuring instruments.

*I cannot pretend to feel impartial about colours. I rejoice with the brilliant ones and am genuinely sorry for the poor browns.*
*- Sir Winston Churchill*

**SYLLABUS**

**MEASURING INSTRUMENTS:** Classification-deflecting, control and damping torques-Ammeters and Voltmeters-PMMC, moving iron type instruments-expression for the deflecting torque and control torque-Errors and compensations, extension of range using shunts and series resistance. Electro static Voltmeters-electrometer type and attracted disc type-Extension of range of Electro Static Voltmeters.

**UNIT-II**

**OBJECTIVE**

This unit focuses about the basic desgin and operational concepts of instruments transformers and power factor meters.

**SYLLABUS**

**INSTRUMENT TRANSFORMERS:** CT and PT-Ratio and phase angle errors-design considerations, Type of P.F. Meters-dynamometer and moving iron type-1 ph and 3 ph meters, frequency meters, resonance type and Weston type, synchoroscopes.

**UNIT-III**

**OBJECTIVE**

To study the working principle of different types of wattmeters with their constructional details.

**SYLLABUS**

**MEASUREMENT OF POWER:** Single phase dynamometer wattmeter, LPF and UPF, Double element and three element dynamometer wattmeter, expression for deflecting and control torques, extension of range of wattmeter using instrument transformers, measurement active and reactive powers in balanced and un-balanced systems.

**UNIT-IV**

**OBJECTIVE**

This unit an attempt is made to understand the working principle of single and three phase energy meter with their constructional details.

**SYLLABUS**

**MEASUREMENT OF ENERGY:** Single phase induction type energy meter-driving and braking torques-errors and compensations, testing by phantom loading using R.S.S. meter. Three phase energy meter-trivector meter, maximum demand meters.

**UNIT-V**

**OBJECTIVE**

In this unit an attempt is made to understand the working principle and applications of potentio meters.

**SYLLABUS**

**POTENTIOMETERS:** Principle and operation of DC Cromptons potentiometers-standardization, measurement of unknown resistance, current, voltage. AC Potentiometers: polar and coordinate types standardization, applications.

**UNIT-VI**

**OBJECTIVE**

This unit gives the knowledge of how to measur low, medium and high resistance

**SYLLABUS**

**RESISTANCE MEASUREMENTS:** Method of measuring low, medium and high resistance-sensitivity of wheatstones bridge-Carey Foster's bridge, Kelvin's double bridge for measuring low resistance, measurement of high resistance-loss of charge method.

**UNIT-VII**

**OBJECTIVE**

This unit gives the knowledge of how to measur inductance and capacitance using AC bridges

**SYLLABUS**

**A.C. BRIDGES:** Measurement of Inductance, quality factor-Maxwell's bridge, Hay's bridge, Anderson's bridge, owen's bridge. Measurement of Capacitance and loss angle, Desauty bridge, Wien's bridge, schering Bridge.

**UNIT-VIII**

**OBJECTIVE**

This unit focuses about the measurement of core losses by different methods.

**SYLLABUS**

**MAGNETIC MEASUREMENTS:** Ballistic galvanometer, equation of motion–flux meter, constructional details, comparison with ballistic galvanometer. Determination of B-H loop methods of reversals six point method-AC testing, Iron loss of bar samples, core loss measurements by bridges and potentiometers.

## 7.2.4.2 GATE SYLLABUS

**UNIT-I**

PMMC, Moving Iron type instruments - Principle and constructional details - Extenstion of range of Ammeters and voltmeters.

**UNIT-II**

Instrument transformer - Ratio and Phase angle errors - Testing of CT's - Dynamo meter type instruments - Power factor meters - 3 phase power factor meters-Frequency measurements - Synchroscope-Wattmeter.

**UNIT-III**

Wattmeters.

**UNIT-IV**

Energy meter- single phase and three phase energy measurements.

**UNIT-V**

D.C. and A.C potentiometers-Error analysis.

**UNIT-VI**

Resistance measurements by bridges - kelvin's double bridge

**UNIT-VII**

Measurement of inductance, capacitance by using bridges.

**UNIT-VIII**

Not covered.

*I always like to know everything about my new friends, and nothing about my old ones.*

- Oscar Wilde

### 7.2.4.3 IES SYLLABUS

**UNIT-I**
Measurement of current and voltage with indicating instruments, PMMC and moving iron type instruments.

**UNIT-II**
Power factor meters.

**UNIT-III**
Wattmeters - Dynamometers type instruments.

**UNIT-IV**
Energy meters - principle of operation

**UNIT-V**
Not covered.

**UNIT-VI**
Measurement of resistance.

**UNIT-VII**
Measurement of inductance and capacitance

**UNIT-VIII**
Not covered

### 7.2.5 SUGGESTED BOOKS

**TEXT BOOKS**

T1 Electrical Measurements and Measuring Instruments, E.W. Golding and F.C. Widdis, 5th Edn., Wheeler Publishing.
T2 Electrical and Electronic Measurement and Instruments, A.K. Shawney Dhanpat Rai and Sons Publications.
T3 Electrical and Electronic Measurement and Instruments, JB Guptha

**REFERENCE BOOKS**

R1 Electrical Measurements, Buckingham and Price, PrenticeHall.
R2 Electrical Measurements, Harris.
R3 Electrical Measurements: Fundamentals, Concepts, Applications, Reissland, M.U. New Age International (P) Limited Publishers.
R4 Electrical Technology, B.L.Theraja

*I am not young enough to know everything.*
- Oscar Wilde

### 7.2.6 WEBSITES

1. www. zone.ni. com
2. www. electronicstalk.com
3. www. applianceaid.com
4. www. eng.ksu.edu.sa
5. www.nj.gov
6. www. eng-tips.com
7. www.ieee-imte.org
8. www. onlinemeasurements. com
9. www. online edu.com
10. www.instrumentation online.com

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   CBIT, Gandipet,
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## 7.2.8 JOURNALS

1. IEEE Transaction Instrumentation& Measurement
2. IEEE Instrumentation & Measurement Society (I&M Magazine)
3. IEEE Transaction on Automatic control
4. Journals of Instrumentation Society of INdia
5. Electrical India
6. Power India
7. Electronics for you

## 7.2.9 FINDINGS AND DEVELOPMENTS

1. Digital measurements station for power quality analysis indistributed environments, Giovanii Bucci,Edoardo Fiorucci published in IEEE transaction on Instrumentation and measurement , Vol 52 No.1 PP75-84, Feb 2003.
2. A strain gauge tactile sensor for Finger-mounted Applications, Josivaldo Godoy da siliva, poriesdson dutra da silva published in IEEE transaction instrumentation and measurement, Vol 51, No. 1, pp 18-22, Feb.2002.
3. Sensors : the first stage in the measurement chain, Kim R. Fowler and John L.Schmagel published in IEEE transactions instrumentation and measurements Vol. 49 PP 60-65, Sept. 2004.
4. Medical measurements and uncertainities, Marco parvis and Alberto vallan published in IEEE transaction instrumentation and measurements vol. PP 12-17, June 2002.

**7.2.10 i. SESSION PLAN**

| Sl. No. | Topics in JNTU Syllabus | Modules and Sub Modules | Lecture No | Suggested Books | Remarks |
|---|---|---|---|---|---|
| 1. | Introduction to the subject | | L1 | T1-Ch17<br>T2-Ch7<br>R3-Ch1 | |
| 2. | Review of Basic Electrical Laws | | L2 | | |
| | | **UNIT- I** | | | |
| 3 | Measuring Instruments, Classification | Definition of Electrical Measurements<br>Absolute, secondary instruments<br>Indicating, Recording and Integrating instruments | L3 | T1-Ch17<br>T2-Ch7<br>R3-Ch1 | GATE<br>IES |
| 4 | Deflecting, control and Damping torques | Effects utilized in measuring instruments<br>Spring and gravity control<br>Airfriction, fluid friction, eddy current damping | L4 | T1-Ch17,18<br>T2-Ch7<br>R4-Ch1 | GATE<br>IES |
| 5 | Ammeters and voltmeters, PMMC instruments, Expression for deflecting and control torque, errors and compensations | Constructional details<br>Expression for deflecting torque and control torque<br>Errors and compensation<br>Advantages and disadvantages | L5 | T1-Ch17<br>T2-Ch9<br>R4-Ch10 | GATE<br>IES |
| 6 | Moving Iron type instruments, Expression for deflecting torque and control torque, errors and compensations | Constructional details<br>Expression for deflecting torque and control torque<br>Errors and compensation<br>Advantages and disadvantages | L 6 | T1-Ch18<br>T2-Ch 9<br>R4-Ch10 | GATE<br>IES |
| 7 | Extension of range using shunts and series resistance | Extension of range of ammeters and voltmeters<br>Multi range ammeters and voltmeters and problems | L7 | T1-Ch19<br>T2-Ch9<br>R4-Ch10 | GATE<br>IES |
| 8 | Electrostatic voltmeter, Attracted disc type | Principle of operation<br>Expression for the deflecting torque<br>Attracted disc type | L8 | T1-Ch18<br>T2-Ch8<br>R4-Ch10 | GATE<br>IES |
| 9 | Electro meter type voltmeters, extension range of electrostatic voltmeters | Quadrant type electro meter | L9 | T1-Ch18<br>T2-Ch9<br>R3-Ch2 | GATE<br>IES |
| | | Extension range of electro static voltmeter and problems | L10 | T1-Ch18<br>T2-Ch9<br>R3-Ch2 | GATE<br>IES |
| | | **UNIT- II** | | | |
| 10 | Instrument transformers, CT and PT – Ratio and Phase angle errors | Instrument transformers introduction<br>Advantages of Inst. Transformers | L11 | T1-Ch19<br>T2-Ch10<br>R3-Ch15 | GATE |
| | | CT, errors in CT, Theory of CT, transformation ratio and phase angle | L12 | T1-Ch19<br>T2-Ch10<br>R3-Ch15 | GATE |

| Sl. No. | Topics in JNTU Syllabus | Modules and Sub Modules | Lecture No | Suggested Books | Remarks |
|---|---|---|---|---|---|
| 11 | Design consideration of CT and PT | Design construction of CT and PT<br>Clamp on ammeters<br>Characteristics of CT<br>Precautions for use of CT | L13 | T1-Ch19<br>T2-Ch10<br>R4-Ch10 | GATE |
| | | Construction details of PT<br>Turns ratio, Phase angle and theory of PT, Errors in PT | L14 | T1-Ch19<br>T2-Ch10<br>R4-Ch10 | GATE |
| 12 | Types of P.F meters, Dynamo meter and Moving Iron type 1-phase and 3 –Ph. Meters | Single phase electro dynamo meter power factor meter, mathematical treatment | L15 | T1-Ch22<br>T2-Ch13<br>R4-Ch 10 | GATE<br>IES |
| | | 3-phase dynamometer power factor meter, moving iron power factor meter<br>Alternating field 3-phase power factor meter | L16 | T1-Ch22<br>T2-Ch13<br>R4-Ch 10 | GATE<br>IES |
| 13 | Frequency meters – resonance type and weston type – Synchroscope | Mechanical Resonance type of vibrating reed frequency meters | L17 | T1-Ch22<br>T2-Ch13<br>R4-Ch10 | GATE<br>IES |
| | | Electrical Resonance frequency meter<br>Weston frequency meter and problems<br>Electro dynamo meter type synchoronos copes | L18 | T1-Ch22<br>T2-Ch13<br>R4-Ch10 | GATE<br>IES |
| | | Moving iron synchroscope | L19 | T1-Ch22<br>T2-Ch13<br>R4-Ch10 | GATE<br>IES |
| | | **UNIT-III** | | | |
| 14 | Measurements of Power single phase dynamometer wattmeter, expression for deflecting and control torques | Constructional details and theory of dynamo meter type instruments | L20 | T1-Ch20<br>T2-Ch9<br>R3-Ch4 | GATE |
| | | Torque equation | L21 | T1-Ch20<br>T2-Ch9<br>R3-Ch4 | |
| | | Constructional details and theory of dynamo meter type watt meter<br>Expression for deflecting torque and control torque | L22 | T1-Ch20<br>T2-Ch9<br>R3-Ch4 | |
| 15 | LPF and UPF wattmeter, Double element and three element dynamo meter wattmeter | Distinction between LPF and UPF wattmeter | L23 | T1-Ch20<br>T2-Ch11<br>R3-Ch4 | GATE |
| | | Expression for deflecting torque and control torque of double element and three element wattmeter | L24 | T1-Ch20<br>T2-Ch11<br>R3-Ch4 | GATE |
| 16 | Extension of range of wattmeter using instrument transformers | Extension of range of watt meter using inst. Transformers | L25 | T1-Ch21<br>T2-Ch11<br>R3-Ch4 | GATE |
| | | Measurement of active and reactive power in three phase balanced and unbalanced systems | L26 | T1-Ch21<br>T2-Ch11<br>R3-Ch4 | |

*To listen to some devout people, one would imagine that God never laughs.*

- Ghose Aurobindo

| Sl. No. | Topics in JNTU Syllabus | Modules and Sub Modules | Lecture No | Suggested Books | Remarks |
|---|---|---|---|---|---|
| | | **UNIT-IV** | | | |
| 17 | Measurement of energy, 1-phase induction type energy meters , driving and braking torques | Single phase induction type energy meter- theory and constructional details | L27 | T1-Ch21<br>T2-Ch12<br>R3-Ch4 | GATE |
| | | Expression for driving and braking torques | L28 | T1-Ch21<br>T2-Ch12<br>R3-Ch4 | |
| 18 | Errors and compensations of 1phase energy meter-Testing by Phantom loading using RSS meter | Errors and compensation of energy meter | L29 | T1-Ch21<br>T2-Ch12<br>R3-Ch4 | GATE |
| | | Testing by Phantom loading using RSS meter | L30 | T1-Ch21<br>T2-Ch12<br>R3-Ch4 | GATE |
| 19 | Three phase energy meter, Trivector meter, Maximum demand meter | Polyphase energy meter | L31 | T1-Ch21<br>T2-Ch12<br>R3-Ch4 | GATE |
| | | Maximum demand indicator trivector meter | L32 | T1-Ch21<br>T2-Ch12<br>R3-Ch4 | |
| | | Problems on energy meter | L33 | T1-Ch21<br>T2-Ch12<br>R3-Ch4 | |
| | | **UNIT-V** | | | |
| 20 | Principle of operation of DC crompton potentiometers | Principle of operation of DC crompton potentio meter | L34 | T1-Ch8<br>T2-Ch15<br>R4-Ch10 | GATE<br>IES |
| | | Standardization of potentiometers | L35 | T1-Ch8<br>T2-Ch15<br>R4-Ch10 | |
| | | Measurement of resistance, current, voltage | L36 | T1-Ch8<br>T2-Ch15<br>R4-Ch10 | |
| 21 | Standardization | Principle of operation of AC potentiometer - polar type potentiometer | L37 | T1-Ch8<br>T2-Ch15<br>R4-Ch10 | GATE<br>IES |
| | | AC co-ordinate type potentiometer | L38 | T1-Ch8<br>T2-Ch15<br>R4-Ch10 | |
| 22 | Measurement of unknown resistance, current, voltage | Problems on DC and AC potentio meter | L39 | T1-Ch8<br>T2-Ch15<br>R4-Ch10 | GATE<br>IES |
| 23 | AC Potentio meters Polar and Co-ordinate types standardization-application | Applications of Potentio meters | L40 | T1-Ch8<br>T2-Ch15<br>R4-Ch10 | GATE<br>IES |

| Sl. No. | Topics in JNTU Syllabus | Modules and Sub Modules | Lecture No | Suggested Books | Remarks |
|---|---|---|---|---|---|
| | | **UNIT-VI** | | | |
| 24 | Res is tance meas urements method of measuring lo w, med iu m and high res istance- sensitivity of wheat stone bridge- Carey Foster's Bridge method | Measurement of Resistance classification Ammeters and voltmeter methods | L41 | T1-Ch7 T2-Ch14 R4-Ch10 | GATE IES |
| | | Wheatstone bridge method | L42 | T1-Ch7 T2-Ch14 R4-Ch10 | |
| | | Carey Foster's Bridge method | L43 | T1-Ch7 T2-Ch14 R4-Ch10 | |
| 25 | Kelv in's double bridge for measuring lo w res istance | Kelv ing's double bridge method Advantages and disadvantages | L44 | T1-Ch7 T2-Ch14 R4-Ch10 | GATE IES |
| 26 | Measurement of high res istance- Loss of charge method | Direct deflect ion method | L45 | T1-Ch7 T2-Ch14 R4-Ch10 | GATE IES |
| | | Loss~ of Charge method Method | L46 | T1-Ch7 T2-Ch14 R4-Ch10 | |
| | | **UNIT –VII** | | | |
| 27 | AC Bridges- Meas urement of Inductance, quality factor, Maxwe ll's bridge, Hay's bridge, Anderson's bridge, Owen's bridge | Maxwe ll inductance bridge | L 47 | T1-Ch6 T2-Ch16 R4-Ch16 | GATE IES |
| | | Maxwe ll's Inductance- capacitance bridge | L 48 | T1-Ch6 T2-Ch16 R4-Ch16 | |
| | | Hay's bridge Owen's bridge | L49 | T1-Ch6 T2-Ch16 R4-Ch16 | |
| | | Anderson's Bridge | L50 | T1-Ch6 T2-Ch16 R4-Ch16 | |
| 28 | Measurement of capacitance Equivalent circuit of an imperfect capacitor | Measurement of capacitance by Desauty Bridge, Schering Bridge. | L 51 | T1-Ch6 T2-Ch16 R4-Ch16 | GATE IES |
| | | Measurement of frequency Wein's bridge Proble ms on bridge | L52 | T1-Ch6 T2-Ch16 R4-Ch16 | |
| | | **UNIT-VIII** | | | |
| 29 | Ballistic Galvanometer - equation of motion | Magnetic measurements Introduction Ballistic Galvanometer - Theory and constructional details | L53 | T1-Ch9 T2-Ch18 R3-Ch16 | |
| 30 | Flu x meter- constructional details, comparison with ballistic galvanometer | Grassot flu x meter – theory and constructional details | L 54 | T1-Ch9 T2-Ch18 R3-Ch16 | |
| | | Extension of range of flu x meter Application of Ballistic galvanometer and Flu x meter | L55 | T1-Ch9 T2-Ch18 R3-Ch16 | |

