JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
[A GOVERNMENT AUTONOMOUS COLLEGE]
JGEC/B.TECH/EE/PE-EE601(d)/2023-24
2024

RENEWABLE & NON-CONVENTIONAL ENERGY

Times: 3 Hours

Full Marks: 70

The figures in the margin indicate full marks.
Candidates are instructed to write the answers in their own words as far as practicable.

GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer *all* questions 5x2=10

1. Explain the advantages of MHD generating system. 2
2. How collector coating can be used to improve the performance of a collector? 2
3. What is the source of tidal energy? What is the minimum tidal range required for a practical tidal plant? 2
4. Explain the mechanism of production of local wind. 2
5. What do you understand by energy farming? 2

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any *FIVE* questions 12x5=60

6.a) What is energy? How can the energy resources be classified? 1+5
b) What are conventional and non-conventional energy sources? . Distinguish between renewable and non-renewable energy sources. 3+3

7.a) Discuss with diagram the extraterrestrial and terrestrial radiation. 4
b) Explain the effect of variation of insolation and temperature in solar cell. 4
c) Discuss the effect of shadowing of solar cell. 4

8.a) Draw the diagram of solar pond electric power plant and explain the function of each component. 6
b) Classify different types of solar thermal collector and show the constructional details of a flat plate collector. 6

9.a) What are the most favourable sites for installing of a wind turbine ? 2
b) Explain major application of wind power. 3
c) Sketch the diagram of a VAWT and explain the functions of its main components. 7

10.a) Compare with diagram the relative performance of a floating drum and fixed dome type biogas plant. 9
b) Explain with the block diagram the production of ethanol in sugarcane industry . 3

11.a) Draw the schematic diagram of binary fluid hydrothermal system and explain its working. 6
b) What do you understand by geothermal energy? What are merits and demerits of geothermal energy. 2+4

12.a) Discuss the technologies available for OTEC. 6
b) Explain in brief the wave energy technology. 6

13.a) Describe the classification of the fuel cell. 5
b) Describe " Alkaline Fuel cells" along with chemical reaction involved. 7

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JGEC/B.TECH/ EE/ OS-CS(EE)601/ 2023-24
2024
Data Structure and Algorithms

Full Marks: 70 Times: 3 Hours

The figures in the margin indicate full marks.
Candidates are instructed to write the answers in their own words as far as practicable.

GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer ***all*** questions 5x2=10

1. Define and classify data structure with suitable examples. [2]
2. What is ADT? [2]
3. Define Tree data structure. [2]
4. What do you mean by static and dynamic queue? [2]
5. Define linked list with suitable diagram. [2]

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any ***four*** questions 4x15 = 60

6. i. What is Asymptotic notation? Explain the utility of Asymptotic notation in Data structure. [1+3]
   ii. Prove all log functions growth in same fashion in terms of Big-O. [4]
   iii. Write an algorithm of matrix addition. Derive its time complexity function and then determine its Big-O. [5]
   iv. What are the limitations of binary search algorithm? [2]

7. i. How are two dimensional arrays stored in physical world? In an array of integers of dimension 5X3, whose base address is 2000, figure out the location of the integer in 2nd row and 3rd column if the array is stored in **row-major** order. [Assume integer = 4Bytes] [2+2]
   ii. Implement the insertion sort algorithms. Sort the following elements in ascending order using insertion sort algorithm : [5+3]
   75, 13, 66, 5, 99, 86, 3, 17, 78
   iii. Write linear search algorithm. [3]

8. i. What are the advantages and disadvantages of linked list over array? [5]
   ii. Write an algorithm to display all elements in linked list. [5]
   iii. Implement push and pop operation of a stack. [5]

9. i. Define linear queue with suitable diagram. [3]
   ii. Implement insertion and display operations of linear queue. [6]
   iii. Write Binary Search algorithm and derive its time complexity. [6]

10. i. Draw the stack data structure in each case when the following operations are performed on an empty stack: [6]
    (a) Push A, B, C, D, E, F (b) Pop two items (c) Push G, H (d) Pop four items (e) Push K
    ii. What is Binary Search Tree? Construct a Binary Search Tree with following items into an empty tree: [6]
    3,2,10,7,13,1,4,9,0,8
    iii. Write a recursive algorithm for generating first N Fibonacci numbers where the value of N is given by the user. [3]

11. i. Explain the insertion operations of array data structure with suitable diagrams. Derive best and worst case time complexity of insertion operation of array data structure. [6]
ii. Write Bubble sort algorithm and discuss its time complexity. [6]
iii. Define overflow and underflow situation of any data structure. [3]

12. **Write short notes on the following topics:(Answer any three)** [3X5]=15
i. Asymptotic notation.
ii. Define linear and nonlinear data structure with suitable examples.
iii. Explain the creation operation of dynamic linked list.
iv. Define Big O, Big omega and Theta notation with suitable expressions and diagrams.

