Total No. of Printed Pages—9

PAR/CCM-25/13

2014

ELECTRICAL ENGINEERING

FIRST PAPER

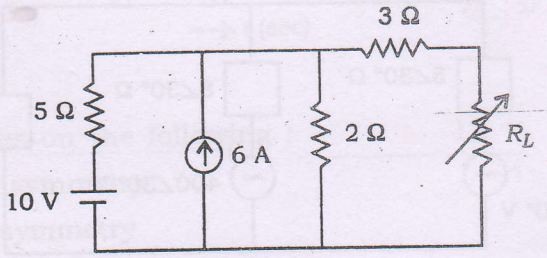
Full Marks : 200

Time : 3 hours

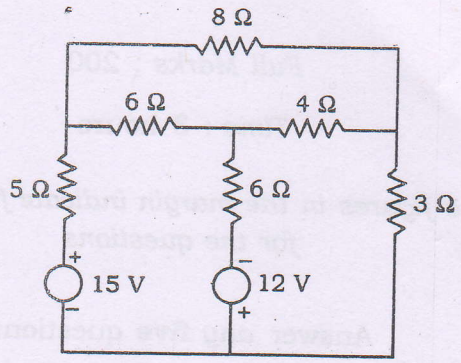
The figures in the margin indicate full marks for the questions

Answer *any* **five** questions

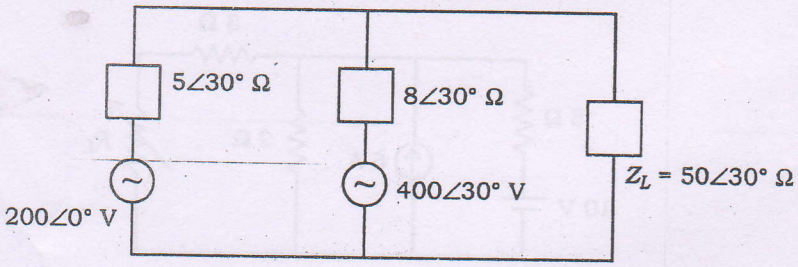
1. *(a)* State maximum power transfer theorem. For the following circuit, find the value of resistance R_L for maximum power and calculate the maximum power : 20



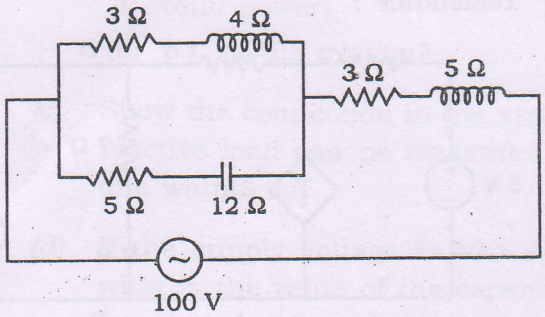
(b) Determine the voltage across 3 Ω resistor in the network shown below. Use nodal analysis : 20



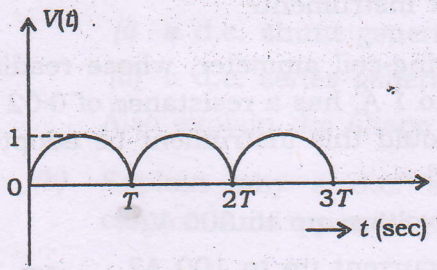
2. (a) Find the current through Z_L in the following circuit, using superposition theorem : 20



(b) Find the current through each element in the following circuit. Also draw the phasor diagram : 20



3. (a) Find the Fourier expression of the following periodic function and sketch the frequency spectrum : 12



(b) Write notes on the following : 12

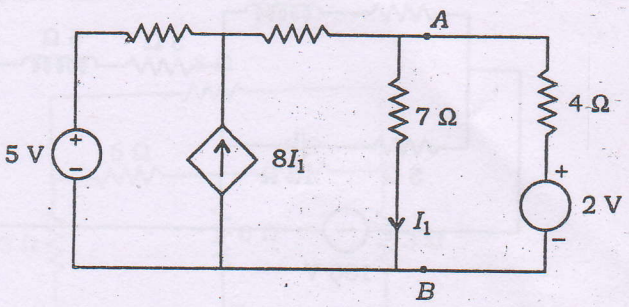
(i) Even symmetry

(ii) Odd symmetry

(iii) Half-wave symmetry

(iv) Effect of above symmetries on Fourier series

(c) Obtain the Thevenin's equivalent circuit across terminal *A-B* for the circuit below and also find the voltage across 4 Ω resistance : 16