*"The reason why kids are crazy is because nobody can face the responsibility of bringing them up."*

- John Lennon

| Sl. No. | Topics in JNTU Syllabus | Modules and Sub Modules | Lecture No | Suggested Books | Remarks |
|---|---|---|---|---|---|
| 31 | Determination of Magnetizing force,- B.H loop methods of reversals six point method | Determination of B-H curve<br>Determination of Hysteresis loop<br>Reversals of six point method | L56 | T1-Ch19<br>T2-Ch18<br>R3-Ch16 | |
| 32 | AC testing – Iron loss of bar samples - core loss measurement by bridges and potentiometer, | AC bridge method of core loss measurement | L57 | T1-Ch9<br>T2-Ch18<br>R3-Ch16 | |
| | | AC potentio meters method of core loss measurement | L58 | T1-Ch9<br>T2-Ch18<br>R3-Ch16 | |

**ii. TUTORIAL PLAN :**

| Sl. No. | Topics to be covered | Salient point of the topic |
|---|---|---|
| 1. | Expression for deflecting torque and control torque | Problems on deflecting and control torque |
| 2. | Errors and compensations, extension of torque using shunt and series resistance | Problems on finding errors series and shunt resistance calculations |
| 3. | Current transformer and potential transformers | Problems on design considerations and CT and PT |
| 4. | Single phase and 3–phase meters, power factor meters. | Problems on single phase and 3-phase meters and also meters problems on design considerations of power factor meter. |
| 5. | Double elements and triple element dynameters wattmeter expression for deflecting and control torques. | Problems on double and triple element dynameters wattmeters, problems on deflecting and control torques. |
| 6. | Measurement of active and reactive power in balanced and unbalanced systems. | Problems on active and reactive power calculation. |
| 7. | Driving and braking torques | Problems on driving and braking torque. |
| 8. | 3-phase energy meter and trivector meter | Problems on 3d energy meter and trivector meter. |
| 9. | Direct current potentiometer | Problems on standardization of Direct current potentiometer |
| 10. | Alternative Current potentiometer | Problems on standardization of A.C. potentiometer. |
| 11. | Measurement of low and medium resistance | Problems on measurement of low, medium resistance by wheatstones bridge carry fosters bridge and kewins double bridge |
| 12. | Measurement and high resistance | Problems on measurement of high resistance by loss of charge method. |
| 13. | Measurement of inductance | Problems on measurement of inductance by max wells bridge and Hays bridge. |
| 14. | Measurement of capacitance and loss angle. | Problems on measurement of capacitance by weins bridge and scheving bridge |
| 15. | Determination of B-H loop and core loss measurement. | Problems on measurement of core loss by bridges potentiometer. |

**7.2.11 QUESTION BANK**

**UNIT–I**

1. a) Derive the torque equation of PMMC instrument.
b) What are the generalized errors occurred in M.I instruments, explain in detail. **(Dec 2014/Jan 2015)**

2. Draw the constructional details attracted disc type electrostatic voltmeter also explain its operation .
Explain the procedure of extension of range of ammeters. **(May/june 2013)**

3. Explain the construction and working of a PMMC ammeter with neat diagrams.
Derive its torque equation from the fundamentals.
What are the advantages and disadvantages of the moving iron instruments? **(May/june2012)**

4.Describe how a D' Arsonval basic meter can be converted into a voltmeter. Discuss about the requirements for the construction of multipliers and how the temperature effects can be eliminate. Derive the equations for force and torque of electrostatic instruments. **(Nov 2010)**

5. State the errors present in electrostatic instruments. **(Nov 2010)**

6. State the advantages and disadvantages of electrostatic instruments. **(Nov 2010)**

7.i. Give the classification of electrical measuring Instruments.
ii. Explain the working principle of PMMC instrument with a neat sketch.
iii. State the advantages and dis-advantages of PMMC instrument. **(Nov 08)**

8. i. Explain the constructional details of PMMC instrument with neat sketch.
ii. Explain why PMMC instruments are the most widely used instruments? Explain their advantages and disadvantages. **(Nov 07, 08)**

9. i. What are the different effects used in producing deflecting torque in an analog instruments. State the examples, in which these effects are used?
ii. Define the terms "indicating instruments", "recording instruments" and "integrating instruments". Give examples of each case.
iii. Derive the equation for deflection if the instrument is PMMC spring controlled. **(Nov 08)**

10. i. Explain the construction and working of an attracted disc type kelvin absolute electrometer.
ii. What are the advantages and disadvantages of the above instrument?
ii. Can it be used for measurement of low voltages such as 100 V? Give the reason. **(Nov 08)**

11. i. What are the different damping methods used in analog indicating instruments? List their advantages and disadvantages.
ii. A permanent magnet moving coil (PMMC) instrument has a full scale deflection of $90^{0}$ for a current of 2A. The deflecting torque in a PMMC instrument is directly proportional to current in the moving coil. Find the value of current required for a deflection of $30^{0}$ if the instrument is
a. spring controlled and b. gravity controlled. **(Feb 08)**

*As we advance in life we learn the limits of our abilities.*
- James A. Froude

12.
i. Explain the various operating forces needed for proper operation of an analog indicating instrument.
ii. Explain the operation of PMMC instrument with the help of a neat sketch.
iii. The following data refers to a moving coil voltmeter.
Resistance = 10,000 $\Omega$ ; dimensions of coil= 30 mm × 30 mm; number of turns of coil = 100; flux density in the air gap = 0.08 wb/m$^2$: spring constant = $3\times10^{-6}$ Nm per degree. Find the deflection produced by a of 200V. **(Feb 08)**

13. i. Explain how a potential divider arrangement is used for multipliers used for multi range voltmeters. Derive the expressions for resistance of different sections for a 4 range voltmeter.
ii. A basic *d'* Arsonval meter movement with an internal resistance Rm =100 $\Omega$ and a full scale current of $I_m$ = 1 mA is to be converted in to a multi range d.c. voltmeter with ranges of 0-10 V, 0-50 V, 0-250 V, 0-500 V. Find the values of various resistances using the potential divider arrangement. **(Feb 08)**

14. i. How is the current range of a PMMC instrument extended with the help of shunts? Explain a method of reducing errors due to temperature changes in the shunt connected instruments with suitable example.
ii. Explain the working of a universal shunt used for multi range- Ammeters. Derive expressions for resistances of different sections of a universal shunt used for a 3 range Ammeter. **(Feb 08, Nov 07)**

15. i. A moving coil instrument whose resistance is 25 ohms gives a full-scale deflection with a current of 1mA. This instrument is to be used with a manganin shunt to extend its range to 100mA. Calculate the error caused by a $10^0$C rise in temperature when :
a. Copper moving coil is connected directly across the manganin shunt.

b. A 75 ohm manganin resistance is used in series with the instrument moving coil . The temperature coefficient of copper is $0.004/^0$C and that of manganin is $0.00015/^0$C.
ii. Give brief description about Multi range Ammeters. **(Feb 08)**

16. i. What are the different types of instruments that are used as ammeter s and voltmeters? Wh at are the errors that occur in ammeters and voltmeters?
ii. Describe how can we obtain different voltage ranges by using a multirange dc voltmeter. Discuss about sensitivity and loading effects of PMMC voltmeters. **(Feb 08, Nov 05)**

17. i. Explain the working of a moving iron ammeter with the help of a neat diagram. Derive the expression for the deflecting torque of a moving iron ammeter in terms of current and rate of change of inductance with deflection.
ii. What are the main sources of errors in the instrument and the methods adopted to reduce the same. **(Feb 08, Apr 05)**

18. i. How are moving iron instruments classified? Describe briefly the construction and working of Ballistic Galvanometer
ii. Why the scale of a moving iron instrument is non uniform? Discuss briefly why the scale is compressed at lower and higher ends. **(Feb 08)**

19. i. Explain heterostatic and idiostatic connections of a quadrant electrometer with the help of neat sketches and derive the torque equations for both the connections.
ii. Discuss about the advantages and disadvantages of Electrostatic instruments. **(Feb 08)**

20. i. Discuss with neat diagrams, th e theory and workin g of an electro static volt-meter of th e quadrant type. Draw the connections for
a. heterostatically connected b. ideostatically connected instruments.
ii. Derive an expression for the force of attraction between the plates in a parallelplate electrostatic voltmeter. **(Feb 08, Mar 06)**

21. i. Explain the working and constructional details of an attraction type moving iron instrument.
    ii. Discuss its advantages and dis-advantages. **(Nov 07)**

22. i. What are the different types of instruments that are used as ammeters and voltmeters? What are the errors that occur in ammeters and voltmeters?
    ii. Describe how can we obtain different voltage ranges by using a multirange dc voltmeter. Discuss about sensitivity and loading effects of PMMC voltmeters. **(Nov 07)**

23. i. Derive the expression for deflection for a rotary type electro static instrument using spring control. Comment upon the scale of the instrument.
    ii. An electrostatic voltmeter is constructed with six parallel, Semi circular fixed plates equispaced at Ymm intervals and five inter leaved semi circular movable plates that move in planer midway between the fixed plates in air. The instrument is spring controlled. If the radius of movable plates is 40mm, calculate the spring constant if 10kV corresponds to full scale deflection of 1000. Neglect edge effects and plate thickness. The permittivity of air is 8.85 x $10^{-12}$F/M. **(Nov 07)**

24. i. Write short notes on the following:-
    a. Current drawn Electrostatic instruments
    b. Operating forces produced
    c. Frequency range

    ii. The capacity of an electrostatic voltmeter reading from "0(zero)" to 2000v increases from 80 to 90PF as the pointer moves from zero to full scale deflection. Calculate the value of external capacitor used to increase its range to 20 kV. If the capacitor is adjusted to make the full scale reading correct, what will be the error at half scale reading? **(Nov 07)**

25. i. Describe the construction & working of a PMMC instrument. Derive the equation for deflection if the instrument is spring controlled.
    ii. A moving coil milli-voltmeter has a resistance of 200 Ω and the full scale deflection is reached when a potential difference of 100 mV is applied across the terminals. The moving coil has effective dimensions of 30 mm x 25 mm and is wound with 100 turns. The flux density in the air gap is 0.2 wb/$m^2$. Determine the control constant if the final deflection is $100^0$ and a suitable diameter of copper wire for the coil winding if 20% of the total instrument resistance is due to the coil winding. Resistivity of copper is 1.7 x $10^{-8}$ Ω /m **(Nov, Feb 07, Nov 05)**

26. i. Derive the force and Torque equations of Electrostatic instruments.
    ii. The capacity of an electrostatic voltmeter reading from 0 to 2000v increases from 80 to 90 PF as the pointer moves from zero to full scale deflection. Calculate the value of external capacitor used to increase its range to 20 kV. If the capacitor is adjusted to make the full scale reading correct, what will be the error at half scale reading? **(Nov, Feb 07)**

27. i. How is the current range of a PMMC instrument extended with the help of shunts? Give the essential requirements for the construction of shunts. Describe a method of reducing errors due to temperature changes in the shunt connected instruments.
    ii. Design an Ayrton shunt to provide an ammeter with current ranges of 1A, 5A, 10A & 20A. A basic meter with an internal resistance of 50W & a full scale deflection current of 1 mA is to be used. **(Nov 07, 06, Mar 06)**

28. i. What are the different types of errors that occur in moving iron instruments? Explain each of them in detail.
    ii. Compare between Attraction and Repulsion type of instruments.
    iii. Give the advantages and disadvantages of moving iron instruments. **(Feb 07)**

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*I know I have the ability to do so much more than just stand in front of the camera the rest of my life.*

- Jennie Garth

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29. i. How are moving iron instruments classified? Describe briefly the construction and working of Ballistic Galvanometer
    ii. Why the scale of a moving iron instrument is non uniform? Discuss briefly why the scale is compressed at lower and higher ends. **(Nov 06)**

30. i. Describe how a D‘ Arsonval basic meter can be converted into a voltmeter.
    Discuss about the requirements for the construction of multipliers and how the temperature effects can be eliminated in voltmeters.
    ii. A moving coil instrument gives a full scale deflection of 10mA when the potential difference across its terminals is 100mV. Calculate
    i. the shunt resistance for a full scale deflection corresponding to 100A,
    ii. the series resistance for full scale reading with 1000V. Calculate the powerdissipation in each case. **(Mar 06)**

31. i. Describe with a neat sketch, the theory of operation, construction and usesof a moving coil voltmeter. Explain how the instrument can be made of highaccuracy.
    ii. The relationship between inductance of a moving iron ammeter, the currentand the position of the pointer is as follows:Reading I. 0.8 1.0 1.2 1.4 1.6 1.8 2.0
    Deflection (degree) 16.5 26 36 46.5 57 70 2.0
    Inductance (μH) 527.8 573.9 575 577.3 578.35 579.45 -
    Calculate the deflecting torque when the current is 1.5A & 2.1A. **(Mar 06)**

32. i. A moving coil instrument whose resistance is 25 gives a full-scale deflection with a current of 1mA. This instrument is to be used with a manganin shunt to extend its range to 100mA. Calculate the error caused by a 100C rise in temperature when :
    a. Copper moving coil is connected directly across the manganin shunt.
    b. A 75 ohm manganin resistance is used in series with the instrument moveing coil . The temperature coefficient of copper is $0.004/^0C$ & that of manganin is $0.00015/^0C$.
    ii. Give brief description about Multi range Ammeters. **(Mar 06)**

33. i. Derive the expression for the deflecting torque in an attraction type movingiron instrument.
    ii. How are controlling torque and damping torque produced in such moving ironinstruments. **(Mar 06, Nov 05)**

34. i. What are electrostatic instruments? What is the basic principle over which they operate?
    ii. Discuss the working of a repulsion type electrostatic instrument with a neat sktch. **(Mar 06, May 04)**

35. i. Derive the expression for capacitance to be connected across the multiplier of a moving iron voltmeter so as to make its circuit non inductive for frequencies up to 125Hz.
    ii. The copper coil of a 150V moving iron voltmeter has a resistance of 400 ohm and 150C and an inductance of 0.75H. The curr ent for full scale deflectionis 0.05A. The temperature coe_cients of resistance for copper and eureka at 150C are $0.004/^0C$ and $0.00001/^0C$ respectively. Calculate
    a. The percentage increase of resistance of this instrument per degree rise in temperature
    b. The indication when 150V at 100Hz is applied, the instrument having been previously calibrated on direct current. **(Apr.05)**

36. i. Compare between spring and gravity control methods.
    ii. The deflecting torque of an ammeter varies as the square of the curr ent passing through it. If a current of 5 amps produces a deflection of $90^0$, what will be the deflection for a current of 10 amps when the instrument is
    a. Spring controlled b. Gravity controlled **(Apr.05)**

*If I had my career over again? Maybe I'd say to myself, speed it up a little.*
- James Stewart

37. i. What are electrostatic instruments? What is the basic principle over which they operate?
ii. Discuss the working of a repulsion type electrostatic instrument with a neat sketch. **(Apr. 05, May 05)**

38. i. What are the advantages and limitations of a moving iron instrument?
ii. The inductance of a moving iron instrument is given by $L = (10 + 5\theta - \theta^2)\mu H$. Where q is the deflection in radian from zero position? The spring constant is $12 \times 10^{-6}$ Nm/rad. Estimate the deflection for a current of 5 amps. **(Nov 04)**

39. i. What is a shunt referred to a PMMC instrument. How is it employed in extending the range of an ammeter?
ii. How temperature effect is corrected in the shunts? Discuss with a neat circuit diagram. **(May 04)**

40. i. Explain different types of electrostatic instruments. Discuss their principle of operation.
ii. Explain the working of quadrant type electrometer. **(May 04)**

41. i. How a quadrant electrometer be modified for measurement of low voltages?
ii. Discuss advantages, disadvantages and limitations of an electrostatic voltmeter. **(May 04)**

42. i. How are measuring instruments classified? Also explain the basic issues concerned with the measurement of electrical quantities.
ii. What are the requirements of an electrical indicating instrument? Discuss. **(Nov 03)**

43. i. What is the principle of working of a repulsion type moving iron instrument?
ii. Explain with the neat sketch the working of such an instrument.
iii. Discuss the various errors in moving iron instruments and suggest methods to compensate these errors. **(May 03)**