$f_{rn}(n)$

JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
[A GOVERNMENT AUTONOMOUS COLLEGE]
JGEC/B.TECH/EE/PC-EE602/2023-24
2024
Power System II

Full Marks: 70 Times: 3 Hours

The figures in the margin indicate full marks.
Candidates are instructed to write the answers in their own words as far as practicable.

GROUP- A
[OBJECTIVE TYPE QUESTIONS]

Answer *all* questions 5×2=10

1. Explain the necessities of fault studies. 2
2. In a three-phase system the phase currents are: I_a= 0.4 + j0.3, I_b= - 0.1 –j0.3, I_c= -0.6 + j 0.3. Calculate the sequence currents. 2
3. What are the objectives of Automatic Generation Control (AGC)? 2
4. In a power system there are 4 buses. Bus no. 2 is slack bus, bus no. 4 is voltage-controlled bus and bus no. 1 & 3 are load buses. For Newton-Raphson load flow using voltage in polar coordinate, what are the elements in mismatch vector and Correction vector-show in matrix form? Explain with justification. 2
5. Derive the expression of Jacobean element $\frac{\partial Q_i}{\partial |V_i|}$ and comment on sign of the partial derivative. 2

GROUP- B
[LONG ANSWER TYPE QUESTIONS]

Answer any *four* questions 4×15=60

6. a Starting from first principle, derive the equation for net real and reactive power injection at a bus as functions of real part and imaginary part of bus voltages. 3
   b Classify the buses for load flow study. Briefly explain the reasons behind the classification. 1+3
   c For a power system, the line data is as shown in Table 1. Form Y_{Bus} for this power system. 4

Table 1: Line Data

From bus	To bus	R (p.u)	X (p.u)	B/2 (p.u)
1	2	0.02	0.06	0.04
1	3	0.06	0.12	0.03
2	3	0.04	0.16	0.02
2	4	0.04	0.16	0.02
3	4	0.01	0.04	0.01

   d In a power system two buses (bus 1 and 2) are connected by a line having series impedance $0.1 + j0.3$ pu and half line charging susceptance =0.05 pu. The voltage of bus 1 and 2 are $V_1 = 1.01\angle 2^0$ and $V_2 = 0.98\angle -1^0$ pu. Calculate (a) complex power flow through line from bus 1 to bus 2 at bus 1 end, and (b) real & reactive loss in the line. 4

7. a Explain why for phase fault protection we use inverse type of over current relay, whereas for earth fault protection we use instantaneous overcurrent relay? 3
   b List different desirable attributes of protection system, and briefly describe any three among them. 4
   c Draw neatly the different parts of a typical SF_6 circuit breaker. Briefly explain its working principle. List the advantages and disadvantages of this breaker. 6
   d Distinguish between a circuit breaker and an isolator. 2

8. a Explain-how convergence is checked in case of Newton-Raphson load flow? 2
   b Explain why and how Y_{Bus} for balanced 3 phase fault study differs from Y_{Bus} for load flow study of same network. 2

c Explain why the natures of shunt admittances at the two sides of a transformer (having off-nominal tap setting) are of different nature: - one capacitive and another inductive depending upon tap position (a>1 or a<1). 3

d For a two-bus system, load flow is to be carried out whose bus data is given in the attached Table. The elements of Y_{bus} for this system are $Y_{11} = Y_{22} = 1 - j2.95$ pu and $Y_{12} = Y_{21} = -1 + j3$ pu. Base MVA is 100. 8

Bus data					
Bus	Generation		Load		Voltage
no	MW	MVAr	MW	MVAr	Magnitude(pu)
1	?	?	10.0	5.0	1.01
2	0	0	60.0	35.0	?

Comment on bus type with justification. Solve for load flow using Newton-Raphson method or 1 (one) iteration.

