MIZORAM PUBLIC SERVICE COMMISSION

GENERAL COMPETITIVE EXAMINATIONS FOR RECRUITMENT TO THE POST OF
JR. GRADE OF MIZORAM FOREST SERVICE (ASST. CONSERVATOR OF FORESTS)
UNDER ENVIRONMENT, FOREST & CLIMATE CHANGE DEPARTMENT, GOVERNMENT OF MIZORAM, 2023

ELECTRICAL ENGINEERING

Time Allowed : 3 hours   Full Marks : 100

*The figures in the margin indicate full marks for the questions.*
Answer any 5 (five) questions taking not more than 3 (three) questions from each section.

SECTION - A

1. (a) (i) Prove that $\nabla X H = J + \dfrac{\partial D}{\partial t}$ **(5)**

        (ii) Find the electric field intensity at a point due to line charge.   **(5)**

    (b) (i) Find the magnetic field intensity at the centre of a 10 A current carrying circular loop of diameter 4 cm.   **(5)**

        (ii) Derive an expression of electric field density at a distance 'r' from an infinite line charge having linear charge density r C/m.   **(5)**

2. (a) Define ferromagnetism and ferromagnetic material. How the hysteresis loop affects the operation of electrical machines?   **(10)**

    (b) Describe breakdown of gas, liquid, and solid dielectric.   **(10)**

3. (a) Calculate current in each branch of the circuit shown in Figure.   **(10)**
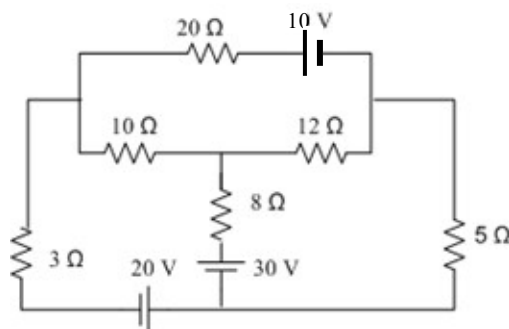
    (b) (i) Find the current in the 4 W resistor shown in network of Figure.   **(5)**
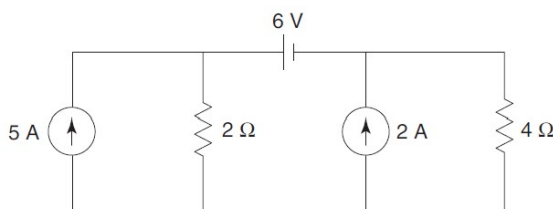
(ii) Find the equivalent resistance between terminals A and B in Figure. **(5)**
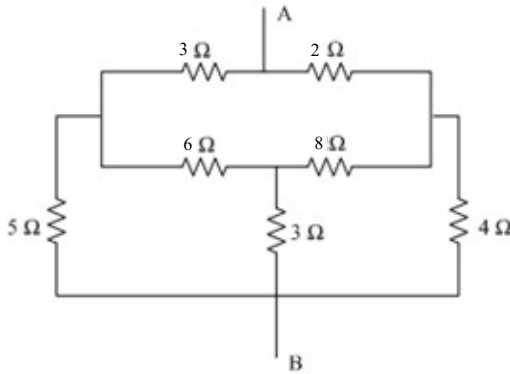
4. (a) Explain the principle of operation of Permanent Magnet Moving Coil (PMMC) instrument with proper circuit diagram and also derive the torque equation developed by PMMC. **(10)**

(b) (i) Express the function of I. indicating instrument, II. integrating instrument, and III. recording instrument. **(5)**