44. i. With usual notation derive an expression for the deflecting torque in a PMMC instrument.
ii. Explain how the PMMC instrument can be employed to measure **(May 03)**
a. Voltage b. Current

45. i. Classify the electrical measuring instruments based on how the deflecting torques is produced.
ii. Explain deflecting system, controlling system and damping system with reference to an electrical indicating instrument. **(May 03)**

46. i. Explain the principle of operation of moving iron type of instruments.
ii. The capacitance of a 0-2000 volts electrostatic voltmeter increase uniformly from 42 to 54mF from zero to full scale deflection. If it is required to increase the range of the instrument to 20000 volts by means of an external capacitor. Calculate the capacitance required. **(Nov 02)**

47. i. Define the terms "Indicating Instruments" "Recording Instruments" and integrating instruments, give examples of each case.
ii. Describe the different methods of producing controlling torque in an analogue instrument.
iii. How is the current range of a PMMC instrument extended with the help of shunts? **(May 02)**

48. Describe the construction and working of permanent magnet moving coil instrument. Derive the equation for deflection if the instrument is spring controlled. Describe the method of damping used in these instruments. **(May 01)**

49. A DC ammeter has a resistance of 0.1 ohm and its current range is 0.100A. If the range is to be extended to 0.500A, the meter requires _______shunt resistance. **(GATE 05)**

50. A DC ammeter has a resistance of 0.1 ohm and its current range is 0.100A. If the range is to be extended to 0.500A, the meter requires _______shunt resistance. **(GATE 05)**

48. The Q-meter works on the principle of _________________ **(GATE 05)**

49. A PMMC voltmeter is connected across a series combination of a DC voltage source V1=2V and an AC voltage source V2(t)-3 sin (4t). The meter reads **(GATE 05)**

50. A galvano meter with a full scal current of 10 mA has a resistance of 1000 ohms. the multiplying power ( the ratio of measured current to galvanometer cur rent ) of a 100 ohm shunt with this galvanometer is _______ **(GATE 04)**

51. A moving coil of ameter has 100 turns, and a length and depth of 10mm and 20 mm respectively. It is positioned in a uniform radial flux density of 200mT. The coil carries a current of 50 m A. the torque on the coil is ______ **(GATE 04)**

52. A moving iron ammeter produces a full scale torque of 240 micro N-m with a deflection of 120 deg at a curent of 10 A. the rate of change of self inductance (micro H/radian) of the instrument at full scale is _________ **(GATE 04)**

53. A rectifier type ac voltmer consists of a series resistance R, an ideal full-wave rectiier bridge and a PMMC instrument as shown in figure. The internal resistance of the instrument is 100 ohm and a full scale deflection is product\ed by a dc current of 1 mA. The value of Rs. required obtain full scal deflection with an ac voltage of 100 V(rms) applied to the input terminals is _____ **(GATE 03)**

54. A Manganin swamp resistance is connected in series with a moving soil ammeter consisting of milliammeter and a suitable shunt in order to _____ **(GATE 03)**

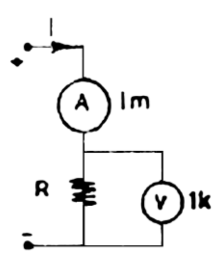
55. The inductance of a certain moving-iron ammeter is expressd as L=10+3theta-theta square/4 micro H, where theta is the deflection in radians from the zero position. The control spring torque in 25X10ex-6 Nm/radian. The deflection of the pointer in radian when the meter carries a current of 5 A , is __________ **(GATE 03)**

56. A 100 micro A ammeter has an internal resistance of 100 om. For extending its range to measure 500 micro A, the shunt required is of resistance (in ohms)__ **(GATE 01)**

57. Resistances R1 and R2 have, respectively, nominal values of 10 ohm and 5 ohm , and tolerances of _+5%and -+10% . The range of values for the parallel combination of R1 and R2 is __ **(GATE 01)**

58. A moving coil instrument, wh ose resistance is 5 Ohms and whose wor king current (for full scale deflection ) is 0.015 A, Is to be used, with a manganin shunt, to measure 100 A. Calculate the error caused by a 10°C in temperature, if the temerature coefficient of copper and manganin are 0.004 ohm/ohm°C, and 0.00014 ohm/Ohm°C respectively. **(GATE 98)**

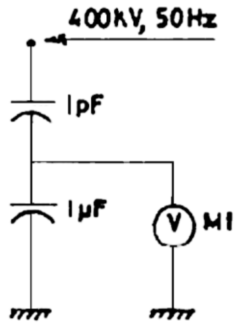
59. In the circuit shown in Figure for measuring resistance 'R' if the ammeter indicates 1Aand the voltmeter indicates 100V, then the value of R is … Ohms and the error in measurement using the ratio V/1 is ……..% **(GATE 97)**



*I play [golf] with friends sometimes, but there are never friendly games.*

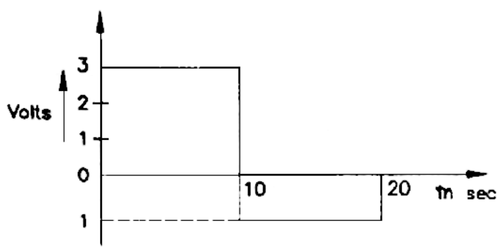
- Ben Hogan

60. In the capacitor divider arrangement shown in figure for measurement of high voltages, the minimum resistance of the voltmeter for 1% error is ……… Ohms and the voltage reading will be …….. V **(GATE 97)**




61. A periodic voltage whose waveform over one complete period is shown in figure is applied to the following types of commercial voltmeters:
   i. Permanent magnet moving coil (PMMC). meter with center zero
   ii. Moving iron type meter
   iii. Full wave rectifier type AC voltmeter
   iv. Peak response type electronic voltmeter

   Find the reading(s) of each instrument, considering the effect of the reversal of connection, if any.




**(GATE 92)**

62. Drive the general torque equation for a moving iron instrument. The inductance of a moving iron ammeter is given by the following expression:
   L = (20 + 10q - 2q²) mH

   Where q is deflection in radians. The spring constant is 24 x $10^{-6}$ Nm/rad. Calculate the value of deflection for a current of 5 A. **(IES 01)**

63. Give the basic principle of working of an electrostatic voltmeter. Explain how you would increase
   i. The operating forces and
   ii. Voltage range of the voltmeter. **(IES 95)**

64. Give the meanings of the following terms
   i. Precision, ii. Accuracy, iii. Standard Deviation, iv. Probable error **(IES 94)**

65. Explain the different types of errors that may occur in measurements. **(IES 93)**

66. What is a digital voltmeter? What are its advantages? List different types of digital voltmeters. How can a DVM be used for the measurement of i. Current and ii. Resistance. **(IES 92)**

**UNIT-II**

**2. Explain the principle of working of:**

**a) Resonance type frequency meters.**

**b) Weston type synchroscope. (Dec 2014/Jan 2015)**

**Explain the operation of acurrent transformer. What are the characteristics of current transformer?**

**A current transformer with primary with a bar primary has 300 turns in its secondary winding.the resistance and reactance of secondary circuit are 1.5ohmd and 1.0 ohms respectively including the transformer winding. With 5A flowing in the secondary winding ,the magnetizing mmf is 100AT and the iron loss is 1.2W.Determine the ratio and phase angle errors.(june/may 2013).**

**Give the constructional features of potential transformers.**

**With the help of diagram explain the principal of operation of Weston type frequency meter.**

**(may/june 2012)**

. A 500/5A, 50Hz current transformer has a secondary burden comprising a non inductive impedance of. The primary winding has one turn. Calculate the flux in the core and ratio error at full load. Neglect leakage reactance and assume the iron loss in the core to be 2.0w at full load. The magnetizing mmf is 105AT. **(JNTU Nov 2010)**

4. Explain the advantages of instrument transformers as regards to extension of range of current and voltage on high voltage A.C. systems. **(JNTU Nov 2010)**

5 . A 1000/5A, 50Hz current transformer has a secondary burden comprising a on- inductive impedance of 1.6.The primary winding has one turn. Calculate the flux in the core and ratio error at full load. Neglect leakage reactance and assume the iron loss in the core to be 1.5W at full load?

**(JNTU Nov 2010)**

6. What are the advantages of Instrument Transformers? **(JNTU Nov 2010)**

1. Draw the equivalent circuit and phasor diagram of a potential transformer. Derive the expressions for its ratio error. State the assumptions made for derivation of this error. **(Nov 08)**

2. i. Explain the constructional details of different types of current transformers.
   ii. A 100/5A, 50 Hz current transformer has a bar primary and a rated secondary burden of 12.5VA. The secondary winding has 196 turns and a leakage inductance of 0.96mH. With a purely resistive burden at rated full load, the magnetizing mmf is 16AT and the loss excitation required 12A. Find ratio and phase angle errors. **(Nov, Feb 08)**

3. Explain the constructional details and working of a single phase electrodynamometer type of powerfactor meter. Prove that the special displacement of moving system is equal to the phase angle of the system. **(Nov 08, 07)**

4. Derive the expressions for ratio and phase angle error of a potential transformer. State the assumptions made for derivation of these errors. **(Nov 08)**

5. i. Obtain the differences between current transformer and potential transformer.

ii. What are the major sources of errors in current transformers? Explain them in detail.
iii. Draw the equivalent circuit of current transformer. **(Feb 08, Nov 07)**

6. Explain the effect of the following on the characteristics of potential transformers.
   i. Burden (VA) of secondary winding cirucuit
   ii. Power factor of secondary winding circuit
   iii. Frequency and
   iv. Supply voltage. **(Feb 08)**

7. i. Draw the phasor diagram of potential transformation.
   ii. Explain the design and constructional features used in potential transformers for reduction of ratio and phase angle errors. **(Feb 08, Nov 07)**

8. i. Explain briefly about the characteristics of current transformers. What are the causes of errors in current transformers?
   ii. A current transformer has a single turn primary and a 200 turns secondary winding. The secondary winding supplied a current of 5A to Non-inductive burden of 1ohm resistance. The requisite flux is set up in the core by an mmf of 80A. The frequency is 50Hz and the net cross section of the core is 1000mm? Calculate the ratio and Phase angle of the transformer. Also find the flux density in the core. Neglect the effects of magnetic leakage, iron losses and $I^2$ R losses. **(Feb 08)**

9. i. What are the different methods of measurement of frequency in the power frequency range.
   ii. Explain the working and construction of a mechanical resonance type frequency meter using a neat sketch. **(Nov 07)**

10. Explain the constructional details and working of a 3-phase electrodynamometer type of power factor meter. Explain why phase splitting is not necessary in this case while in a single phase power factor phase splitting has to be done by using R in one circuit and L in another circuit of the moving coils. **(Nov 07)**

11. i. Describe the constructional details and working of a 3 ö electro dynamometer type of power factor meter.
   ii. Describe why phase splitting is not necessary in this case while in a single phase power factor phase splitting has to be done by using 'R' in one circuit and 'L' in another circuit of the moving coils. **(Nov 07)**

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*The biggest things are often the easiest to do because there is so little competition.*

- William Van Horne

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12. i. Explain the constructional features used in potential transformers to reduce the ratio and phase angle errors.
    ii. Explain the characteristics of potential transformers in detail. **(Feb 07, Nov 06)**

13. i. Explain the errors in potential transformers and means of reducing the same.
    ii. Describe the following methods for testing of a current transformer :
    a. Mutual inductance method b. Silsbee's method **(Feb 07)**

14. i. Explain how po-wer can be measured by using instrument transformers
    ii. The total resistance of the pressure coil circuit and the inductance of a wattmeter the 4000 Ω and 6.5mH. respectively Given the shunted capacitor method of compensating the inductance error and also determine across what portion of the series resistane a 0.1µF capacitor should be shunted to effect compensation. **(Nov, Feb 07)**

15. i. With neat sketch, explain how high currents and voltages can be measured with the help of instrument transformers. Describe the advantages of instrument transformers for extension of range of current and voltage on high voltage a.c. systems.
    ii. A current transformer with 5 primary turns has a secondary burden consisting of a resistance of 0.16 Ω and an inductive resistance of 1.12ohm. When the primary current is 200A, the magnetizing current is 1.5A and the iron loss current is 0.4A. Determine the expressions used, the number of secondary turns needed to make the current ratio 100:1 and also the phase angle under these conditions. **(Nov 06)**

16. With a neat sketch explain the working and construction of electro resonance type power factor meters. Draw the phasor diagrams under di”erent power factor conditions. **(Nov 06)**

17. i. Explain Resonance type synchroscope.
    ii. In a deflection frequency meter working on the principle of electrical resonance, there are two parallel circuits each consisting of an inductance and capacitance in series. One circuit has C1=1µF and is tuned to a frequency f1=60Hz. The other has C2=1.5µF and is tuned to a frequency, f2 below 50Hz.. The resistance of each circuit is R1=R2=100 oh ms. What must be the inductance of the second circuit, and to wh at frequency must it be tuned, in order that the current in both the circuits shall be same at a frequency of 50Hz. **(May 06)**

18. Describe the constructional details and working of a 1ö electro dyn amometer type of power factor meter. And also prove that special displacement of moving system is equal to the phase an gle of the system. **(May 06)**

19. Write short notes on the followin g : i. Weston type fr equency meter ii. Ratiometer type Frequency meter. **(May 06)**

20. i. Draw the equivalent circuit and phasor diagram of a potential transformer and derive the expressions for actual transformation ratio and phase angle.
    ii. A current transformer of turn s 1 : 199 is rated as 1000/5A, 25VA. The core loss and magnetizing component of the primary curr ent are 4 and 7A un der rated conditions. Determine the phase angle and ratio errors for the rated burden and rated secondary current at 0.8p.f. lagging and 0.8 pf leading. Neglect the resistance and leakage resistance of secondary winding. **(Mar 06)**

21. i. Draw the equivalent circuit and phasor diagram of a current transformer. Derive the expressions for transformation ratio and phase angle.
    ii. A single phase potential transformer has a turns ratio of 3810/63. The nom inal secondaryvoltage is 63V and th e total equivalent r esistance and leakage reactance referr ed to the secondary side are 2 and 1 respectively. Calculate the ratio and phase angle errors when the transformer is supplying a burden of 100+j200. **(Mar 06)**

22. i. Derive the expressions for ratio and phase angle error of a current transformer.
    ii. A 1000/5A, 50 Hz current transformer has a Secondary burden comprising a non- inductive burdenof 1.6 ohm. The primary winding has one turn. Calculate the flux in the core and ratio error at full load. Neglect leakage reactance and assume the iron loss in the core to be 1.5W at full load. **(Mar 06)**

23. Describe the construction and working of a Weston type synchroscope. How is it assured that the
    i. Incoming machine has the same voltage as that of the bus bars and also whether they are in phase with each other (or) note
    ii. Incoming machine has the same phase sequence as the busbars to which it has to be connected.
    iii. Frequency of the incoming machine is same as that of the busbars.
    iv. Incoming machine is Faster or slower than the bus bars. **(Nov 05)**

24. i. Explain briefly about the characteristics of current transformers. What are the causes of errors in current transformers?
    ii. A current transformer has a single turn primary and a 200 turns secondary winding. The secondary winding supplied a current of 5A to Non-inductive burden of 1 resistance. The requisite flux is set up in the core by an mmf of 80A. The frequency is 50Hz and the net cross section of the core is 1000mm? Calculate the ratio and Phase angle of the transformer. Also find the flux density in the core. Neglect the effects of magnetic leakage, iron losses and I2 R losses. **(Apr. 05)**

25. Write short notes about dial type Synchroscope. **(Nov 03)**

26. Write short notes on following
    i. Resonance type frequency meter.
    ii. Advantages and disadvantages of Moving Iron power factor meter. **(Nov 03)**

27. List out the differences between instrument transformers and power transformers. **(Nov 03)**

28. i. Explain the construction and working of a MI type power factor meters.
    ii. Describe the construction and working of Weston type synchroscope. **(May 02)**

29. i. Explain the construction and working of a MI type power factor meters.
    ii. Describe the construction and working of Weston type synchroscope. **(May 02)**

30. Describe a direct reading frequency meter for measuring a frequency of the order of either
    i. 50 cycles per second (or)
    ii. 500 cycles per second Suggest a suitable method for calibrating the instrument.

31. A 50 Hz, bar primary CT has a secondary with 500 turns. The secondary supplies 5 A current into a purely resistive burden of 1 ohm. The magnetizing ampere-turns is 200. The phase angle between the primary and secondary current is _ **(GATE 04)**

32. The core flux in the CT of above problem under the given operating condition is ____ **(GATE 04)**

33. A 500A/5A, 50 Hz current transformer has a bar primary.Te secondary burden is apure resistance of 1 ohm and it draws a current of 5 A. If the magnetic core requires 250 At for magnetization, the percentage ratio error is _____ **(GATE 03)**

34. Describe the construction and working principle of a single phase electrodynamic power factor meter. Compare it working with a moving iron type power factor meter. **(IES 01)**

35. Draw a functional block diagram and explain the principle of working of a digital frequency meter **(IES 96)**

36. Give the constructional features and principles of working of a synchroscope. **(IES 95)**

**UNIT-III**

1. **Describe the constructional details of an electro dynamometer type wattmeter. Derive the expression for torque when the instrument is used on ac. (Dec 2014/Jan 2015)**

Explain the working of a 3 phase watt meter.draw a neat sketch of the wattmeter and also its connections.describe how the mutual effects between the two elements of the wattmeter are eliminated.