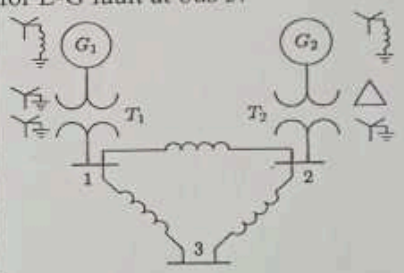
9 a Explain why zero sequence impedance of a 3-phase generator is lesser than positive or negative sequence impedance of it? 3

b Explain why for fault at generator terminal, a single line to ground fault may be more severe than three phase fault? 3

c For a big power system network, how can we calculate $Z_{Thevenin}$ at a bus where unsymmetrical fault has occurred? 3

d The one-line diagram of a simple power system is shown in the figure below. The neutral of generator 1 and generator 2 are grounded through current-limiting reactor of 0.03 and 0.02 per unit on a 100-MVA base respectively. The system data expressed in per unit on a common 100-MVA base is tabulated below. Draw positive and zero sequence networks for this power system. Determine positive and zero sequence Thevenin's impedance for L-G fault at bus 3. 6

Item	Base MVA	Voltage Rating	X^1	X^0
G_1	100	20kV	0.12	0.05
G_2	100	20kV	0.10	0.04
T_1	100	20/220kV	0.10	0.10
T_2	100	20/220kV	0.10	0.10
L_{12}	100	220kV	0.15	0.30
L_{13}	100	220kV	0.15	0.35
L_{23}	100	220kV	0.20	0.50

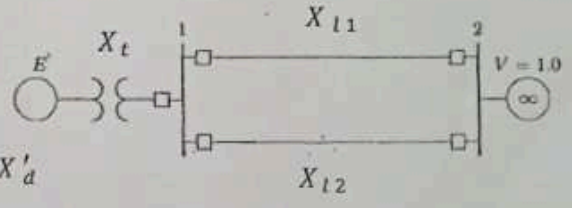


10 a Explain the necessities of stability studies of synchronous machine in a power system. 2

b A synchronous generator is connected to infinite bus. Suddenly a step increase in mechanical power input occurs. Explain the swing phenomenon (i.e. variation in acceleration, rotor speed and power angle with time) and also explain the condition for the stability. 4

c Explain any three important measures to show its contribution in improving transient stability of synchronous machine. 4

d A 50-Hz synchronous generator having inertia constant H = 6.5 MJ/MVA and a transient reactance X'_d is connected to an infinite bus through a purely reactive circuit as shown in figure. Reactances are $X'_d = 0.15$, $X_t = 0.1$, $X_{l1} = X_{l2} = 0.4$ p.u. on a common system base. 5



The generator is delivering real power of 1.6 per unit at 0.8 power factor lagging to the infinite bus at a voltage of V = 1 per unit. A three-phase fault occurs at the middle of one of the lines with zero fault impedance ($Z_F = 0$). The fault is sensed, and the faulted line is isolated. Determine the critical clearing angle.

11 a Explain why economic load dispatch is required for power system? 2

b Explain how B-coefficients in p.u. are related to B-coefficients in MW? 3

Ps = Pmax sin δ

c Derive the condition for economic load dispatch considering transmission loss. 4

d The fuel-cost functions in $/hr for three units of a power plant are given by 2 + 3 + 1

$C_1 = 500 + 7.0P_1 + 0.003P_1^2, C_2 = 600 + 7.2P_2 + 0.0025P_2^2, C_3 = 800 + 7.4P_3 + 0.002P_3^2$

where, P_1, P_2 and P_3 are in MW. Determine the optimal scheduling of generation for total load of 1000 MW

(i) by analytical technique,

(ii) using Iterative method. Start with an initial estimate of A =8.0 $/MWh.

(iii) find the savings in $/h for each case compared to the costs when the generators share load equally.

12 a Draw the block diagram of load frequency control system considering governor (with speed regulation), prime mover, rotating mass and electrical load. Show the input and output variables in each stage and the constants of each block. 3

b We are given an isolated power system with a 600-MVA generating unit having a momentum (M) = 7.6 p.u.MW/p.u.frequency/sec on a machine base. The unit is supplying a load of 400 MVA. The load changes by 2% for a 1% change in frequency. Suppose the load suddenly increases by 10 MW. Derive the expression of frequency drop as a function of time ($\Delta\omega(t)$) and final value of frequency for 50Hz system. 4

c List and explain the advantages of per unit method for power system. 4

d A three phase 3 winding Y-Y-Δ transformer is rated as under: 4

Primary 132kV, 30MVA, Secondary 11kV, 20MVA, tertiary 6.6kV, 10MVA.

