CSM—28/24

PART—II/PAPER—VI

ELECTRICAL ENGINEERING

PAPER—I

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Time : 3 Hours

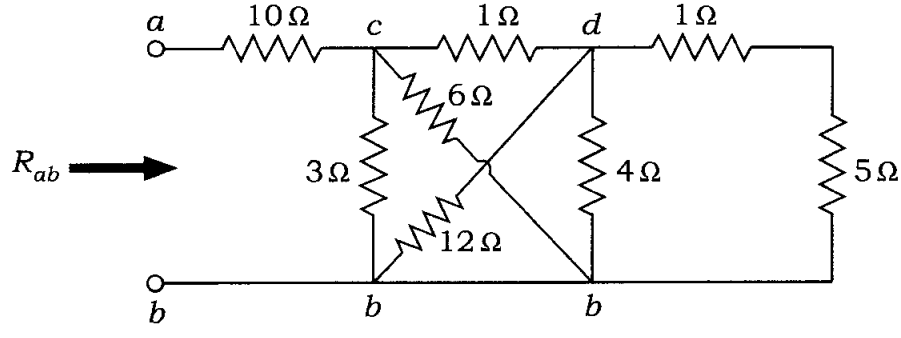
Full Marks : 250

The question paper contains **18 (Eighteen)** *questions in* **GROUP—A, (12)** *and* **GROUP—B, (06)** *together.*

GROUP—A

Candidates to attempt **10** ***(ten)*** *questions within word limit of* **250**. *Each question carries* **15** *marks.*

1. Calculate the equivalent resistance R_{ab} in the circuit given below :



2. Point out the necessary and sufficient conditions for a positive real function. Justify that the following function can be a driving-point impedance of a reactance network.

$$Z(s) = \frac{s(s^2+2)}{(s^2+1)(s^2+4)}$$

Give the realization of the network using first Foster form of this network.

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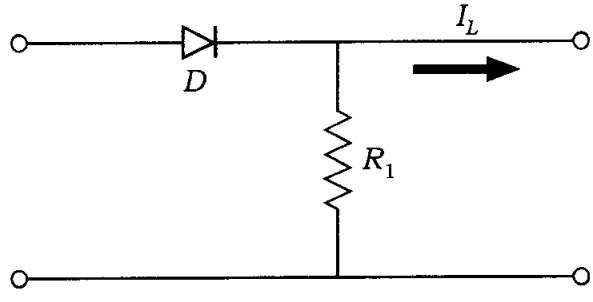
3. Find the inverse z-transform of

$$X(z) = \frac{2z^3 - 5z^2 + z + 3}{(z-1)(z-2)} \quad |z| < 1$$

4. Explain travelling waves on a transmission line and define Standing Wave Ratio (SWR). A high frequency lossless transmission line has a characteristic impedance of 600 Ω. Calculate the value of current SWR when the load is $(500 + j300)\,\Omega$.

5. An input of $E = \pm 50$ V is applied to the clipping circuit. The output current from the circuit is to be $I_L = 20$ mA and the negative output voltage does not exceed –0.5 V. Calculate the value of R_1. Specify the diode in terms of forward current, power dissipation and peak reverse voltage. Assume the reverse saturation current I_S is 5 μA and forward voltage of diode, $V_F = 0.7$ V.



6. What is meant by the term pinch-off voltage of a JFET? Draw the drain characteristics of a JFET for $V_{GS} = 0$ V and show the pinch-off voltage in the diagram. Define the terms transconductance and amplification factor of a JFET. In an FET, as V_{GS}, the gate to source voltage is varied from –1.5 V to –2 V, keeping V_{DS} constant, I_D of an FET decreases from 7.5 mA to 5.5 mA. What is the transconductance of the FET? If the a.c. drain resistance is 210 kiloohms, find the amplification factor.

7. Explain briefly the functions of 'De-multiplexer' and 'Multiplexer'. Explain with a necessary diagram the operation of a 4 to 1 line multiplexer.

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8. A 300 kVA, 11 kV/440 V, 50 Hz, 3-phase ΔY-transformer gave the following test results :

At rated voltage no load : 440 V, 21.1 A, 1.3 kW (LV side).
At rated current on short circuit : 630 V, 15.7 A, 3.08 kW (HV side)

Evaluate the rated loss, impedance voltage, per unit resistance and leakage reactance, efficiency and regulation on full load at 0.8 p.f. lagging.