How the active and reactive powers of unbalanced systems are measured ? explain with a neat circuit diagram.**(JNTU May/june 2013)**

**Derive expression for torque of an electrodynamometer type wattmeter.**

**Explain the construction and working of a single phase energy meter. (JNTU May/june 2012)**

. Explain how power can be measured in a three phase circuit with the help of two watt meters. Illustrate your answer with the help of a phasor diagram for a balanced star connected load. **(JNTU Nov 2010)**

4. The inductive reactance of the pressure coil circuit of dynamometer wattmeter is 8% of its resistance at normal frequency and the capacitance is negligible, calculate the percentage error and correction factor due to reactance for loads at

i) 0.6 p.f leading

ii) 0.8 p.f leading **(JNTU Nov 2010)**

5. Give the constructional details of electrodynamometer type wattmeter with a neat sketch. **(JNTU Nov 2010)**

6. Prove that the true power= COS_COS_:COS(_□)_ Actual wattmeter reading for electrodynamometer type of watt meters, where cos_ =p.f of the circuit, =tan□1□wLR_where L and R are the inductance and resistance of the pressure coil of the circuit. **(JNTU Nov 2010)**

1. i. Give the constructional details of electrodynamometer type wattmeter with a neat sketch.

   ii. Prove that the true power= $\left|\frac{COS\phi}{COS\phi.COS(\phi-\beta)}\times\right|$ Actual wattmeter reading for electrodynamometer type of wattmeters, where $\cos\phi$ =p.f of the circuit, $\beta = \tan^{-1}\left(\frac{wL}{R}\right)$ where L and R are the inductance and resistance of the pressure coil of the circuit. **(Nov 08)**

2. i. Explain the working of a 3-phase wattmeter. Draw a neat sketch of the wattmerter and also its connections. Also, explain how the mutual effects between the two elements of the wattmeter are eliminated.

   ii. A voltage: $100\sin wt+40\cos(3wt-30^0)+50\sin(5wt+50^0)$V is applied to the pressure circuit of a wattmeter and through the current coil is passes a current of $8\sin wt+6\cos(5wt-120^0)$A. What will be the reading of the wattmeter? **(Nov 08)**

3. i. Draw the possible methods of connection the pressure coil of a wattmeter and compare the errors. Explain the meaning of "Compensation winding" in a Wattmeter and show how they help to reduce the error.

   ii. A dynamometer type wattmeter has a field system which may be considered long compared with its moving coils. The flux density is 0.012T, the mean diameter of the moving coil is 3 cm and the moving coil turns are 500. The current through the moving coil is 0.05A and power factor of the circuit of which power is measured is 0.866. Calculate the torque when the axis of the field and moving coils are
   a. $30^0$ b. $90^0$. **(Nov 08)**

4. i. Draw the necessary circuit diagram for measurement of three phase power by two wattmeter method. Make necessary derivations. In case of balanced, discuss the effects of the following load power factors on the two wattmeter readings.
   a. zero b. unity

   ii. The power to a 3-phase induction motor was measured by this method, and the readings were 3,400 and ?1,200 watts respectively. Calculate the total power and power factor. **(Nov 08)**

5. Write short notes on the following:
   i. Power measurements methods in 3-phase balanced and unbalanced circuits.
   ii. Extension of wattmeter range by instrument transformers.
   iii. Polyphase wattmeter. **(Feb 08)**

6. i. Explain the constructional details and working principle of Low power factor wattmeter (electrodynamometer type).

   ii. A dynamometer wattmeter is used to measure the power factor of a 20 µF capacitor. The pressure coil of the wattmeter having a resistance 1000 ohms and an inductive reactance of 15 ohms is connected across a 50Hz supply. The current coil of the wattmeter, a variable resistor R and the capacitor are connected in series across the same supply. The wattmeter deflection is made zero by adjusting the value of R to 1.65ohms. If the current coil resistance is 0.1 ohms and inductance is negligible. Determine the power factor of the capacitor. **(Feb 08)**

7. Write short notes on the following:
   i. Errors present in 1-phase electrodynamometer type wattmeter.
   ii. Extension of wattmeter range by instrument transformers.
   iii. Polyphase wattmeter. **(Feb 08)**

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*The concentration and dedication- the intangibles are the deciding factors between who won and who lost.*

- Tom Seaver

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8 i. Show that the power in a 3-phase system is measured by the use of
a. only one watt meter and b. two wattmeters.
Indicate how the power is determined. Comment on the accuracy of the measurements when the load is unbalanced and the supply is a four-wire system.
ii. Two wattmeters used to measure the power input in a 3-phase circuit indicate 1000w and 500w respectively. Find the powerfactor of the circuit.
a. When both wattmeters readings are positive
b. When the latter is obtained by reversing the current coil connections. **(Feb 08)**

9. i. Explain the working of a 3 phase wattmeter with the help of a neat sketch.
Describe how the mutual effects between the two elements of the wattmeter are eliminated.
ii. If the current in the pressure coil of a wattmeter lags 20 behind the voltage and instrument is accurate when $\cos\theta=1$, find the percentage error when $\cos\theta=0.8$, 0.6 and 0.4 respectively. **(Feb 08)**

10. i. Explain how power can be measured by using instrument transformers
ii. The total resistance of the pressure coil circuit and the inductance of a wattmeter the 4000 ohms and 6.5mH. respectively Given the shunted capacitor method of compensating the inductance error and also determine across what portion of the series resistane a 0.1μF capacitor should be shunted to effect compensation. **(Feb 08)**

11. i. Describe the three ammeter method for measurement of power and power factor in a single phase circuit. Derive the expressions for power and power factor
ii. The power flowing in a 3 phase, 3 wire balanced load system is measured by two wattmeter method. The reading of wattmeter A is 7500W and of wattmeter B is 1500W What is the power factor of the system?
iii. If the voltage of the circuit is 400V, what is the value of capacitance which must be introduced in each phase to cause the whole of the power measured to appear on wattmeter A. The frequency is 50Hz. **(Feb 08)**

12. i. Explain the errors caused due to pressure coil inductance and pressure coil capacitance in electro dynamometer wattmeter.
ii. Discuss the shape of scale of electro dynamometer wattmeters with the help of a neat sketch. **(Feb 08)**

13. i. Discuss the various types of errors and their methods of compensation in the dynamometer type wattmeter.
ii. What are the differences between LPF and UPF wattmeters. **(Nov 07)**

14. i. Explain how do you measure the total power in a 3-phase circuit with the help of two wattmeters only.
ii. In a balanced three phase system power is measured by two wattmeter method and the ratio of two wattmeter readings is 2:1. Determine the power factor of the system and deduce the relation used? **(Nov 07)**

15. i. Show that the power in a 3-phase system is measured by the use of
a. only one watt meter and b. two wattmeters.
Indicate how the power is determined. Comment on the accuracy of the measurements when the load is unbalanced and the supply is a four-wire system.
ii. Two wattmeters used to measure the power input in a 3-phase circuit indicate 1000w and 500w respectively. Find the powerfactor of the circuit.
a. When both wattmeters readings are positive
b. When the latter is obtained by reversing the current coil connections. **(Nov 07)**

16. Derive the torque equation for an electrodynamometer type wattmeter. Explain why it is necessary to make the potential coil circuit purely resistive? Comment upon the shape of scale if spring control is used. **(Nov 07)**

17. i. Explain with the help of a neat circuit diagram, how the power and the power factor in a 3-phase circuit can be measured by two wattmeter method. Explain how the readings of the two wattmeters change with load p.f?

ii. A balanced load is supplied from a 3-phase, 400V, 3 wire system whose power is measured by two wattmeters. If the total power supplied is 26 KW at 0.75 pf lagging, find the readings of each of the two wattmeters. **(Nov 07)**

18. Explain the following methods of measurement of reactive power in three phase circuits
a. Two autotransformers method b. A single electrodynamometer type wattmeter method **(Nov 07)**

19. i. Describe the construction & working of electro dynamo meter wattmeter. Derive the expression for torque when the instrument is used on a.c.

ii. The pressure coil of an electro dynamo meter wattmeter has a resistance of 6600 $\Omega$ . When the voltage applied to the pressure coil is 120V and a current of 20A flows in the series coil, the deflection is 1600. What additional resistance must be connected in the pressure coil circuit to make the meter constant equal to 20W per degree. **(Feb 07, Mar 06)**

20. Explain how the power in a 3 phase system is measured by the use of
i. Only one wattmeter
ii. Two wattmeters. Indicate how the power factor is determined. **(Feb 07)**

21. A non inductive resistance is connected in series with a coil across a 230V, 50Hz supply. The current is 1.8A and the potential difference across the resistance and the coil is 80 & 171 volts respectively. Calculate
i. Resistance and inductive reactance of the coil
ii. The supply power and pf **(Feb 07)**

22. i. Describe with a connection diagram, how would you standard ardize the wattmeter with the help of standard potentiometer. Mention all relevant precautions.

ii. A voltage : 100 Sin.t + 40 cos (3.t-300)+50SinVt+6cos(5.t-1200)A. What will be the reading on the wattmeter? What percentage of this power is due to fundamental frequency? **(Feb 07)**

23. Explain the following methods of measurement of reactive power in three phase circuits
i. Two autotransformers method
ii. A single electrodynamometer type wattmeter method **(Feb 07)**

24. A dynamometer wattmeter measures power in a 50Hz, single phase circuit without error, at all power factors. The resistance of the voltage coil & its series resistance has a disturbed self capacitance equivalent to a shunt capacity of 20pf. What is the self inductance of the pressure coil? **(Feb 07)**

25. Explain with the help of a neat circuit diagram, how the power & the power factor in a 3ö circuit can be measured by two wattmeter method. Explain how the readings of the two wattmeters change with load p.f? **(Feb 07)**

26. A balanced load is supplied from a 3$\phi$, 400V, 3 wire system whose power is measured by two wattmeters. If the total power supplied is 26 KW at 0.75 pf lagging, find the readings of each of the two wattmeters. **(Nov, Mar 06)**

27. Write short notes on the following :
i. Errors in power measurements due to connections of wattmeter in di"erent ways
ii. Two wattmeter method of measuring 3 phase power
iii. Extension of wattmeter range by instrument transformers **(Nov, Mar 06)**

28. i. Explain the errors caused due to pressure coil inductance and pressure coil capacitance in electro dynamometer wattmeter.

ii. Discuss the shape of scale of electro dynamometer wattmeters with the help of a neat sketch. **(Mar 06)**

*A wise system of education will at last teach us how little man yet knows, how much he has still to learn.*

- Sir John Lubbock

29. i. Explain the following errors for electro dynamometer wattmeters. i. Mutual inductance effects
 ii. Errors due to connections iii. Eddy currents iv. Stray Magnetic fields (e) Vibration of Moving system (f) Tempetature errors. **(Nov 05)**

30. i. Explain the 3 voltmeter method of power measurement with the help of vector & connection diagrams
 ii. In a dynamometer wattmeter the moving coil has 500 turns of mean diameter 30mm. Estimate the torque if the axes of the field & the moving coils are at i. 600 ii. 900 when the flux densityproduced by field coils is 15 x 10-3wb/m2, the current in moving coil is 0.05A & the power factor is 0.866. **(Nov 05)**

31. i. Explain th e errors caused due to pressure coil in ductance and pressure coil capacitance in electro dynamometer wattmeter.
 ii. Discuss the shape of scale of electro dynamometer wattmeters with the help of a neat sketch. **(Apr. 05)**

32. i. Explain the construction and theory of operation of a single phase electrodynamometer type wattmeter.
 ii. A certain circuit takes 10A at 200V and the power absorbed is 1000W. If the wattmeters current coil has a resistance of 0.15W and its pressure coil a resistance of 5000W and an inductance of 0.3H, find
 a. The error due to the resistance for each of the two possible methods of connection
 b. The error due to the inductance if the frequency is 50Hz;
 c. Total error in each case. **(Nov 04)**

33. i. Explain with the help of a phasor diagram the error caused by the inductance of the pressure coil of a dynamometer wattmeter. In dicate the dependen ce of the error on load power factor and supply frequency.
 ii. A 500V, 20A dynamometer instrument is used as a wattmeter. Its current coil has 0.1W resistance and pressure coil has 25KW resistance and 0.1H inductance. The meter was calibrated on dc supply. What is the error in the instrument if it is used to measure the power in a circuit with supply voltage 500v, load current 24A at 0.2 p.f. Assume that the pressure coil is connected across the load. **(Nov 03)**

34. Two wattmeters, which are connected to measure the total power on a three-phase system supplying a balanced load, read 10.5 KW and -2.5 KW, respectively.The total power and the power factor, respectively, are______ **(GATE 05)**

35. The circuit in figure is used to measure the power consumed by the load. The current coil and the voltage coil of the wattmeter have 0.02 ohm adn 1000ohm resistances respectively. The measured power compared to the load power will be ___ **(GATE 04)**

36. A single phase load is conected between R and Y terminals of a 415 V, symmeterucal, 3-phase, 4 wire system with phase sequence RYB. A wattmeter is connected in the system as shown in figure. The power factor of the load is 0.8 lagging. the wattmeter will read _____ **(GATE 04)**

37. A wattmeter reads 400 W when its current coil is connected in the R phase and is pressure coil is conected between this phase and the neutral of a symmetrical 3-phase system supplying a balanced star connected 0.8 pf inductive load. The phase squence is RYB What wil be the reading of this wattmeter if its pressure coil alone is reconnected between the B and Y phases, all other connections remaining as before? **(GATE 04)**

38. Describe a method of power measurement for a 3 phase 3 wire-unbalanced load. How can power factor of a balanced load be determined by the method? **(IES 02)**

**UNIT-IV**

Explain the construction and opresation of single phase induction type energy meters.derive necessary equations. **(Dec 2014/Jan 2015)**

Explain the construction and working of Merz price maximum demand indicator. **(JNTU May/june 2013)**

**Explain the procedure of measuring reactive power in three phase balanced system.**

**A 3-phase,2 element energy meter has a constant of 5 revolutions of disc per KWH.the meter is being used with a P.T of ratio 33KK/220V and a C.T of ratio 200/5A. if the line voltage is 220V,current is 20A,time to complete 200 revolutions is 50 seconds t 0.8 p.f lagging,determine the error expressed as a percentage of the correct reading. (JNTU May/june 2013)**

1. Explain the sources of errors in single phase induction type energy meters. **(JNTU Nov 2010)**
2. Explain how KVAH and KVA measurements can be done with the help of a trivectormeter? **(JNTU Nov 2010)**
3. What are the errors in energy meter and how are the compensated in multi element induction type energy meter? How these energy meter errors will compare with that of watt-meter? **(JNTU Nov 2010)**
4. The disc of an energy meter makes 600 revolutions per unit energy. When a 1,000 watt load is connected, the disc rotates at 10.2 rpm, if the load is on for 12 hours, how many units are recorded as error? **(JNTU Nov 2010)**
5. What are the errors in energy meter and how are the compensated in multielement inductions type energy meter? How these energy meter errors will compare with that of watt-meter? **(JNTU Nov 2010)**

1. Derive the expression for deflecting torque in single phase induction type Energy water. Show that deflection is maximum when the phase angle between two fluxes is $90^0$ and when the disc is purely non-inductive.

