Total No. of Printed Pages—7

RP–IX–XII–25

42 2011

ELECTRICAL ENGINEERING

FIRST PAPER

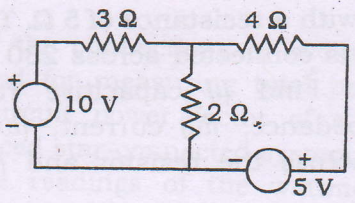
Full Marks : 200

Time : 3 hours

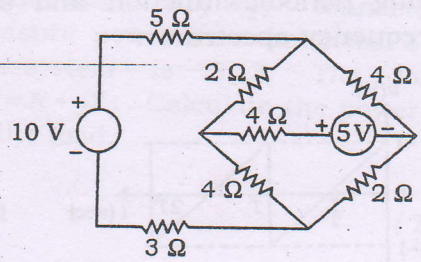
The figures in the margin indicate full marks for the questions

Answer *any* **five** questions

1. *(a)* Find the current in the 2 Ω resistor of the following circuit using Thevenin's theorem : 20



(b) Find the current in the 3 Ω resistor of the following circuit using nodal analysis : 20

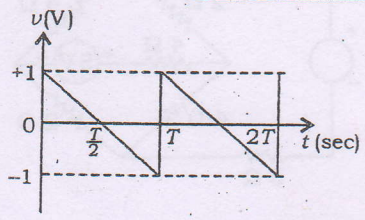


2. *(a)* Two coils *A* and *B* have resistances of 12 Ω and 6 Ω, and inductances of 0·02 H and 0·03 H respectively. They are connected in parallel and a voltage of 200 V at 50 Hz is applied to their common terminals. Find *(i)* the currents in the coils, *(ii)* the total current and *(iii)* the power factor of the combination. 15

(b) If a capacitance of 15 Ω in series with a condenser of 120 μF is connected with the combination in part *(a)*, find the total current and its p.f. 15

(c) A capacitance of 50 μF is connected in series with a resistance of 5 Ω. The series circuit is connected across 230 V, 50 Hz supply. Find *(i)* capacitive reactance, *(ii)* impedance, *(iii)* current, *(iv)* voltage drop across the resistor and *(v)* power factor. 10

3. *(a)* Find the Fourier expression of the following periodic function and sketch the frequency spectrum : 20



(Continued)

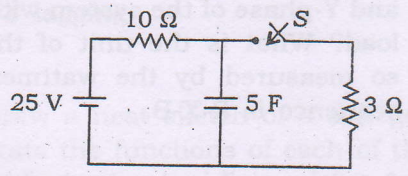
(b) The circuit shown below is in the condition for a long time. The switch S is closed at $t = 0$, find—

(i) voltage v immediately before S is closed;

(ii) voltage v immediately after S is closed;

(iii) expression of v in time domain;

(iv) time constant of the circuit.



20

4. (a) Show the connections of two-wattmeter method for measuring total power and the circuit power factor of a 3-phase balanced star-connected system in terms of the readings of the wattmeters W_1 and W_2. 15

(b) The ratio of the readings of two wattmeters, W_1 / W_2, connected to measure power in a balanced 3-phase star-system is 5 : 3. The load is $Z_L = R + jX_L$. Calculate the power factor of the load. 15

(c) A wattmeter reads 5·54 kW when the c.c. of the instrument is connected in R-phase and p.c. is connected across R-phase and neutral of a star-connected balanced 3-phase system supplying a total balanced load of 30 A at 400 V. What will be the reading of the instrument if the connection of the c.c. is kept unchanged and the p.c. of the wattmeter is connected across B-phase and Y-phase of the system with the same load? What is the unit of the quantity so measured by the wattmeter? Phase sequence is R-Y-B. 10

5. (a) A moving-coil instrument gives full-scale deflection of 20 mA. The resistance of the coil is 4 ohms. How will you convert the instrument to be an ammeter to read up to 20 A and to be a voltmeter to read up to a voltage of 30 V? Calculate the values. 15

(b) Describe a suitable AC bridge for measuring the loss angle of a condenser at 50 Hz frequency. Draw the vector diagram of the balanced bridge and obtain an expression for the loss angle and dielectric loss. 25

6. (a) Explain with necessary circuit diagram, how OC and SC tests are performed on a single-phase transformer. 15

(b) Deduce expressions of an equivalent circuit R_{01} of a single-phase transformer in terms of primary and secondary resistances R_1, R_2 and turns ratio N_1 / N_2. 10

(c) A 600 kVA, single-phase transformer has an efficiency of 92% both at full-load and half-load at unity p.f. Determine its efficiency at 60% of full-load at a p.f. of 0·8 lagging. 15

7. (a) Draw a neat sketch of a d.c. generator. State the functions of each of the parts. Deduce the e.m.f. equation of a d.c. generator. 20

(b) A 220 V, 8·8 kW, 1000 r.p.m., d.c. shunt generator has $R_a = 0 \cdot 5\ \Omega$ and $R_{sh} = 110\ \Omega$. Friction and windage loss is 200 watts and it has negligible core loss. The brush drop is 1 volt per brush. Calculate—

(i) efficiency at full-load and rated speed;

(ii) voltage regulation;

(iii) terminal voltage at 800 r.p.m.;

(iv) output voltage at 800 r.p.m. 20

8. *(a)* Determine whether the following fields satisfy Laplace's equation : 10

(i) $V = x^2 - y^2 + z^2$

(ii) $V = r\cos\theta + \phi$

(b) Determine the value of the charge density at the point $P(2, 0, -3)$ in the free space for a potential field

$$V = 5(x^2 + 2y^2 - 3z^2)$$ 10

(c) Express Maxwell's equation for time-varying fields in differential and integral forms in free space. 20

9. *(a)* Define transistors. Define delay time, rise time, turn-on time, fall time. Which is the most commonly used transistor configuration and why is it the most commonly used type? 25

(b) Compare the frequency response characteristics of an amplifier with and without feedback. 15

10. *(a)* Describe the structure of a seven-segment decoder and explain its function. Develop logical expressions relating inputs and outputs for the segments. 25

(Continued)

(b) What are adders and subtractors in a digital system? Explain the operations of full-adder and full-subtractor circuits. 15

11. Write notes on any *four* of the following : 10×4=40

(a) Full-wave bridge rectifier circuit

(b) Speed control of d.c. shunt motor

(c) Parallel operations of transformer

(d) Voltage control and compensation of reactive power

(e) Network synthesis

(f) Autotransformer

(g) Wave-shaping circuit

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