The result of short circuit test are as under:

Secondary open circuited, tertiary short circuited, primary excited x=8% on 132kV, 30 MVA;

Secondary short circuited, primary open circuited, tertiary excited x=2% on 6.6kV, 10 MVA;

Primary short circuited, tertiary open circuited, secondary excited x=5% on 11kV, 20 MVA.

Calculate leakage reactance of primary, secondary and tertiary windings.

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JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
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JGEC/B.TECH/ EE/ PE-EE 602(c)/ 2023-24
2024
Digital Signal Processing

Full Marks: 70 Times: 3 Hours

The figures in the margin indicate full marks.
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GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer ***all*** questions 5x2=10

1. What do you mean by aliasing? 2
2. Why ROC is not necessarily defined in DTFT? 2
3. State the initial and final value theorem in Z transform 2
4. What is Ridix-2 algorithm in FFT analysis? 2
5. Give any two properties of Butterworth low pass filter 2

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any ***four*** questions 4x15 = 60

6. a) The impulse response of a linear time invariant system is h(n) = {1,2,1,-1}.Determine the response of the system to the input signal x(n)={1,2,3,1} using linear convolution (graphical method). 7
   b) Why difference equation used to describe discrete systems instead of differential equation? A discrete-time system is characterized by the following difference equation: 2+6
   Check this system for BIBO stability:
   $$y(n) = x(n) + e^{a} y(n-1)$$

7. a) Find the inverse Z-transform of 6
   $$X(z) = \frac{1}{1-3z^{-1}+2z^{-2}}$$ using convolution method
   b) Write the necessary and sufficient conditions for Jury's stability criterion in Z domain. Apply the same in the following function to check the stability 3+6
   $$F(z) = z^5+2.6z^4-0.56z^3-2.05z^2+0.775z+0.35$$

8. a) A signal x(n) has the fourier transform : $X(e^{j\omega}) = 1/(1-ae^{-j\omega})$.Determine the Fourier transforms of following signals: 3+3
   i) $e^{n\pi/2}\, x(n+2)$
   ii) x(-2n)
   b) Determine the frequency response of $H(e^{j\omega})$ for the system and plot the magnitude and phase response 3+6
   $$y(n)+1/4y(n-1) = x(n)-x(n-1)$$

9. Explaining the Decimation–in–time method of FFT radix-2 algorithm (with proper butterfly structures of every stage) for a 8 point sequence, find the DFT of the sequence {1, 1, 1, 1, 2, 2, 2, 2} using the same. 10+5

10. a) Design an ideal band pass filter with a frequency response
    $$H_d(e^{j\omega}) = 1 \quad \text{for } \frac{\pi}{4} \le |\omega| \le \frac{3\pi}{4}$$ 10
    $$= 0 \quad \text{otherwise}$$
    b) Realize the second order digital filter $y(n) = 2r\cos(\omega_0)y(n-1) - r^2y(n-2)+x(n) - r\cos(\omega_0)x(n-1)$ 5

11. a) Differentiate between FIR and IIR filters. 3
    b) How to design FIR filters using window techniques? 5
    c) Derive the expression for spectrum of Rectangular window and draw its frequency spectrum for N=25 4+3

12. a) Write the properties of twiddle factor. 3

b) Determine the circular convolution of the following sequences and 8+4
$x(n) = [1, 0.5, 1, 0.5, 1, 0.5, 1, 0.5]$ {4,5,4,5,4,5
$h(n) = [0, 1, 2, 3]$
How circular convolution result can be verified with linear convolution?

JALPAIGURI GOVERNMENT ENGINEERING COLLEGE

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JGEC/B.TECH/EE/PC-EE601/2023-24

2024

ELECTRIC DRIVES

Full Marks: 70 [redacted] Times: 3 Hours

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Candidates are instructed to write the answers in their own words as far as practicable.

GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer ***all*** questions 5×2=10

1. Explain active and passive load torques for an electric motor with examples.
2. What is short circuit torque (Tsc) of an electric motor?
3. How to employ dynamic braking in dc series motors?
4. How to identify stable operating point in the torque-speed characteristics of motor and load?
5. What is seal-in logic based rung in PLC Ladder logic Programming ?