**(Nov 08)**

2. Explain the functions of the following in a single phase induction type Energymeter.
   i. Shunt and series magnets
   ii. Moving disc
   iii. Permanentmagnet
   iv. Shading bands and holes in disc. **(Nov 08)**

3. Explain the constructional details of a single phase induction type energy meter. Explain, why the phase of shunt flux is made exactly in quadrature with that of applied voltage so as to produce a deflecting torque exactly proportional to power. **(Nov 08)**

4. i. Explain the different sources of errors in single phase induction type energymeter.
   ii. A 50 A, 230 V meter on full load test makes 61 revolutions in 37 seconds. If the normal disc speed is 520 revolutions per Kwh, find the percentage error. **(Nov 08)**

5. i. What is phantom loading? Explain with an example how is it more advantages than teating with direct loading?
   ii. The constant for a three phase, 3 element integrating energymeter is 0.12 revolution of disc per Kwh. If the meter is normally used with a potential transformer of ratio 22,000/110v and a current transformer of ratio 500/5A. Find the error expressed as a percentage of the correct reading from the following test results for the instrument only:
   Line voltage = 100V; Current =5.25 A; p.f=1 . Time to complete 40 revolutions=61sec. **(Feb 08, Nov 07)**

6. i. What is creeping? How can it be prevented?
   ii. A correctly adjusted, single phase, 240V Induction watt hour meter has a meter constant of 600 rev per Kwh. Determine the speed of the disc, for a current of 10 A at a power factor of 0.8 lagging. If the lag adjustment is altered so that the phase angle between voltage fluse and applied voltage is 860. Calculate the error introduced at a. unity p.f b. 0.5 p.f lagging. Give comments upon the results. **(Feb 08, Nov 07)**

7. i. Explain the construction and working of a single phase induction type energymeter. Show that the total number of revolutions made by its disc during a particular time is proportional to the energy consumed.
   ii. The disc of an energymeter makes 600 revolutions per unit of energy. When a 1,000 watt load is connected, the disc rotates at 10.2 rpm. If the load is on for 12 hours, how many units are recorded as error? **(Feb 08)**

8. i. Draw a neat sketch showing the construction of a single phase induction type energy meter. Give the theory and operation of the instrument
   ii. An energy meter is designed to make 100 revolutions of the disc for one unit of energy. Calculate the no. of revolutions made by it when connected to a load carrying 20A at 230volts at 0.8 pf for an hour. If it actually makes 360 revolutions, find the percentage error. **(Feb 08, Nov 07)**

9. Explain how the following adjustments are made in a single phase induction type energy meter.
   i. Lag adjustment
   ii. Adjustment for friction compensation
   iii. Creep
   iv. Overload compensation and
   v. Temperature compensation. **(Nov 07)**

*Education costs money, but then so does ignorance.*

- Sir Claus Moser

10. Explain the working of the following with neat diagrams
    i. Maximum demand indicator.
    ii. Trivector meter. **(Nov 07)**

11. i. Explain how KVAh and KVA measurements can be done with the help of a trivector meter
    ii. Explain the method of testing a.c. meters by phantom loading **(Nov 07)**

12. Draw a neat sketch showing the construction of a single phase induction type energy meter. Give the theory and operation of the instrument **(Feb 07, Nov 06, 05, Mar 06)**

13. An energy meter is designed to make 100 revolutions of the disc for one unit of energy. Calculate the no. of revolutions made by it when connected to a load carrying 20A at 230volts at 0.8 pf for an hour. If it actually makes 360 revolutions, find the percentage error. **(Feb 07, Nov 06, 05, Mar 06)**

14. What are the different factors which affect the precision measurement of medium resistances with wheat stone bridge? Explain how their effects are minimized/eliminated **(Feb 07)**

15. A wheat stone bridge is used for measuring the value of change of resistance of a strain gauge which forms one of the arms of the bridge. All the arms of the bridge including the strain guage have a resistance of 100“ each. The maximum allowable power dissipation from the strain gauge is 250 MW. Determine the value of maximum permissible current through the strain gauge and maximum allowable value of bridge supply voltage. Suppose a source of 20V is available, find the value of series resistance to be connected between the source and the bridge to limit the input voltage of the bridge to permissible level. **(Feb 07)**

16. Describe the construction & working of a Merz price maximum Demand indicator. **(Feb 07)**

17. A single phase induction type energy meter is adjusted to read correctly at unity pf. It is observed that 1/ 4 full load current at 0.5 lagging pf the effective voltage magnet flux lags behind the current magnet flux by 270, Will it introduce any error in the measurement? If so, calculate thepersentage error introduced. **(Feb 07)**

18. i. Draw a neat circuit diagram of a single phase watt hour meter and explain its working. What are the various sources of errors and how they are compensated?
    ii. A large consumer has a KVA demand and a KVAh tari_ measured by “Sine” and “cosine” watthour type meters each equipped with a Merz price demand indicator. The tari_ is Rs.40 per month per KVA of demand plus 30 paise per KVAh. Determine the monthly bill for 30 days based upon the following readings: ‘Sine’ meter advances by 90,000 reactive KVAR demand indicator 150 KVAR, ‘cosine’ meter advances by 120,000 kwh & demand indicator by 200kw. What is the average monthly pf and the total cost per unit? **(Nov, 06, 05, Mar 06)**

19. Explain the constructional details of 3 - ph energy meter. **(Mar 06, Nov 05)**

20. A correctly adjusted single phase 240Volts, induction watt hour meter has ammeter constant of 6000 revolution per kwh. Determine the speed of the disk, for a current of 10 Amps. At a power factor of 0.8 lagging If the lag adjustment is altered so that the phase angle between flux and applied voltage is $86^0$. Calculate the error introduced it
    a. unit pf    b. 0.5pf lagging. **(Mar 06, May 03)**

21. Explain the testing of energy meter using R.S.S. meter. **(Nov 05)**

22. What is energy meter testing? Explain phantom load testing. **(Nov 05)**

23. The meter constant of a 230V, 10A, watt our meter is 1800 revolutions per Kwh. The meter is tested at half load and rated voltage and unity power factor. The meter is found to make 80 revolutions in 138 second. Determine the meter error at half load. **(Nov 05)**

24. A 220V, 5A, DC energy meter is tested at its marked ratings. The resistance of pressure circuit is 8800W and that of current coil is 0.1W. Calculate the power consumed when testing the meter with phantom loading with current circuit excited by a 6 volts battery. **(Nov 05)**

25. A correctly adjusted single phase 240 volts, induction watt hour meter has ammeter constant of 6000 revolution per Kwh. Determine the speed of the disc, for a current of 10 Amps. At a power factor of 0.8 lagging. If the lag adjustment is altered so that the phase angle between flux and applied voltage **(Nov 05)**

26. Describe the construction & working of two element Induction type energy meter **(Nov 05)**

27. The constant for a three phase, 3 element integrating wattmeter is 0.12 revolu tion of disc per kwh. If the meter is normally used with a potential transformer of ratio 22,000/110V & a current transformer of ratio 500/5A, find the error expressed as a percentage of the correct reading from the following test figures for the instrument only Line voltage=100V; current=5.25A; pf =1 time to complete 40 revolutions = 61Sec.**(Apr 05)**

28. A dc A-h meter is rated for 15 A, 250 V. The meter constant is 14.4 A-sec/rev. The meter constant at rated voltage may expressed as _______ **(GATE 04)**

29. The effect of stray magnetic fields on the actuating torque of a portable instrument is maximum when the operating field of the instrument and the stray fields are ____ **(GATE 03)**

30. Explain the phenomena of 'creeping'. If an energy meter disc makes 10 revolutions in 100 seconds when a load of 360W is connected to it determine the meter constant in revolutions / k. Wh. **(IES 02)**

**UNIT-V**

1.a)Describe the construction and working principle of crompton's dc potentiometer.
b) Explain why a potentiometer does not load the voltage source whose voltage is being determined. **(Dec 2014/Jan 2015)**

Explain the principle and operation of DC crompton's potentiometer.
Discuss the applications of A.C potentiometers. **(JNTU May/june 2013)**

**With a neat sketch explain the procedure of measuring power using a potentiometer.**

**A potentiometer that is accurate to +or-0.00015 volts is used to measure current through a standard résistance of 0.15ohmpercent.the voltage across the resistance is measured to be 0.3124V.what is the current and to what accuracy it has been determined. (JNTU May/june 2012)**

1. . Explain how wattmeter is calibrated using D.C potentiometer. **(JNTU Nov 2010)**
2. What is volt-ratio box? Explain. Design a volt ratio box with a resistance of and ranges 25V, 50V, 75V, 150V and 300V. The volt-ratio box is to be used with a potentiometer having a measuring range of 1.6V? **(JNTU Nov 2010)**
3. Explain the construction and working principle of a co-ordinate type A.C. potentiometer with the help of a neat diagram? **(JNTU Nov 2010)**
4. Explain with the help of suitable diagrams, how a D.C. potentiometer can be used for

i. Calibration of voltmeter
ii. Calibration of ammeter? **(JNTU Nov 2010)**

1. i. How a co-ordinate type A.C. potentiometer is standardized? Explain how an unknown voltage can be measured by using this potentiometer?
   ii. What are the sources of errors in the above potentiometer? **(Nov 08)**

2. Explain the following in A.C. potentiometer:
   i. Drysdale phase shifting Transformer.
   ii. Transfer instrument. **(Nov 08)**

3. i. Draw the circuit of d.c. potentiometer. Explain how you can calibrate the same against a standard cell. Discuss the effect of room temperature on this calibration.
   ii. Explain how the potentiometer may be used for precise measurement of voltage (240V d.c.). **(Nov 08)**

4. i. Describe the steps when D.C. crompton's potentiometer is used to measure an unknown resistance?
   ii. A basic slide wire potentiometer has a working battery voltage of 3 volts with negligible internal resistance. The resistance of slide wire is 400 ohms and its length is 200 cm. A 200 cm scale is placed along the slide wire. The slide wire has 1 mm scale divisions and it is possible to read upto of a division. The instrument is standardized with 1.018 V standard cell with sliding contact at the 101.8 cm mark on scale. Calculate:
   a. Working current
   b. The resistance of series rheostat
   c. The measurement range and
   d. The resolution of the instrument. **(Nov, Feb 08, Nov 06)**

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*We're given a code to live our lives by. We don't always follow it, but it's still there.*

- Gary Oldman

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5. i. Explain how "time zero" is obtained in a crompton?s potentiometer? **(Feb 08)**
   ii. Explain the reasons why a separate "standard cell dial circuit" is provided in modern d.c. potentiometer?

6. Explain the basic principle of operation of d.c. potentiometer with a neat sketch. Explain why a potentiometer does not load the voltage source whose voltage is being measured? **(Feb 08)**

7. i. Draw the circuit diagram of a basic slide wire d.c. potentiometer. Explain its working?
   ii. A single range potentiometer has a 18 step dial switch where each step represents 0.1V, the dial resistors are 10ohms. The slide wire of the potentiometer is circular and has 11 turns and a resistance of 11ohms each. The slide wire has 100 divisions and interpolation can be done to one fourth of a division. The working battery has a voltage of 6 volts and negligible internal resistance. Calculate:
   a. the measuring range of potentiometer b. the resolution
   c. working current and d. setting of rheostat. **(Feb 08)**

8. i. Find the working current of the slide wire and the rheostat setting
   ii. If the slide wire has divisions marked in mm and each division can be interpolated to one fifth, calculate the resolution of the instrument.
   iii. What is standardization and explain with an example, how it is obtained. **(Feb 08)**

9. i. Describe the construction and working of a co-ordinate type a.c. potentiometer. How is it standard? Explain how an unknown voltage can be measured with it.
   ii. Discuss the source of errors with respect to a.c potentiometers. **(Feb 08)**

10. Describe the construction and working of a polar type potentiometer. How is it standardized? What are the functions of the transfer instrument and the phase shifting transformer? **(Feb 08, 07, Nov 07, 06, 05)**

11. Explain the construction and working principal of a polar type potentiometer with a neat sketch. **(Nov 07)**

12. Explain the following:
   i. How would you apply a correction for thermo-emf in d.c. potentiometer measurement?
   ii. What is the difference between and A.C. potentiometer and a d.c. potentiometer?
   iii. What are the practical diculties associated with a.c. potentiometers?
   iv. How the d.c. potentiometer is standardized? **(Nov 07)**

13. i. Explain how an unknown voltage can be measured by using a polar type potentiometer?
   ii. Calculate the inductance of a coil from the following measurement on an a.c. potentiometer. Voltage drop across a 0.1" standard resistor connected in series with the coil = 0.613 $\angle 12^0 6'$. Voltage across the test coil through a 100/1 volt-ratio box = 0.781 $\angle 50^0 48'$ V. Frequency is 50 Hz. **(Nov 07)**

14. Explain the following:
   i. Standardization procedure of d.c. cropmtons potentiometer.
   ii. Applications of d.c. crompton potentiometer. **(Nov 07)**

15. Explain with the help of suitable diagrams, how a.c. potentiometers can be used for
   i. Calibration of voltmeters
   ii. Calibration of ammeters
   iii. Calibration of wattmeters and energy meters
   iv. Measurement of reactance of a coil **(Nov 07)**

*Every aspect of Western culture needs a new code of ethics -- a rational ethics -- as a precondition of rebirth.*
- Ayn Rand

16. i. Find the working current of the slide wire and the rheostat setting
    ii. If the slide wire has divisions marked in mm and each division can be interpolated to one fifth, calculate the resolution of the instrument.
    iii. What is standardization and explain with an example, how it is obtained. **(Feb 07, Nov 06, May 05)**

17. Describe the construction, principle of operation of a duo-range potentiometer by drawing its circuit diagram. Also explain its advantages. **(Feb 07)**

18. i. Explain the reasons why d.c. potentiometers cannot be used for a.c. measurement. Explain the modifications that are needed in a d.c. potentiometer to be used for a.c. applications.
    ii. In the measurement of power by a polar potentiometer, the following readings were obtained : Voltage across a 0.2 $\Omega$ standard resistance in series with the load = 1.46 $|32^0$V Voltage across a 200:1 potential divider across the line = 1.37560V. Estimate the current, voltage, power and power factor of the load. **(May 06)**

19. i. Explain the operation of any one type of AC potentiometer.
    ii. Explain clearly how such a potentiometer can be employed for measurement of unknown inductance and unknown capacitance. **(May 06, 05)**

20. i. Explain the term "Standardization" of a dc potentiometer.
    ii. With a neat circuit diagram explain salient features of self balancing poteniometer. **(May 06)**

21. i. Explain how "true zero is obtained in a crompton's potentiometer.
    ii. What are the applications of potentiometers. **(Nov 05)**

22. i. Explain with neat sketch Gall Tinsley co-ordinate AC potentiometer to measure unknown voltage. Indicate clearly how it is standardized.
    ii. Explain how the ration and phase angle error of a CT can be measured using AC potentiometer. **(Nov 05)**

23. i. Explain how "true zero is obtained in a crompton's potentiometer.
    ii. What are the applications of potentiometers.
    iii. With a neat circuit diagram explain salient features of a self balancing potentiometers. **(Nov 05)**

24. i. With a neat sketch, explain the measurement of resistance using a potentiometer.
    ii. Draw circuit diagram and explain the measurement of power using potentiometer. **(May 04)**

25. i. Explain how potentiometer is employed in measuring resistance, power and calibration of watt meter?
    ii. During the measurement of a low resistance using a potentiometer the following readings were obtained.
    Voltage drop across the low resistance under test – 0.4221V voltage drop across the 0.1 $\Omega$ standard resistance – 1.0235V. Calculate the value of unknown resistance, Current and power lost in it. **(May 03)**

26. i. Draw the circuit diagram of Crompton's potentiometer and explain its working. Describe the steps used when measuring an unknown resistance.
    ii .Power is measured with an AC potentiometer. The voltage across a 0.1 standard resistance connected in series with the load is 0.35 – J 0.10V. The voltage across 300:1 potential divider connected to the supply is 0.8+J 0.15V. Determine the power consumed by the load and the PF. **(May 03)**

27. Explain the term "Standardization of a potentiometer". Describe the procedure for the standardization of a DC potentiometer. **(Nov 03)**

28. i. Write a circuit diagram to explain salient features of self balancing potentiometer.
    ii. Explain clearly the construction and working principle of "DRYSDALE" polar type AC potentiometer. **(Nov 03)**

29. A slide wire potentiometer has a battery of 4V and negligible internal resistance. The resistance of slide wire is 100 Ohms and its length 200cm. A standard cell of 1.018V is used for standardizing the potentiometer and the Rheostat is adjusted so hat balance is obtained when the sliding contact is at 101.8 cm. Find the working current of slide wire and the rheostat setting. If the slide wire has division marked in mm and each division can be interpolated to one fifth, calculate the resolution of the instrument. **(Nov 03)**

30. A dc potentiometer is designed to measure up to about 2V with a slide wire of 800 mm. A standard cell of emf 1.18V obtains balance at 600 mm. A test cell is seen to obtain balance at 680mm. The emf of the test cell is_____ **(GATE 04)**

31. A 0-10000 micro ampere microammeter guaranteed to be 8.7 accurate needs to be calibrate using a 1.0 V DC potentiometer. Draw the circuit diagram and find the value of the standard resistance used an d the least count of the potentiometer. **(GATE 97)**

32. The current taken by a small iron core choke coil is measured by a rectangular coordinate AC potentiometer. A 1.0 Ohm non inductive resistance is connected in series with the choke coil. The voltage measured across the resistance and the coil are (0.8 – j0.75) volt and (1.2 + j0.3)V respectively.Assuming sinusoidal voltage and current determine the core loss in the coil. **(GATE 97)**

33. A slide wire potentiometer of 150cm in length has resistance of 150 Ohms, the working battery has an emf of 4.2 V and negligible internal resistance. The galvanometer resistance is 20 Ohms. The standard cell has an emf of 1.018V and internal resistance of 1.5 Ohms. The rheostat in the circuit is adjusted so that the standard cell is in balance with the slide wire contact at 101.8 cm. Find the resistance of the rheostat. **(GATE 97)**

34. Calculate the inductance of a coil from the following measurements on an AC potentiometer. Voltage drop across a 0.3 Ohms standard resistor connected in series with the coil = 0.612ë12°6V voltage **(GATE 97)**

35. The balance is obtained at a length of 60 cm when the emf of standard cell used for standardization is 1.0186 volts. Determine
    i. The emf of the cell which balances at 75cm
    ii. The current flowing through a standard resistance of 2 ohms if the Pd across it balances at 66 cm.
    iii. The voltage of a supply main which is reduced by a volt ratio box to one hundred and balance is obtained at 84 cm. **(GATE 97)**

36. A Crompton's potentiometer consists of a resistance dial having 15 steps of 10 Ohms each and a series connected slide wire of 10 Ohms which is divided into 100 division. If the working current of the potentiometer is 10 mA and each division of slide wire can be read accurately up to 1/5 of its span. Calculate the resolution of the potentiometer in volt. **(GATE 97)**

**UNIT-VI**

**1.a) Derive the balance conditions of wheatstone's bridge.state its limitations.**
**b) explain the measurement of high resistances using loss of charge method. (Dec 2014/Jan 2015)**

Explain kelvin's double bridge method of measuring low resistances.