(ii) A single phase energy meter has a constant of 1000 rev./kWh. When a load of 2kW is connected, the disc rotates at 42 rpm. If the load is on for 8 hours, how many units are recorded by the energy meter? Also find the percentage error. **(5)**
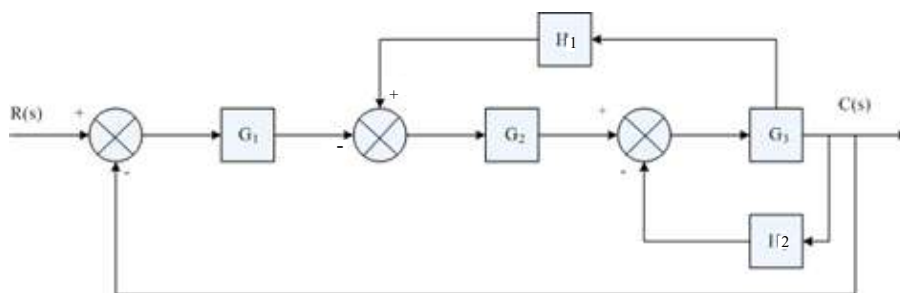
5. (a) A control system is described as below: **(10)**

$$\dot{x} = Ax + Bu$$

and y = Cx where, $A = \begin{bmatrix} 1 & 4 \\ -2 & -5 \end{bmatrix}$, $x(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ and

$C = \begin{bmatrix} 1 & 0 \end{bmatrix}$. Determine the time response.

(b) (i) Find the ratio C(s)/R(s) of the block diagram shown in Figure. **(5)**


(ii) Sketch the polar plot for the transfer function shown below. **(5)**

$$\frac{20}{s(s+1)(s+2)}$$

SECTION - B

6. (a) A transformer is rated at 100 kVA. At full load its copper loss is 1.1 kW and its iron loss is 0.9 kW. Calculate (i) the efficiency at full load, unity power factor, (ii) the efficiency at half load, 0.9 power factor, and (iii) the load kVA at which maximum efficiency will occur. **(10)**

   (b) Explain the principle of operation of 3 phase Induction Machine. **(10)**

7. (a) With a neat schematic diagram explain the working of a nuclear power plant. **(10)**

   (b) (i) What are differences between normal switch and circuit breaker? What is the main purpose of the application of circuit breakers in a power system network? **(5)**

   (ii) $I_a = 20\underline{|0°}A$, $I_b = 10\underline{|100°}A$, $I_c = 10\underline{|280°}A$, find $I_{a_1}, I_{a_2}, I_{a_0}$ **(5)**

8. (a) (i) What is PN junction diode? What is the concept behind variation of depletion region? **(5)**

   (ii) The waveforms A and B shown in Figure are applied to a NAND gate. Draw the output waveform in reference to the input waveforms. **(5)**
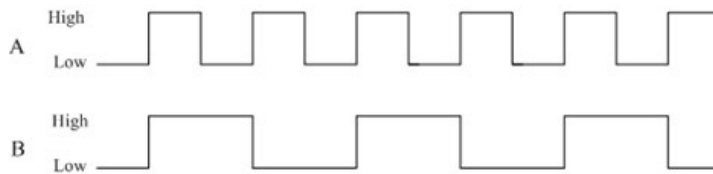
   (b) (i) On the output characteristics of BJT, show the region of operation of (i) an amplifier (ii) a switch **(5)**

   (ii) Explain JK flip-flop with the help of logic diagram, truth table and timing diagram. **(5)**

9. (a) Draw the block diagram of 8085 microprocessor and explain in detail. **(10)**

   (b) Define Frequency modulation (FM) broadcasting. Describe FM transmitter through block diagram based on indirect and direct methods. **(10)**

10. (a) Describe a 3-phase 120 degree mode voltage source inverter operation with the help of voltage waveforms, switching pulses and respective circuit diagrams. **(10)**

   (b) (i) Describe the switching characteristics of power MOSFET with relevant circuit diagram. **(5)**

   (ii) A 1-phase full bridge-controlled rectifier is operated from 220V, 50Hz. The load resistance is 10 ohm. If the average output voltage is 45% of the maximum possible average output voltage. Determine (i) Firing angle (ii) rms and average output current. **(5)**

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