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any ***four*** questions 4×15=60

6. i) With appropriate diagrams describe the four-quadrant operation of a hoist drive. 5
   ii) What are different components of load torque need to consider during dynamic analysis of an electric drive system? Discuss in details. 5
   iii) How does the braking resistance control the dynamic braking torque in dc separately excited motor? 5

7. i) Estimate the equivalent value of moment of inertia (J) referred to motor shaft for a drive system where a motor driving two loads, one coupled directly to the motor shaft and other through a gear with a ratio of n/n1=a1. Take necessary assumptions. 4
   ii) The parameters of a separately excited dc motor are given below: 7
   r_a=1Ω, L_a=0, C=1.8 V.s/rad, J (motor and load combined) =3.5 Kg.m^2, F(=F_m+F_L i.e. motor and load combined)=0.3 Kg.m^2/sec. The load torque is proportional to the speed (T_L=F_L. ω_m). The field excitation remains constant at rated level. A voltage of 220V is suddenly applied across the motor armature terminals. (a) Derive an equation for speed (ω_m) as a function of time. (b) Determine steady state speed. (c) Determine the time required for the motor to reach 75% of the steady state speed.
   iii) Explain equivalent current & power methods to determine the motor rating for intermittent loads. 4

8. i) Discuss the technique to select voltage ratings of supply system and generator in buck-boost method of speed control of dc shunt motor. 5
   ii) A 230V, 960rpm and 200A separately excited dc motor has an armature resistance of 0.02ohm. The motor is fed from a chopper which provides both motoring and braking operations. The source has a voltage of 230V. Assume continuous conduction and lossless chopper. 6
      a) Calculate duty ratio of chopper for motoring operation at rated torque and 350rpm.
      b) Calculate duty ration of the chopper for braking operation at rated torque and 350rpm.
      c) If the maximum duty ratio of the chopper is limited to 0.95 and maximum permissible motor current is twice the rated, calculate maximum permissible motor speed obtained without field weakening and power fed to the source.
   iii) Deduce the expression of loss of energy during starting of a separately excited DC motor. Take necessary assumptions. 4

9. i) Derive the heating-cooling characteristics of an electric motor working in continuous mode. Take necessary assumptions. 6
   ii) A motor has a thermal heating time constant of 45 minutes. When the motor runs continuously at full load, its final temperature rise is 80°C. 6

(a) What would be the temperature rise after 1 hour, if the motor runs continuously on full load?

(b) If the temperature rise in 1 hour rating is 80°C, find the maximum steady-state temperature at this rating.

(c) How long will the motor take for its temperature to rise from 50°C to 80°C, if it is working at its 1hour rating?

iii) A motor of smaller rating can be selected for a short time duty. Justify 3

10. i) Explain static rotor resistance control scheme to vary speed of a 3-ph slip ring induction motor. 4

ii) Why V/f method of speed control of 3-phase induction motor is preferable over frequency control method? Draw typical speed-torque curves for both the methods 6

iii) What is slip power recovery method of speed control? With proper circuit diagram and characteristics describe how slip power recovery is implemented in the Static Scherbius drive. 5

11. i) With the help of torque-speed characteristics discuss the different methods of braking an induction motor with appropriate details. 5

ii) Explain how cyclo-converter can be used to control the speed of synchronous motor drives 5

iii) How to estimate response time of PLC? How does a MCR (Master Control Relay) function in PLC programme? 3+2

12. *Write short notes on any **three**:* 3×5

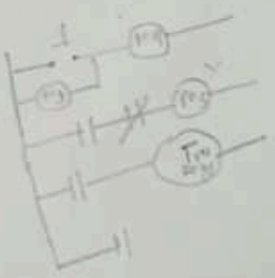
i) "Self-controlled mode" of speed control operation of a synchronous motor

ii) Regenerative braking for dc motor

iii) Microprocessor based firing angle control method used in single-phase full converter for DC motor speed control

iv) Ladder logic programming in PLC and associated hardware design for Star-Delta Starter of Induction motor

v) Dual converter based four-quadrant operation of DC motors.



$V = E_b + I_a R_a$

$I_a = \frac{V - E_b}{R_a}$

JALPAIGURI GOVERNMENT ENGINEERING COLLEGE
[A GOVERNMENT AUTONOMOUS COLLEGE]
JGEC/B.TECH/ EE/ PC-EE603/ 2023-24
2024
ELECTRICAL AND ELECTRONIC MEASUREMENTS

Full Marks: 70 Time: 3 Hours

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Candidates are instructed to write the answers in their own words as far as practicable.