In a caurey foster's bridge a resistance of 1.0125ohm is compared with standard resistance of 1.0000ohm,the slide wire has a resistance of 0.250ohms in 100 divisions. The ratio arms normally each 10 ohms are actually 10.05 ohm and 9.95 0hm respectively. How far in scale divisions are the balance positions from those which would obtaion the ratio of arms wre to their nominal value ? the slide wire 100cm long. **(JNTU May/june 2013)**

Derive the equation for unknown resistance when kelvin's double bridge is under balance**(JNTU May/june 2012)**

1. Describe with a neat diagram the loss of charge method for determining the insulation resistance of a length of cable. **(JNTU Nov 2010)**
2. In a Carey Fosters Bridge, a resistance of 0.959Ω is compared with a standard resistance of , the slide wire has a resistance of 0.1Ω235Ω in 100 divisions. The ratio arms normally each are actually 10.0310ΩΩ and 9.94Ω respectively. How far (in scale divisions) are the balance positions from those which would obtain if arms ratio were true to their nominal value? The slide wire is 100 cm long **(JNTU Nov 2010)**
3. Explain the loss of charge method for measuring high resistance. Mention the possible errors and suggest methods to minimize these. **(JNTU Nov 2010)**
4. The four arms of a Wheatstone bridge as follows: AB = 200; BC = 20; CD = 4; and DA = 50 the galvanometer has resistance of 150, a sensitivity of 100 mm/_A and is connected across AC. A source of 5 V d.c. is connected across BD. Calculate the current through the galvanometer and its defection if the resistance of arm DA is changed from 200 to 210. **(JNTU Nov 2010)**

1. i. What are the different difficulties encountered in the measurement of high resistances? Explain how these difficulties are overcome?

   ii. A highly sensitive galvanometer can detect a current as low 0.1 nano-Amperes. This galvanometer is used in a wheat-stone bridge as a detector. The resistance of galvanometer is negligible. Each arm of the bridge has a resistance of 1K ohm. The input voltage applied to the bridge is 20V. Calculate the smallest change in resistance, which can be detected. The resistance of the galvanometer can be neglected as compared with the internal resistance of bridge. **(Nov 08)**

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*We do not so much need the help of our friends as the confidence of their help in need.*

\- Epicurus

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2. Explain the following: **(Nov 08, 07)**
   i. Why is Kelvin's double bridge superior to the wheat-stone bridge for the purpose of low resistance measurement?
   ii. How the difficulties associated with the measurement of a very high resistance are over come?
   iii. How the effects of contact resistance and resistance of the connecting leads are eliminated in the measurement of resistance by Kelvin's double bridge?
   iv. Why is the Voltmeter-Ammeter method unsuitable for the precise measurement of the low resistance?

3. i. Explain how insulation resistance of a cable can be measured with a help of loss of charge method?
   ii. The following results were obtained by loss of charge method of testing cable: discharged immediately after charging the deflection = 200 divisions; discharged 30 seconds after charging the deflection = 125 divisions; discharged 30 seconds after charging, when in parallel with a resistance of 10 M ohms, the deflection = 100 divisions. Calculate the insulation resistance of the cable. **(Nov 08)**

4. i. Draw the circuit diagram of a Wheatstone bridge and derive the conditions for balance.
   ii. The four arms of a Wheat shone bridge are as follows: AB = 100$\Omega$; BC = 10$\Omega$; CD = 4$\Omega$; DA = 50$\Omega$. The galvanometer has a resistance of 20$\Omega$ and is connected across BD. A source of 10V d.c. is connected across AC. Find the current through the galvanometer. What should be the resistance in the arm DA for no current through the galvanometer? **(Nov 08)**

5. What are the different problems associated with measurement of low resistances. Explain the principle of working a Kelvin's Double Bridge and explain how the effect of contact resistance and resistance of leads is eliminated? **(Feb 08)**

6. i. Explain the Ammeter-Voltmeter method of measurement of resistances. There are two ways in which the circuit of Ammeter Voltmeter method can be used.
   a. Ammeter connected to the side of unknown resistance and
   b. Voltmeter connected to the side of unknown resistance. Derive a condition, that decides which circuit is to be used for a particular set of Ammeter, Voltmeter and unknown resistance. Assume equal relative error in both the cases.
   ii. In a laboratory a voltmeter of 200 ohm resistances and an ammeter of 0.02 ohm resistance are available. Calculate the value of resistance that can be measured by the Ammeter voltmeter method for which the two different circuit measurements give equal errors. **(Feb 08)**

7. i. Explain the loss of charge method for measurement of insulation resistance of cables.
   ii. A length of cable is tested for insulation resistance by the loss of charge method. An electrostatic voltmeter of infinite resistance is connected between the cable conductor and earth, forming there with a joint capacitance of 600 pF. It is observed that after charging the voltage falls from 250V to 92V in 1 minute. Calculate the insulation resistance of the cable. **(Feb 08)**

8. i. Mention some of the difficulties in measuring of high resistance.
   ii. Derive an expression for insulation resistance of a single core cable. The conductor of a cable has a diameter of 5 mm and the over all diameter of the cable is 35cm. If the insulation resistance of the cable is 16,000ohm/km, calculate the specific resistance of insulating matrial. **(Feb 08)**

9. i. What are the different difficulties encountered in the measurement of high resistances? Explain how these difficulties are overcome.
   ii. Explain in detail the use of guard circuit for measurement of high resistance
   iii. Classify the resistances from the point of view of measurements. **(Feb 08)**

10. Explain the loss of charge method for measuring high resistance. Mention the possible errors and suggest methods to minimize these. **(Nov 07)**

11. Explain what do you mean by low, medium and high resistances? Suggest various suitable methods for measuring them giving justification. Explain any method to measure a low resistance with accuracy? **(Nov 07)**

12. i. Classify the resistances from the point of view of measurements.
 ii. Explain in brief the different methods used for measurement of medium resistances.
 iii. A voltmeter of resistance 500 ohm and a milliammeter of 1ohm resistance are used to measure a resistance byAmmeter-Voltmeter method. If the Voltmeter reads 20V and milli-Ammeter 100 mA, Calculate the value of measured resistance.
 a. If the Voltmeter is put across the resistance and the milli-Ammeter connected in series with the unknown resistance.
 b. If the voltmeter is put across the resistance with ammeter connected on the supply side. **(Nov 07)**

13. i. What are the different factors which affect the precision measurement of medium resistances with wheat stone bridge? Explain how their effects are minimized/eliminated
 ii. A wheat stone bridge is used for measuring the value of change of resistance of a strain gauge which forms one of the arms of the bridge. All the arms of the bridge including the strain guage have a resistance of 100“ each. The maximum allowable power dissipation from the strain gauge is 250 MW. Determine the value of maximum permissible current through the strain gauge and maximum allowable value of bridge supply voltage. Suppose a source of 20V is available, find the value of series resistance to be connected between the source and the bridge to limit the input voltage of the bridge to permissible level. **(Nov 07)**

14. i. Describe with a neat diagram the working of a Carey Foster Slide wire bridge method.
 ii. In a Carey Fosters bridge a resistance of 1.0125 ohms is compared with a standard resistance of 1.0000 ohm, the slide wire has a resistance of 0.250 ohm in 100 divisions. The ratio arms nominally 10ohm each are actually 10.05 ohm and 9.95 ohm respectively. How far (in scale divisions) are the balance positions from those which would obtain of arms ratio were true to their nominal value? The slide wire is 100cm long. **(Feb 07, May 06)**

15. Describe a method by which the insulation resistance to earth of each of a pair of live mains can be measured by a voltmeter of known resistance. Discuss the limitations of the method **(Feb 07)**

16. The following readings were taken with a 250V, 1000ohms per volt, voltmeter Between two mains ) 218 volts Positive main to earth ) 188 volts Negative main to earth ) 10 volts Calculate the insulation resistance of each main. **(Feb 07)**

17. A moving coil galvanometer has a sensitivity of 4 cm per micro ampere, with a scale of 1 metre distant, and the time of free oscillation is 2.8 seconds If the galvanometer is dead beat when the total circuit resistance (coil and external circuit) is 2500 ohms, find the moment of inertia of the moving system. Prove the formula used **(Nov 06)**

18. Describe about the Kelvin double bridge for the comparison of small resistances. Explain the precauctions followed for achieving highest prescision **(Nov 06)**

19. Draw the circuit of Kelvin double bridge used for measurement of low resis tances. Derive the condition for balance. **(Nov 06)**

20. A highly sensitive galvanometer can detect a current as low as 0.1 nA. This galvanometer is used in a whetstone bridge as a detector. The resistance of galvanometer is negligible. Each arm of the bridge has a resistance of 1K. The input voltage applied to the bridge is 20V. Calculate thesmallest change in the resistance which can be detected. **(May 06)**

21. What are the various limitations of whetstone bridge for measurement of high and low resistances. **(Nov 06)**

22. The four arms of a whetstone bridge are as follows. AB = 100W, BC = 1000W, CD = 4000W and DA = 400W. The galvanometer has a resistance of 100W, a sensitivity of 100mm / Micro Amp. And is ohms connected across AC. A source of 4V DC is connected across BD. Calculate th e current through the galvanometer. **(May 03)**

23. Describe any one method of measuring a very high value of resistance. **(May 03)**

24. A lissajous pattern on the oscilloscope is stationary and has 6 vertical maximum values and 5 horizontal maximum values. The frequency of horizontal Input is 1500Hz. Determine the frequency of vertical Input. **(May 03)**

25. How do you classify the resistances from the point of view of measurements. **(May 03)**

26. Describe the method of measurement of medium resistances by wheatstone bridge method derive the conditions for balance. **(May 03)**

27. Describe the construction and principle of operation of a Meggar with a neat sketch? **(May 03)**

28. Explain the construction and operation principle of vibration galvanometer. **(May 03)**

29. A Kelvin Double bridge has each of the ratio arms P = Q = p = q = 1000W. The emf of the battery is 100V and a resistance of 5W is included in the battery circuit. The galvanometer has a resistance of 500W and the resistance of the link connecting the unknown resistance to the standard resistance may be neglected. The bridge is balanced when the standard resistance S = 0.001W.
    i. Determine the value of unknown resistance.
    ii. Determine the current (approximate value) through the unknown resistance R at balance.
    iii. Determine the deflection of the galvanometer when the unknown resistance, R, is changed by 0.1 percent from its value at balance. The galvanometer has a sensitivity of 200mm/mA. **(May 03)**

30. A modified wheatstone bridge n etwork is constituted as follows: AB is resistance P in par allel with resistance p; BC is a resistan ce Q in parallel with a resistance q; CD and DA are resistances R an d S respectively. The nominal values of P, Q and S are each 10W. **(May 03)**

31. Why is wheatstone bridge unsuitable for measurements of very low resistances? **(May 03)**

32. Describe with a neat sketch, the Kelvin's double bridge method of measuring low resistances. How does it overcome the defect of wheatstone bridge? **(May 03)**

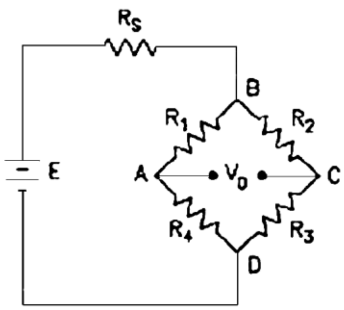
33. Draw the circuit of Kelvin double bridge used for measurement of low resistances. Derive the condition for balance. **(May 02)**

34. A highly sensitive galvanometer can detect a current as low as 0.1nA. This galvanometer is used in a wheat stone bridge as a detector. The resistance of galvanometer is negligible. Each arm of the bridge has a resistance of 1KW. The input voltage applied to the bridge is 20V. Calculate the smallest change in the resistance, which can be detected. **(May 02)**

35. Give the meaning of the following terms:
i. Precision
ii. Accuracy
iii. Standard deviation and
iv. Probable error

Two resistors $R_1$ and $R_2$ are connected in series and then in parallel. The value of resistances are $R_1 = 100.0 \pm 0.1$ □
$R_2 = 50 \pm 0.05$ □ **(IES 94)**
Calculate the uncertainty in the combined resistance for both series and parallel arrangements.

36. A bridge circuit is shown in figure




**(IES 93)**

i. The output signal of the bridge is $V_0$, Looking into this part find an expression for the Thevenin equivalent resistance of the bridge.
ii. If $R_1 = R(1-x)$, $R_4 = R(1+x)$ and $R_2 = R_3$, find an expression for the output voltage $V_0$ in terms of E and x. Take $R_S = 0$ in this case.

37. The resistance of an unknown resistance is determined by wheat stone bridge. The solution for the unknown resistance is stated as,

$$R_4 = \frac{R_1 R_2}{R_3}$$

The limiting value of various resistance are $R_1 = 500+1\%$, $R_2 = 615+1\%$, $R_3 = 100+0.5\%$
Calculate
i. The nominal value of the unknown resistance
ii. Its limiting error in percent
iii. Its limiting error in Ohms **(IES 93)**

38. What are the difficulties associated with measurement of low resistance? Describe how low resistance is measured accurately by Kelvin's double bridge? **(IES 92)**

39. Describe the substitution method of measurement of medium resistance. List the factors on which the accuracy of the method depends. **(T2-Ch14)**

40. Draw the circuit of a wheatstone bridge and derive the condition of balance. **(T2-Ch14)**

41. Explain the loss of charge method for measurements of insulation resistance of cables. **(T2-Ch14)**

**UNIT-VII**

**1.a) derive the bridge balance condition for Hay's bridge.draw the vector diagram under balanced conditions.**

**b) draw circuit diagram of maxwell's bridge and explain the measurement procedure for measuring unknown inductance using this bridge.derive formula used. (Dec 2014/Jan 2015)**

1. Explain the measurement of inductance using
2. I) Maxwell's bridge ii) Hay's bridge
   Explain capacitance measurement using schering bridge.

**(JNTU May/june 2013)**

3. **Draw the maxwell's bridge and derive the expression for the unknown element at balance.**

**With neat sketches,explain the measurement of capacitance using low voltage schering bridge.Also draw the phasor diagram. (JNTU May/june 2012)**

4.

5. . Derive the equations of balance for an Anderson's bridge. Draw the phasor diagram for conditions of under balance. **(JNTU Nov. 2010)**

6.

**7.** 4. In an Anderson's bridge for the measurement of inductance the arm AB consists of an unknown impedance with inductance L and R, a unknown variable resistance in arm BC, fixed resistance of 600 each in arms CD and DA, a unknown variable resistance in arm DE and a capacitor with fixed capacitance of 1_Fin the arm CE. The a.c. supply of 100Hz is connected across A and C and the detector is connected between B&E. If the balance is obtained with a resistance of 400 in the arm DE and a resistance of 800in the arm BC, Calculate the value of R and L. **(JNTU Nov. 2010)**

8. **5.** Draw the circuit diagram of Anderson's bridge. Also derive equations under balance. **(JNTU Nov. 2010)**

9. 6. In an AC bridge arm ab consists pure capacitance of1.5*F*μ, arm bc consists pure resistance of800, arm cd consists an unknown impedance and arm da has a Ω400Ω resistance in parallel with 0.5*F*μcapacitor. Find the R and C (or) L constants of arm cd considering it as a series circuit. The frequency of the bridge is 1000Hz **(JNTU Nov. 2010)**

**10.** 7. Derive the equations for balance in the case of Maxwell's Inductance Capacitance Bridge. Draw the phasor diagram for balance conditions. State the advantages of this bridge. **(JNTU Nov. 2010)**

1. i. State the advantages and disadvantages of Anderson's bridge.
   ii. Draw the phasor diagram for Anderson's bridge under balance conditions.
   iii. A bridge consists of the following:
   Arm ab - a choke coil having a resistance $R_1$ and inductance $L_1$
   Arm bc - a non-inductive resistance $R_3$.
   Arm cd - a mica condenser C4 in series with a non-inductive resistance $R_4$
   Arm da - non-inductive resistance $R_2$.
   When this bridge is fed from a source of 500 Hz, balance is obtained under following conditions. $R_2$=2410Ω; R . 3=750Ω; C . 4=0.35 μF ; R4 = 64.5Ω. The series resistance of capacitor is 0.4Ω. Calculate the resistance and inductance of the choke coil.The supply is connected between a and c and the detector is between b and d. **(Nov 08)**

2. i. Draw the circuit diagram and phasor diagram of Owen's bridge under balance conditions. Derive the equations under balance conditions.
   ii. An owen's bridge is used to measure the properties of a sample of sheet steel at 2KHz. At balance, arm ab is test specimen; arm bc is R3 =100Ω; arm cd is C4 = 0.1 μF. Calculate the effective impedance of the specimen under test conditions. **(Nov 08)**

3. i. Explain the working of Hay's bridge for measurement of inductance with a circuit diagram. Derive the equations for balance and draw the phasor diagram under balanced conditions.
   ii. The four arms of a Hay's bridge are arranged as follows: AB is a coil of unknown impedance; BC is a non-reactive resistor of 100Ω; CD is a nonreactive resistor of 833Ω in series with a standard capacitor of 0.38μF; DA is non-reactive resistor of 16800Ω. If the supply frequency is 50 Hz, determine the inductance and the resistance at the balanced conditions. **(Nov 08)**