9. A star-connected squirrel-cage induction motor has the following parameters and rating :

$$R_S = 2\ \Omega, R_r' = 3\ \Omega, X_S = X_r' = 3.5\ \Omega,$$

$$V = 400\ \text{V}, 50\ \text{Hz}, 1380\ \text{RPM}$$

It is driven by a voltage source inverter, which gives constant V/f control to IM. If the inverter frequency is variable from 10% of rated frequency to base frequency, calculate frequency for a speed of 1000 RPM and full load torque and torque for a frequency of 35 Hz and speed of 950 RPM.

10. Describe the turn-off process in a GTO with relevant voltage and current waveforms. Enumerate the advantages and disadvantages of a GTO as compared to a conventional thyristor and draw the symbols and characteristics of the devices : Diode, Thyristor and GTO.

11. A single-phase fully controlled bridge converter is used to control the speed of a separately excited DC motor. A reactor of 50 mH is connected in the armature circuit. The converter is connected to a 220 V, 50 Hz supply and is operated at a firing angle (α) of 90°. The back e.m.f. of the motor is 180 volts. Draw the output voltage waveform of the converter and determine the peak value of current drawn. Neglect the resistance and reactance of DC machine armature.

12. An AM transmitter radiates 10 kW with the carrier unmodulated and the antenna current is 10 A. When the carrier is modulated by a single sine wave, the antenna current increases to 11 A. Find the percentage of modulation. The antenna current increases to 12 A as a result of simultaneous modulation by another sine wave. What is the modulation index if the carrier is modulated using only the second sine wave? Determine the total radiated power when the carrier is modulated using both the sine waves simultaneously.

GROUP—B

Candidates to attempt **05** ***(five)*** *questions within word limit of* **300**.
Each question carries **20** *marks.*

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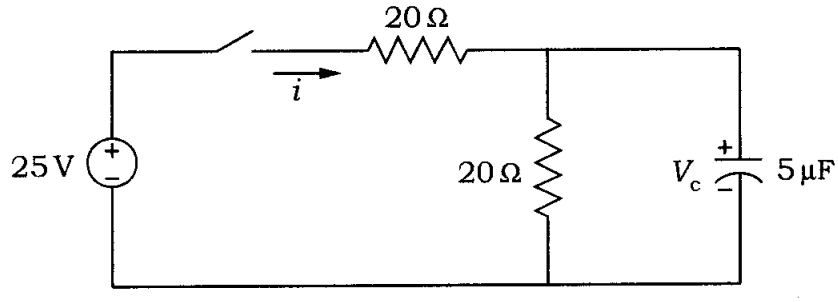
13. In the circuit shown in the figure given below, the switch is closed at $t = 0$. Obtain the current i and capacitor voltage V_c, for $t > 0$.



14. Describe with necessary diagrams :

An Integrator and a differentiator using operational amplifier circuits. How the offset voltage can be minimized in an integrator at the output, and what is to be done to reset the integrator? Discuss how in a practical differentiator high frequency oscillation can be prevented. How the outputs of a differentiator varies when Ramp input is used, Rectangular input is used?

15. Design a digital sequence detector circuit to detect the sequence 0110 in a serial input signal, using D flip-flops. The sequence detector should produce an output 1 whenever it detects the sequence 0110 in the serial input signal, e.g.,

Serial input X = 00110101101
Output Y = 00001000010

16. A 6.6 kV star-connected synchronous motor has synchronous impedance $Z_s = (2 + j10)\,\Omega$ per phase. Its excitation is so adjusted that for an input power of 500 kW, the motor power factor is 0.7 leading. Now the motor is connected in parallel with a load drawing 1000 kW at 0.8 p.f. lag, while its input power is changed to 600 kW with the same excitation as above. Find the new load angle of the motor and the total input power factor for the load and synchronous motor combination.

17. A full-bridge inverter (IGBT) has a switching sequence that produces a square-wave voltage across a series *R-L* load. For the instant case, the switching frequency is 50 Hz. $V_{dc} = 100\ V$, $R = 10\ \Omega$, $L = 25\ mH$. Determine the amplitude of the Fourier series terms for load current and the power absorbed by the load. Consider only the 3rd, 5th and 7th harmonics terms. Compute THD for voltage and currents. If the switching sequence is modified to produce quasi-square waveform, what changes will be observed in the Fourier coefficients and in the THD of the voltage and current waveforms?

18. A 100 kVA transformer has its maximum efficiency of 98% at full load and unity p.f. During the day it is loaded as follows :

12 hr	—	20 kW at a p.f. of 0.5 lag
6 hr	—	20 kW at a p.f. of 0.9 lag
6 hr	—	20 kW at a p.f. of 0.8 lag

Calculate the "all day efficiency" of the transformer.

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