GROUP-A
[OBJECTIVE TYPE QUESTIONS]

Answer ***all*** questions 5x2=1

1. Mention merit and demerit of null balance measurement over deflection method.
2. State Blondel's theorem.
3. What is the purpose of the 'trigger pulses' in the CRO?
4. Why PMMC instruments are used only for DC applications?
5. A 16-bit analog to digital converter (ADC) measures voltages in the range of 0 to 15 V. What is the resolution

GROUP-B
[LONG ANSWER TYPE QUESTIONS]

Answer any ***Four*** questions 4x15= 60

6. a) What do you understand by dynamic characteristics of an instrument – mention with examples. 2

b) A voltmeter reading 70 V on its 100 V range and an ammeter reading 80 mA on its 150-mA range are used to determine the power dissipated in a resistor. Both these instruments are guaranteed to be accurate within ±1.5% at full scale deflection. Determine the limiting error of the power 3

c) Explain working principle of a PMMC movement along with schematic details. 6

d) A moving coil instrument has the following data: 2+2
Number of turns = 100
Width of the coil = 20 mm
Depth of the coil = 30 mm
Flux density in the gap = 0.1 Wb/m2
Calculate the deflecting torque when carrying a current of 10 mA. Also calculate the deflection, if the control spring constant is 2×10^{-6} Nm/degree.

7. a) Explain with schematic details, the principle of working of a Kelvin's double bridge for measurement of unknown low resistances. Explain how the effects of contact resistance and resistance of leads are eliminated. 6+3

b) A voltmeter of 600 Ω resistance and a milliammeter of 0.8 Ω resistance are used to measure two unknown resistances by voltmeter–ammeter method. If the voltmeter reads 40 V and milliammeter reads 120 mA in both the cases, calculate the percentage error in the values of measured resistances if (a) in the first case, the voltmeter is put across the resistance and the milliammeter connected in series with the supply, and (b) in the second case, the voltmeter is connected in the supply side and milliammeter connected directly in series with the resistance. 3+3

8. a) Derive equations for balance for an Anderson's bridge. Draw its phasor diagram under balance. What are its advantages and disadvantages? 5+2 +2

b) The four arms of a Maxwell's inductance–capacitance bridge at balance are, 4
Arm AB : A choke coil L1 with an equivalent series resistance R1
Arm BC : A non-inductive resistance of 800 Ω.
Arm CD : A mica capacitor of 0.3 μF in parallel with a noninductive resistance of 800 Ω.
Arm DA : A non-inductive resistance 800 Ω.
Supply is given between terminals A and C and the detector is connected between nodes B and D. Determine values of L1 and R1 .

c) Mention the field of application of ac bridges for various purposes along with suitable examples. 2

9. a) Enlist various types of errors of a 'dynamometer type wattmeter.' An electrodynamometer-type wattmeter has a current coil with a resistance of 0.1 Ω and a pressure coil with resistance of 6.5 kΩ. Calculate the percentage errors while the meter is connected as 2+4
(i) current coil to the load side, and
(ii) pressure coil to the load side.
The load is specified as 12 A at 250 V with unity power factor.

b) Explain how power factor of an unknown three-phase (balanced star connected) load can be estimated by using two-wattmeter method. 5

c) Two wattmeters are connected to measure the power consumed by a 3-phase balanced load. One of the wattmeters read 1500 Ω and the other 700 Ω. Find power factor of the load, when 2+2
(i) both the readings are positive, and
(ii) when the reading of the second wattmeter is obtained after reversing its current coil connection.

10. a) Draw the basic block diagram of an oscilloscope and state the functions of the grid circuit of it. 2+2

b) Explain the working principle of a dual trace CRO. State the advantages of dual trace over dual beam. 2+2

c) Explain with the help of a block diagram how current (dc & ac) and resistance can be measured by a digital multimeter. 5

d) Define sensitivity of a digital meter. The lowest range on a $4\frac{1}{2}$ digit multimeter is 10 mV full scale. Determine the sensitivity of the meter 2

11. Write short notes on any three of the following: 3x5
a) Potentiometer
b) Lissajous method of measurement of phase and frequency using CRO.
c) Analog-to-digital converter
d) DSO
e) Instrument transformer