4. i. What is the difference between L.V. schering bridge and H.V. schering bridge?
   ii. Draw the circuit diagram of H.V. schering bridge.
   iii. A capacitor bushing forms arm ab of a schering bridge and a standard capacitor of 500 pF capacitance and negligible loss, forms arm ad. Arm bc consists of a noninductive resistance of 300 ohms. When the bridge is balanced arm cd has a resistance of 72.6 ohms in parallel with a capacitance of 0.148 μF. The supply frequency is 50 Hz. Calculate the capacitance and dielectric loss angle of capacitor. Derive the equations for balance and draw the phasor diagram under conditions of balance. **(Nov, Feb 08)**

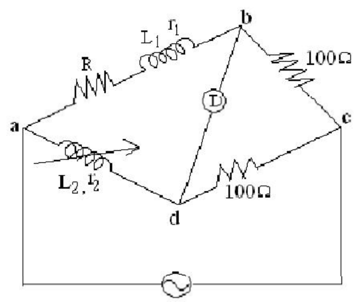
5. i. What are the limitations of L.V. schering bridge?
   ii. Define dissipation factor? Derive the equation for dissipation factor in case of L.V. schering bridge?
   iii. In a Low-voltage schering bridge designed for the measurement of permittivity, the branch ab consists of two electrodes between which the specimen under test may be inserted; arm bc is a non-reactive resistor R3 in parallel with a standard capacitor C3; arm CD is a non-reactive resistor R4 in parallel with a standard capacitor C4; arm da is a standard air capacitor of capacitance C2. Without the specimen between the electrodes, balance is obtained with the following values, C3 = C4 = 120 pF, C2 = 150 PF, R3 = R4= 5000ohms. With the specimen inserted, these values become C3 = 200 PF; C4 = 1000 pF; C2 = 900 pF, and R3 = R4 = 5000ohms In each test w = 5000 rad/sec. Find the relative permittivity of the specimen. **(Feb 08, Nov 07)**

6. i. In a Maxwell's Inductance-Capacitance bridge the dial of variable capacitor can be made to read the value of unknown inductance directly. How is it done?
   ii. Explain why Maxwell's Inductance-Capacitance bridge is useful for measurement of inductance of coils having quality factor between 1 and 10.
   iii. The four arms of a Maxwell's capacitance bridge at balance are: arm ab, an unknown inductance L1, having an inherent resistance R1; arm bc, a noninductive resistance of 1000 ohms. Derive the equation of balance for the bridge and determine the value of R1 and L1. Draw the phasor diagram of the bridge under balance conditions. **(Feb 08)**

*Your goal should be out of reach but not out of sight.*

- Anita DeFrantz

7. i. Draw the circuit diagram of Maxwell's Inductance Capacitance Bridge. Also, draw the phase figure 7 under balance conditions.
   ii. State the advantages and disadvantages of the above bridge.
   iii. A Maxwell's bridge shown in figure.1 has the following constants: Arm ab consists of a coil with inductance L1 and resistance r1 in series with a noninductive resistance R. Arm bc and cd each are a non-inductive resistance of 100ohms. Arm ad consists of standard variable inductor L of resistance 32.7ohms. Balance is obtained when L2 = 47,8mH and R=1/36ohms. Find the resistance and inductance of the coil in arm ab. **(Feb 08)**




8. i. Derive the general equations for balance of an a.c. bridge. Prove that "For balance in an a.c. bridge, both magnitude and phase have to be satisfied unlike a d.c. bridge where in only the magnitude condition is to be satisfied".
   ii. Describe the sources and the null detectors that are used for a.c. bridges. **(Feb 08)**

9. i. Derive the equations for balance in the case of Maxwell's Inductance capacitance bridge. Give its advantages. Draw the phasor diagram for balanced conditions.
   ii. An a.c bridge circuit is working at 1000Hz. Arm ab is 0.2µF pure capacitance, arm bc is a 500ohms pure resistance, arm cd contains an unknown impedance and arm da has a 300ohms resistance in parallel with a 0.1µF capacitor. Find the R and C (or) L constants of arm cd considering it as a series circuit. **(Feb 08, 07)**

10. i. Discuss the advantages and disadvantages of Anderson's bridge.
   ii. The arms of Five node bridge are as follows :
   arm ab : an unknown impedance (R1, L1) in series with a
   non-inductive variable resistor x1
   arm bc : a non inductive resistor R3 = 100ohms
   arm cd : a non inductive resistor R4=200ohms
   arm da : a non inductive resistor R2=250ohms
   arm de : a non inductive variable resistor r
   arm ec : a loss-less capacitor C=1 µF,
   and arm be : a detector An a.c. supply is connected between a and c. Calculate the resistance and inductance R1,L1, when under balanced conditions r1=43.1ohm and r=229.7ohm. **(Feb 08)**

11. Describe the working of Hay's bridge for measurement of inductance. Derive the equations for balance and draw the phasor diagram under conditions of balance. Why is this bridge suited for measurement of Inductance of high Q coils. **(Feb 08, Nov 07, May 06)**

12. Explain the following:
   i. Why is schering bridge particularly suitable for measurement at high voltage?
   ii. Why a spark is connected across resistance arms in a schering bridge?
   iii. Why is vibration galvanometer widely used as detector for operation of A.C. bridges?
   iv. Why is wagner's earthing device used in measurements by A.C. bridges? **(Nov 07)**

13. i. Explain the method of measuring the dielectric loss of the capacitor at high voltage and high frequency. Derive the condition of balance for the bridge. Also, explain the precautions to be taken to ensure accuracy. Draw the phasor diagram under balance conditions.
   ii. In an Anderson bridge for measurement of inductance Lx and Resistance Rx in the arm AB, the arm CD and DA have resistances of 600 ohms each and the arm CE has a capacitor of 1µ F capacitor with A.C. supply at 100 Hz supplied across A and C, balance is obtained with a resistance of 400 ohms in arm DE and 800 ohms in the arm BC. Calculate the value of Lx and Rx. **(Nov 07)**

14. i. In Maxwell's Inductance-capacitance bridge the dial of variable capacitor can be made to read the value of unknown inductance directly? How is it done? **(Nov 07)**
   ii. A Maxwell's inductance capacitance bridge is used to measure an unknown inductance in comparison with capacitance. The various values at balance : are
   R2 of arm ad =400 ohms, R3 of arm bc = 600 ohms, R4 and C4 of arm Cd = 1000 ohms, 0.5 µ Calculate the values of R1 and L1 arm ab calculate also the value of storage factor of coil if requency is 1000Hz.

15. i. What are the different sources of errors in a.c. bridges? Explain the precautions taken and the techniques used for elimination/minimization of these errors.
   ii. Explain the function and working of wagner Earth devices. **(Nov 07)**

16. i. Explain why Maxwell's inductance - capacitance bridge is useful for measurement of coils having storage factor between 1 and 10.
   ii. An ac bridge circuit is working at 1000Hz. Arm ab is 0.2µF pure capacitance, arm bc is a 500ohms pure resistance, arm cd contains an unknown impedance and arm da has a 300 ohms resistance in parallel with a 0.1µF capacitor. Find the R and C (or) L constants of arm cd considering it as a series circuit. **(Nov 07)**

17. i. Discuss advantages and disadvantages of D'Sauty Bridge
   ii. Describe the working of a low voltage schering bridge. Derive the equations for capacitance and dissipation Factor. Draw the phasor diagram of the bridge under balanced conditions. **(Feb 07)**

18. i. What are the different sources of errors in a.c. bridges? Explain the precautions taken and the techniques used for elimination/minimization of these errors.
   ii. Explain the function and working of wagner Earth devices. **(Nov 06)**

19. i. What are the usual errors encountered in a.c. bridges and how are they eliminated
   ii. Explain how capacitance of an imperfect capacitor is measured using A.C. bridge and draw the phasor diagram for the balanced bridge. **(Nov 06)**

20. i. Describe how relative permittivity of a specimen of insulating material can be determined using a schering bridge.
   ii. A sheet of bakelite 4.5mm thick is tested at 50Hz between electrodes 0.12 m in diameter. The schering bridge employs a standard air capacitor C2 of 106 PF capacitance, a non-reactive resistance R4 of 1000/ð ohms in parallel with a variable capacitor C4, and a non-reactive variable resistance R3. Balance is obtained with C4=0.5µF and R2=260". Calculate the power factor,capacitance and relative permittivity of sheet. **(Nov 06)**

21. i. Give advantages and disadvantages of Hays bridge in details
   ii. A bridge consists of arm ab, a choke coil having a resistance R1 and inductance L1. arm bc a non - inductive resistance R3. When this bridge is fed from a source of 500Hz, balance is obtained under following conditions: R2=2410ohms, R3=750ohms, C4=0.35µF, R4=64.5ohms. The series resistance of capacitance is = 0.4". Calculate the resistance and inductance of the choke coil. The supply is connected between a and c and the detector is between b and d. **(Nov 06)**

22. i. Explain wh at is meant by sliding balance. How is this condition avoided by choosing var iables for manipulation of balance i.e. why variables are so chosen that the two equations for balance are independent of each other?
    ii. Why is it preferable in bridge circuits, that the equations for balance are independent of Frequency? Explain. **(May 06, Nov 05)**

23. i. Explain how mutual inductance is measured in terms of self inductance.
    ii. Explain Heaviside mutual inductance bridge with the help of circuit and vector diagrams. Obtain balance equations. **(May 06)**

24. i. Discuss in detail about high voltage schering bridge
    ii. The Four arms of a bridge are : arm ab : an imperfect capacitor C1 with an equivalent series resistance of rarm bc : a non inductive resistance R3 arm cd : a non-inductive resistance R4, arm da : an imperfect capacitor C2 with an equivalent resistance of r2 series with a resistance R2 A supply of 450Hz is given between terminal a and c and the detector is con- nected between b and d. At balance : R2=4.8, R3=2000, R4=2850 and C2=0.5µF and r2=0.4. Calculate the value of C1 and r1 and the dissipating factor. **(May 06)**

25. i. Explain how mutual inductance is measured in terms of self inductance.
    ii. Explain Heaviside mutual inductance bridge with the help of circuit and vector diagrams Obtainbalance equations. **(May 06)**

26. i. Discuss th e advantages and disadvantages of Anderson's bridge. ii. The arms of Five n ode bridge are as follows : arm ab : an unknown impedance (R1, L1) in series with a non-inductivevariable resistor x1 arm bc : a non inductive resistor R3 = 100A arm cd : a non inductive resistor R4=200A arm da : a non inductive resistor R2=250 arm de : a non inductive variable resistorarm ec : a loss-less capacitor C=1 µF, and arm be : a detector An a.c. supply is connected between a and c. Cal- culate the resistance and inductance R1,L1, when under balanced conditions r1=43.1and r=229.7. **(May 05)**

27. i. Give advantages and disadvantages ofMaxwell's Inductance capacitance bridge
    ii. The four arms of a Maxwell's capacitance bridge at balance are : arm ab, an unknown inductance L1, having a resistance R1, arm bc, a non-inductive resistance of 1000 , arm cd, a capactitor of 0.5µF in parallel with a resistance of 1000, arm da, a resitance of 1000. Find the inductance L1 of arm ab. **(May 05)**

28. i. Derive the equations for balance in the case of Maxwells inductance bridge for the measurement of self Inductance
    ii. Arm ab consists of a coil with inductance L1 and resistance r1 in series with a non inductive resistance R. Arm bc and ad are each a non-inductive resistance of 100. Arm ad consists of standard variable inductor L of resistance 32.7. Balance is obtained when L2=47.8mH and r=1.36. Find the resistance and inductance of the coil in arm ab. **(May 05)**

29. i. Explain wh at is meant by sliding balance. How is this condition avoided by choosing var iables for manipulation of balance i.e. why variables are so chosen that the two equations for balance are independent of each other?
    ii. Why is it preferable in bridge circuits, that the equations for balance are independent of frequency? Explain. **(May 05)**

30. The four arms of a bridge are:
Arm ab: an imperfect capacitor $C_1$ with an equivalent series resistance of $r_1$
Arm bc: a non-inductive resistance $R_3$ cd: a non-inductive resistance $R_4$
Arm da: an imperfect capacitor $C_2$ with an equivalent resistance of $r_2$ in series with a resistance $R_2$. A supply of 450 Hz is given between terminal a and c and the detector is connected between b and d. At balance:
$R_2$ = 4.8Wm, $R_3$ = 2000W, $R_4$ = 2850W and $C_2$ = 0.5mF and $r_2$ = 0.4W.
Calculate the value $C_1$ and $r_1$ and also of the dissipating factor for this capacitor. **(May 04)**

31. i. Derive the equations of balance for an Anderson's bridge. Draw the phasor diagram for conditions under balance. Discuss advantages and disadvantages of the bridge.
ii. In an Anderson bridge for the measurement of inductance the arm AB consists of an unknown impedance with inductance L and R, a known variable resistance in arm BC, fixed resistance of 600W each in arms CD and DA, a known variable resistance in arm DE and a capacitor with a fixed capacitance of 1mF in the arm CE. The AC supply of 100Hz is connected across A and C and the detector is connected between B and E. If the balance is obtained with a resistance of 400W in the arm DE and a resistance of 800W in the arm BC calculate the values of unknown R and L. **(May 03)**

32. i. Explain the difference between balance conditions for DC and AC bridges.
ii. An AC bridge circuit working at 1000Hz, have its arms as follows Arm AB is 0.2 Micro Farad capacitance. Arm BC is a 500 ohms resistance; arm CD contains an unknown impedance and arm DA has a 300resistance in parallel with a 0.1 Micro Farad capacitor. Find the R and L or C constants of arm CD considering it as a series circuit. **(May 03)**

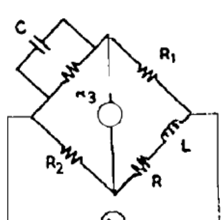
33. The four arms of Maxwell's capacitance bridge at balance are: arm ab, an unknown inductance $L_1$, having an inherent resistance $R_1$; arm bc, a non-inductive resistance of 1000W; arm cd, a capacitor of 0.5mF in parallel with a resistance of 1000W; arm da, resistance of 1000W.
Derive the equations of balance for the bridge and determine the value of $R_1$ and $L_1$. Draw the phasor diagram of the bridge. **(May 03)**

34. i. Describe how an unknown capacitance can be measured with the help of D'Sauty's bridge. What are the limitations of this bridge? **(May 02)**

35. Describe the working of a low voltage Schering bridge. Derive the Equations for capacitance and dissipation factor. **(May 01)**

36. A reading of 120 is obtained when a standard inductor was connected in the circuit of a Q - meter and the variable capacitor is adjusted to a value of 300 pF. A lossless capacitor of unknown vlaue Cx is then connected in parallel with the variable cpacitor and the same reading was obtained when the variable capacitor is readjusted to a value of 200 pF. The value of Cx in pF is _______ **(GATE 03)**

37. Figure Shows a bridge for measuring the resistance and inductance of a choke.



i. Write down the condition for bridge balance and obtain expressions for R and L
ii. If the resistors $R_1$, $R_2$ and $R_3$ can have a variation of ±0.2% and C a variation of ±0.1% from their nominal values, estimate the percentage error in the evaluation of R and L. **(GATE 91)**

38. In a Hay bridge, the four arms are $R_1 - L_1$, $R_2$, $R_3 - C_3$ $R_4$ connected in clockwise order. Show that, under the 'phase-null' condition, Q of the coil is given by

$$Q = \frac{\text{Voltage across } C_3}{\text{Voltage across } R_3}$$ **(IES 02)**

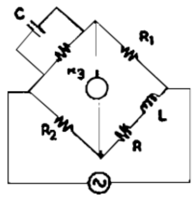
39. The items in Group I represent the various types of measurements to be made with a reasonable accuracy using a suitable bridge. The items in Group II represent the various bidges availabel for this purpose. Select the correct choice of the item in Group II for the correspinding item in group I from the folowing
Group I
Group II
P Resistance in the m Ohm range .
1. Wheat stone bridge.
Q. Low values of capacitance
2. Kelvin double bridge
R. Comparison of resistnaces which are
3. Schering Bridge.
nearly equal
4. Weins bridge.
S. Inductance oa coil with a large time-constant
5. Hay's bridge
6. Carey-Foster Bridge

40. How can frequency can be determine using a bridge? Draw this bridge and derive condition for balance. Why and how are two resistances and capacitances made equal? **(IES 01)**

41. What is Wein-bridge? What are it uses? Show how variable frequency oscillator can be built using an operational amplifier with bridge. Derive an expression for frequency of oscillation of the circuit. **(IES 99)**

42. List the factors that may load to inaccuracies in measurement by AC bridges.
The four arms of a bridge are:
Arm ab :
an imperfect capacitor $C_1$ with an equivalent series resistance of $r_2$
Arm bc :
a non inductive resistance $R_3$
Arm cd :
a non inductive resistance $R_4$
Arm da :
an imperfect capacitor $C_2$ with an equivalent resistance $r_2$ in series with a resistance $R_2$.
A supply of 450 Hz is given between terminals a and c and a detector is connected between b and d. At balance $R_2$ = 5 ohms, $R_3$ = 2000 ohms, $R_4$ = 29050 ohms, $C_2$ = 0.5mF and $r_2$ = 0.4 ohm. Calculate the values of $C_1$ and $r_1$ and also the dissipating factor for this capacitor. Derive the relations used. If any. **(IES 95)**

43. Figure shows a schering bridge circuit used for measuring the power loss in the dielectrics. The specimens are in the form of discs 0.3 cm thick and have a dielectric constant of 2.3. The area of each electrode 314 $cm^2$ and the loss angle is 9' for a frequency of 50 Hz. $e_0$ = 8.855 x $10^{-12}$ F/m. The fixed resistors of the network has a value of 1000 Ohm and the fixed capacitance is 50mF. Find the values of variable resistor and capacitor required at balance. Derive the expression used, if any.