4. (a) How is deflecting torque produced in a moving-iron instrument? Why is the graduation of scale not uniform in this type of instrument? 20

(b) A moving-coil ammeter, whose reading is up to 1 A, has a resistance of 0·02 Ω. How could this instrument be adopted to read—

(i) a voltage up to 300 V;

(ii) a current up to 100 A? 20

5. The power flowing in a 3-phase, 4-wire, balanced load system is measured by two-wattmeter method.

(a) Show the wattmeters connection with a neat diagram. 10

(Continued)

(b) The readings of wattmeter A is 7500 W and the wattmeter B is –1500 W. What are the—

(i) total power;

(ii) p.f. of the system? 10

(c) Show the connection in the system how reactive load can be measured by only one wattmeter. 10

(d) If the supply voltage is 400 V, 50 Hz, what is the value of the capacitance to be connected in each phase to cause the total power measured to be indicated by the wattmeter A? 10

6. (a) Draw the load characteristics of—

(i) a d.c. shunt generator;

(ii) a d.c. series generator.

Also explain the shape of the curves. 15

(b) Explain why a d.c. series generator cannot build up voltage at no-load. 10

(c) A 500 V d.c. shunt generator has a full-load current of 100 A and stray losses are 1·5 kW. R_a and R_f are 0·3 Ω and 250 Ω respectively. Calculate—

(i) the input power;

(ii) the efficiency at full-load. 15

7. *(a)* Develop the speed equation for a d.c. shunt motor. How can speed of d.c. shunt motor be controlled? Describe any one method with the help of a neat circuit diagram. 20

(b) A d.c. shunt machine runs at no-load at 1000 r.p.m. taking 480 W at 120 V. The shunt field current is 2 A and the armature resistance is 0·1 Ω.

(i) Compare the line currents, both as generator and motor at maximum efficiency.

(ii) Find the maximum efficiency. 20

8. *(a)* The load connected to a three-phase supply contains three balanced impedances connected in star. The line currents are 50 A and the kVA and kW inputs are 50 and 27 respectively. Find the line and phase voltages, kVA R_{input} and the resistance and reactance of each coil. 20

(b) The input three-phase power of a balanced impedance load of $Z_L = (4 + j3)\ \Omega$ per phase is measured by two-wattmeter method. Determine the wattmeter readings if the source is a balanced 220 V, 3-phase of 50 Hz supply and the loads are connected *(i)* in Y and *(ii)* in Δ. 20

(Continued)

9. *(a)* What are various losses in a transformer? Explain how they vary with load. 10

(b) Explain the OC and SC tests of a single-phase transformer with neat circuit diagrams for each test. Also mention the uses of these tests. 15

(c) A 50 kVA transformer has an efficiency of 98% at full-load, 0·8 p.f. and 97% at half full-load, 0·8 p.f. Determine—

(i) the full-load copper loss;

(ii) the iron loss;

(iii) the load at which the maximum efficiency occurs;

(iv) the maximum efficiency. 15

10. *(a)* A 10 kVA, 2000/200 V, 50 Hz, 1-phase transformer has parameters given below :

$r_1 = 3 \cdot 6\,\Omega$ $r_2 = 0 \cdot 04\,\Omega$

$x_1 = 5 \cdot 2\,\Omega$ $x_2 = 0 \cdot 056\,\Omega$

(i) Calculate the impedance referred to primary side.

(ii) Calculate the impedance referred to secondary side.

(iii) Draw the equivalent circuit referred to primary side. 15

(b) A transformer gave the following test results :

OC test :

$V_1 = 120$ V $\quad V_2 = 35$ V

$W_0 = 5$ W $\quad I_0 = 0 \cdot 125$ A

SC test :

$V_1 = 4$ V $\quad W_1 = 3$ W

$I_1 = 0 \cdot 8$ A

Determine—

(i) turn ratio;

(ii) parameter of the equivalent circuits;

(iii) efficiency at full-load. 25

11. (a) Draw the schematic diagram of an *R-C* couppled amplifier in the common emitter configuration and potential biasing. Derive the relation for A_V and R_{input}. Symbols carry their usual meanings. Discuss the effects of various parameters which can cause shift in the operating point of a junction transistor. 20

(b) Describe the structure of a seven-segment decoder and explain its function. Develop a logical expressions relating inputs and outputs for the segments. 20

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

(a) Multivibrator

(b) Full-adder and full-subtractor circuits

(c) Shift register

(d) Network synthesis

(e) Electrostatic field

(f) Electromagnetic wave propagation

(g) Filter circuits for full-wave rectifier

(h) Role of reactive power in power system operation

(i) d.c. motor starter

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