**(IES 94)**

44. Explain with help of circuit diagram, the principle of working of a Q-meter. **(IES 94)**

45. How can frequency be determined using a bridge? Draw this bridge and derive condition for balance. Why and how are two resistances and capacitances made equal? **(IES 94)**

46. The arms of an Anderson's bridge are as follows:
Arm AB :
An unknown impedance ($R_1$, $L_1$) in series with a non – inductive resistor $R_1$
Arm BC :
A non inductive resistor $R_3$ = 100W
Arm CD :
A non inductive resistor $R_4$ = 150W
Arm DA :
A non inductive resistor $R_2$ = 200W
Arm DE ;
A variable non inductive resistor r
Arm EC :
A loss less capacitor C = 1mF
AC supply is connected across A and C, and the detector is connected between B and E. Deduce conditions of balance and calculate $R_1$ and $L_1$ under balance conditions when $r_1$ = 40W and r = 220 **(IES 93)**

47. Describe the Wien-bridge method for measuring unknown frequencies in the audio range. What are the other applications of this bridge? **(IES 93)**

48. An a.c. bridge ABCD has the following four arms taken in sequence:
Arm AB :
A capacitance with series loss effect resistance R in seies with the primary of a mutual inductance M.
Arm BC :
Resistance $R_2$
Arm CD :
Resistance $R_3$
Arm DA :
Loss – less capacitance $C_A$
The primary of mutual inductance has self-inductance L and negligible resistance. The secondary of mutual inductance is connected in series with detector across BD. The source of angular frequency w is connected across AC. Determine the capacitance C and associated loss angles if the bridge is balance with w = $10^3$, M = 0.0015 H, $R_2 = R_{3=10}{}^4$□, L = 0.0045 H and $C_4$ = $0.15^{.00}$F, derive the balance conditions and there from the expressions used. Comment on the source of error in measurement. **(IES 92)**

*Like all weak men he laid an exaggerated stress on not changing one's mind.*
- W. Somerset Maugham, "Of Human Bondage", 1915

**UNIT-VIII**

**1. Explain the construction and working of ballistic galvanometer with neat diagram. (Dec 2014/Jan 2015)**

**1.a) Describe a method of experimental determination of the flux densityin a specimen of magnetic material using ballistic galvanometer.explain how the correction of flux in the air space between and the coil is applied.**

**b) compare flux meter with ballistic galvanometer. (JNTU May/june 2013)**

**derive an expression for equation of motion of a ballistic galvanometer.**

**A fux meter is connected to a search coil having 400 turns and a mean area of 450 $mm^2$.the search coil is placed at the center of a solenoid 1 meter long,wound with 900 turns when a current of 6A is reversed, there is a deflection of 25 scale divisions.calculate the flux linkages per scale division. (JNTU May/june 2012)**

. The cores of two identical transformers A and B carry alternating fluxes whose instantaneous values are (0.01 sin 314t)W and 0.012 (1.1 sin 628t+0.1 sin 1884t) W respectively. Find the ratio of eddy current loss of B to A. Find also the ratio of hysteresis loss of B to A. **(JNTU Nov. 2010)**

4. Explain the constructional details of the following:

(a) Ballistic galvanometer.

(b) Flux meter. **(JNTU Nov. 2010)**

5. What are the differences between Flux meter and Ballistic galvanometer? **(JNTU Nov. 2010)**

6. The coil of ballistic galvanometer has 115 turns of mean area 25 _ 40mm2. The flux density in the air gap is 0.12Wb/m2 and the moment of inertia is 0.5 _10□6 Kg-m2.The stiffness constant of spring is 45 _ 10□6 Nm/rad. What current must be passed to give a deflection of 1000 and what resistance must be added in series with the movement to give critical damping **(JNTU Nov. 2010)**

1. Explain the construction and working principle of a ballistic galvanometer with a neat sketch. **(Nov 08)**

2. i. What is ballistic galvanometer? What are its special features?
   ii. Explain the theory and working principle of ballistic galvanometer? **(Nov 08)**

3. Explain the construction and working principle of flux meter with a neat diagram. **( Nov 08, 07)**

4. i. Explain the theory of flux meter with a neat sketch.
   ii. A flux density =0.05 $W/m^2$; turns on moving coil=40; area of moving coil=750 $mm^2$ If the flux linking with a 10 turn search coil of 20 $mm^2$ area connected to the flux meter is reversed in a uniform field of 0.5 $W/m^2$, calculate the deflection of the flux meter. **(Nov 08)**

5. Explain the following:
   i. Why are magnetic measurements more in accurate than other types of measurements?
   ii. Why is a ballistic galvanometer usually light damped?
   iii. How does a flux meter differ from ballistic galvanometer?
   iv. Flux measurement with flux meter. **(Feb 08)**

6. i. Why are ring specimens preferred over rods or strips for magnetic testing?
   ii. Explain with the help of a neat diagram, a method for the determination of B-H curve of a magnetic sample. Point out the various sources of errors and the methods of minimizing them? **(Feb 08, Nov 07)**

7. i. Compare the relative merits of Ballistic galvanometer and flux meter as means of making magnetic measurements.
   ii. A flux meter is connected to a search coil having 1000 turns and a mean area of 4 cm2. The search coil is placed at the center of a solenoid 1.2 meters long wound with 1200 turns. When a current of 5A is reversed, there is a deflection of 25 scale divisions on the flux meter. Determine the flux meter constant. **(Feb 08)**

8. i. Describe briefly the different types of tests that are used for testing of magnetic materials.
   ii. Explain the principle of operation of Ballistic galvanometer with neat circuit diagram? **(Feb 08)**

9. i. What are the differences between flux meter and Ballistic galvanometer?
   ii. The coil of a ballistic galvanometer has 115 turns of mean area $25 \times 10$ $mm^2$. The flux density in the air gap is 0.12 $W/m^2$ and the moment of Inertia is 0.5×10-6 kg-m2. The stiffness constant of springs is $45 \times 10^{-6}$ Nm/rad. What current must be passed to give a deflection of 1000 and what resistance must be added in series with the movement to give critical damping? **(Feb 08, Nov 07)**

10. i. Give advantages of Burrow's permeameter with respect to others.
    ii. A ring having a mean diameter of 0.3m and a cross-sectional area 400mm 2 has a primary winding of 80 turns wound uniformly. The secondary winding of 30 turns is connected to a fluxmeter having a constant of 0.12x10-3 weber turn per division. A deflection of 46 divisions is observed when a current of 2A is reversed in the primary winding. Calculate the relative permeability of iron. **(Feb 08, 07)**

11. Describe a method of experimental determination of flux density in a specimen of magnetic material using a ballistic glavanometer **(Feb 08, 07, Nov 07)**

12. i. Derive an expression for equation of motion of a ballistic galvanometer?
    ii. A flux meter is connected to a search coil having 500 turns and a mean area of 500 $mm^2$. The search coil is placed at the center of a solenoid 1 metre long, wound with 800 turns. When a current of 5A is reversed, there is a deflection of 25 scale divisions. Calculate the flux linkages per scale division. **(Nov 07)**

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*Happiness is when what you think, what you say, and what you do are in harmony.*

- Mahatma Gandhi

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13. Explain the methods of seperation of iron losses into their two components: eddy current and hysteresis losses. If the maximum value of flux density is maintained constant and
    i. frequency is varied keeping the form factor constant.
    ii. form factor is varied keeping the frequency constant. **(Nov 07)**

14. Explain the methods of seperation of iron losses into their two components: eddy current and hysteresis losses. **(Feb 07)**

15. i. Explain in detail about Ewing double bar permeameter.
    ii. Explain in detail about Fahy's simplex p. **(Feb 07)**

16. Describe a method of experimental determination of flux density in a specimen of magnetic material using a ballistic glavanometer **(Nov 06, May 06)**

17. i. Explain in detail how measurement of leakage factor can be done using flux meter?
    ii. In loss tests on a sample of iron laminations the following results were recorded:
    a. 60hz,250v total iron loss=200w b. 40hz,100v, total iron loss=40w.
    Calculate the eddy current and hysteresis loss for each test. The Stienmetzindex is 1.6. **(Nov 06)**

18. i. Explain in detail about Ewing double bar permeameter.
    ii. Explain in detail about Fahy's simplex permeameter. **(Nov 06)**

19. i. Explain with neat diagram the principle of operation of a grassot flux meter.
    ii. How is the range of meter extended? What are its applications? **(May 06)**

20. i. The iron loss in a sample is 300W at 50Hz. with eddy current loss component 5 times as big as the hysteresis loss component. At what frequency will the iron loss be double if the flux density is kept the same.
    ii. Briefly explain about iron loss curves. **(May 06)**

21. i. Explain with neat diagram the principle of operation of a grassot flux meter.
    ii. How is the range of meter extended? What are its applications? **(May 05)**

22. Describe the Lloyd Fisher square for measurement of Iron losses in a specimen of laminations. Describe how correction for resistance of wattmeter pressure coil and resistance of secondary winding are applied. How is the true value of flux density obtained in the laminations determined? **(May 05)**

23. i. Describe briefly the different types of tests that are used for testing of magnetic materials.
    ii. Explain the principle of operation of Ballistic galvanometer with neat circuit diagram? **(Nov 05)**

24. A ballistic galvanometer gives a first swing of $60^o$ for a discharge of 1000mc. Find the quantity of electricity to produce
    i. A swing of $90^o$ in the instrument
    ii. A spot deflection of 20mm on a scale 1 m away. **(May 04)**

25. i. Describe with a diagram a method of getting the relative permeability of the bar specimen using a flux meter.
    ii. In a test on a specimen of total weight 13Kg the measured values of iron loss at a given value of flux density wer e 17.2 watts at 40 Hz and 28.9 watts at 60w. Estimate the values of hysterisis and eddy current losses at 50 Hz for the same value of peak flux density. **(May 04)**

26. i. Describe the step by step method of getting B-H curve of a ring specimen using ballistic galvanometer?
ii. An iron ring has a mean diameter of 0.15m and a cross sectional area of 34.5 sq.mm. It is wound with a magnetizing winding of 330 turns and a secondary winding of 220 turns. On reversing a current of 12 Amps in the magnetizing winding a ballistic galvanometer gives a throw of 272 scale division. With a HMS with 10 turns and flux of 0.00025wb. gives a reading of 102 scale division. Other conditions remaining the same find the relative permeability of the specimen. **(May 04)**

27. Explain with suitable diagram the working of Ballistic galvanometer in the magnetic measurement. Show that the instrument is proportional to the total charge. **(May 03)**

28. i. With a suitable diagram explain the working of ballistic galvanometer.
ii. Show that by using flux meter the leakage factor can be measured in the specimen. **(May 03)**

29. i. Describe the method of obtaining hysterisis loop of a ring specimen using flux meter.
ii. The mutual inductance between magnetizing winding and a search coil wound on a specimen is 9mH. The search coil has 20 turns and the specimen has a cross sectional area of 5000Sq.mm r eversal of current of 3 amps in magnetizing winding produces galvanometer through of 60 divisions. Calculate the value of the flux density in the specimen if the reversal of curr ent in the magnetizing winding produces a galvanometer deflection of 3 divisions. **(May 03)**

30. Write a short notes on the following:
i. Loss of energy due to hysteresis
ii. Measurement of permeability **(Nov 03)**

31. i. Describe the construction and working of a moving coil ballistic galvanometer.
ii. Describe the method of experimental measurement of flux density in a specimen of magnetic material using ballistic galvanometer. **(May 02)**

32. Write the short notes on the following:
i. Shunted flux meter
ii. Hibberts Magnetic standard and its applications. **(May 02)**

33. Briefly explain the following instruments:
i. Lloyd Fisher square ii. Flux meter
iii. PF Meter iv. Megger **(May 02)**

34. Describe the method of reversal used for the determination of B-H loop of a sample material. State the advantages of this method over step by step method. How do you calculate hysterisis loss in this specimen. **(May 01)**

35. Discuss the construction and working principle of a flux meter. **(May 01)**

36. Explain th e principle of electrostatic focusing of electron beam in a CRO. Calculate the maximum velocity of the beam of electrons in CRT having a cathode anode voltage of 1000 V. Assume the electrons to live the cathode with zero velocity. Charge of electron = $1.6 \times 10^{-19}$C; and mass of electron = $9.1 \times 10^{-31}$ Kg. **(IES 95)**

37. Explain with the help of functional block diagram, the principle of working of an X-Y recorder. **(IES 92)**

38. Describe a method of experimental determination of flux density in a specimen of magnetic material using a ballistic galvanometer. Explain how the correction for flux in the air space between the specimen and the coil is applied. **(T2-Ch18)**

*There are men who would quickly love each other if once they were speak to each other; for when they spoke they would discover that their souls had only separated by phantoms and delusions.* - Ernest Hello

39. Explain how the value of AC permeability of magnetic materials is determined through the use of
   i. Maxwell's Bridge
   ii. Campbell's Bridge. **(T2-Ch18)**

40. Describe briefly the different types of tests that are used for testing of magnetic materials. **(T2-Ch18)**

41. Describe how magnetizing and loss components of no load current of a transformer to determined by using an AC potentiometer. **(T2-Ch18)**

42. A solenoid 30 cm long of radius 2 cm is wound uniformly with 4,500 turns of wire. A current of 2A flows through the coil.
   i. What is the solenoid current density?
   ii. What is the value of B on the axis at the center?
   iii. What is the value of B on the axis at the end?
   iv. What is the flux through one end?
   v. What is the flux at the middle?

   Derive any formula used. **(T2-Ch18)**

43. The discharge of a capacitor through a ballistic galvanometer produces a frequency of oscillations 0.125 hz and successive maximum deflections of 12,9.6 and 7.68 cm. Determine the value of the logarithmic decrement. Derive any formulae used. **(T2-Ch18)**

44. The coil of a ballistic galvanometer has 115 turns of mean area 2.5 x 4 $cm^2$. The flux density in the air gap is 0.12 $Wb/m^2$ and the moment of inertia is 5 x $10^{-7}$ $kg.cm^2$. The stiffness is 4.5 x $10^{-5}$ N-m per radian. What current must be passed to give a deflection of 100° and what resistance must be added in series with the movement to give critical damping? **(T2-Ch18)**

45. A ballistic galvanometer, connected to a search coil for measuring flux density in a core, gives a throw of 100 scale divisions on reversal of flux. The galvanometer coil has a resistance of 180 Ohms. The galvanometer constant has 100 mC per scale division. The search coil has an area of 50 $cm^2$ with 100 turns having a resistance of 20 Ohms Calculate the flux density in the core. **(T2-Ch18)**

46. An iron ring specimen of 4 $cm^2$ cross section area and a mean length of 1.0 m is wound with 200 turns. A secondary coil of 100 turns is wound over and connected to a Ballistic galvanometer for measurement of permeability of the specimen. The Ballistic galvanometer gives a throw of 100 scale divisions on current reversal of 5A in the coil. Calculate the permeability. Assume galvanometer constant = 1mC/division and resistance of measuring circuit = 1,000 Ohms. **(T2-Ch18)**

47. A ballistic galvanometer of resistance 2,500 Ohms gives a throw of 75 division when the flux through the search coil to which it is connected, is reversed. If the flux density is 0.1T, the search coil has 1400 turns, a mean area of 55 $cm^2$ and a resistance of 200 Ohms Calculate the galvanometer constant in terms of coulombs per scale division. **(T2-Ch18)**

48. A ballistic galvanometer having a circuit resistance of 5,000 Ohms and a constant of 0.1 mC per scale division is connected in turn with a coil of 2 turns wound round a field coil of a DC machine and then to the coil of 3 turns placed on the armature surface to embrace the total flux entering the armature, when the normal field current is broken the galvanometer readings are 113 and 136 scale divisions. Calculate the flux per pole and leakage factor. **(T2-Ch18)**

49. A ballistic galvanometer gives a first maximum deflection of 60° for a discharge of 100 mC. Find the quantity of the electricity which when discharged through this galvanometer gives rise to a spot deflection of 10 divisions on a millimeter circular scale 1.0 meter away. **(T2-Ch18)**

50. A flux meter is connected to a search of coil having 1,000 turns and a mean area of 4 $cm^2$. The search coil is placed at the center of a solenoid 1.2 meters long wound with 1200 turns. When a current of 5A is reversed, there is a deflection of 25 scale divisions on the flux meter. Determine the flux meter constant. **(T2-Ch18)**

51. A long solenoid 1.0 m long uniformly wound with 2500 turns has a search coil of 50 turns andsectional area of $3 \times 10^{-4}$ $m^2$ at its center. Reversal of current of 2A in the solenoid causes a displacement of 10 scale divisions in a ballistic galvanometer connected to the search coil. Calculate the galvanometer constant in Wb-turn division. **(T2-Ch18)**