Major

NOTE: Time for the exam is 2 hours. Marks are in the parentheses. Good luck!

1. Consider a separately excited DC machine. The armature resistance is $R_A = 0.5\ \Omega$. What is the

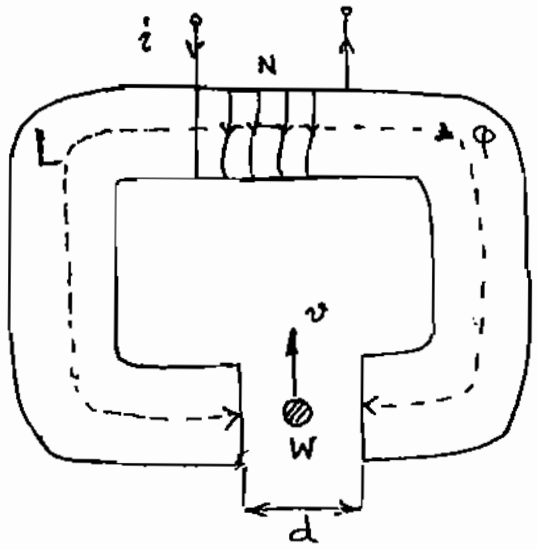
   a) Generated EMF E if the machine operates as a generator and supplies 100 A at 250 V at the terminal? (4)

   b) Developed EMF E if the machine operates as a motor and consumes 50 A at 250 V at the terminal? (4)

2. The same machine as in question 1 works as a generator at 20% higher RPM and supplies a load of 2 Ω. What is voltage at the terminal? (10)

3. Let there be a magnetic field directed along positive Z-axis having a value of $B_1 = 1$ T to the left of Y-axis and a value of $B_2 = 2$ T to the right of Y-axis. Suppose a wire of length 0.5 meters, mass of 1 kg carries a current of 2 A (directed towards positive Y-axis) and is placed at $t = 0$ with no initial speed centered at the coordinate (-2,0), where the units are in meters. Find the time it takes for the conductor to reach the line (4,0)? (12)

4. A coil of N turns is wound around an arm of a C-shaped iron piece with an air-gap as shown. The length of the dotted flux path in iron is L meters while that of the air-gap is d meters. The permeability of air is μ_0, while the relative permeability of iron is μ_r. If the coil is carrying i Amperes of current, find the magnitude of the EMF developed per unit length in the wire W moving upward with velocity v. (12)



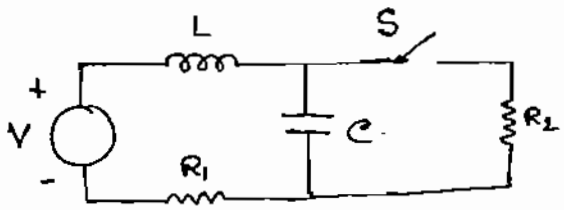
5. Consider a *RLC* circuit operating at steady state with AC input. Find the equivalent impedance of the circuit with the supply frequency of *f* Hz. Compute the value of *f* for which the equivalent impedance will be minimum. (Note: This is also called the resonant frequency.) (10)

6. For the given circuit with a DC source *V*, switch *S* is closed at $t = 0$ after remaining open for a long time.

(a) Find expression for *Z(s)* between *V* and *i* after *S* is closed. (5)

(b) Find expression for the natural component current $i_n(t)$ after $t = 0$ through the source. (5)

(c) Find expression for the total current (i.e. complete response) *i(t)* through the source after $t = 0$. (5)



$R_1 = 1\ \Omega$

$R_2 = 4\ \Omega$

$L = 1\ H$

$C = \frac{1}{20}\ F$.

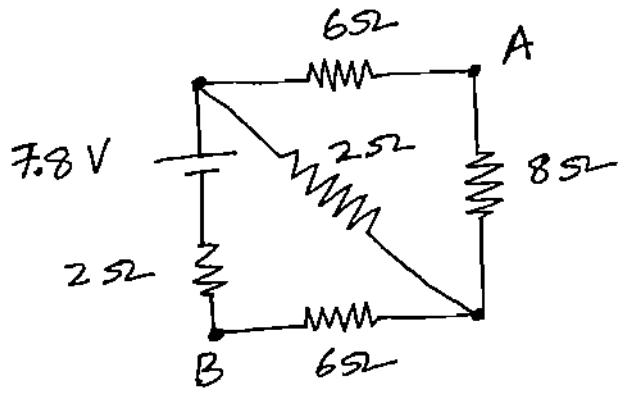
$V = 1$ Volt.

7. Design a circuit built with ideal op-amps whose output voltage denoted by v_0 is a function of two input voltages v_1 and v_2 and is given by

$$v_0 = a\,v_1 + b\,v_2 + c,$$

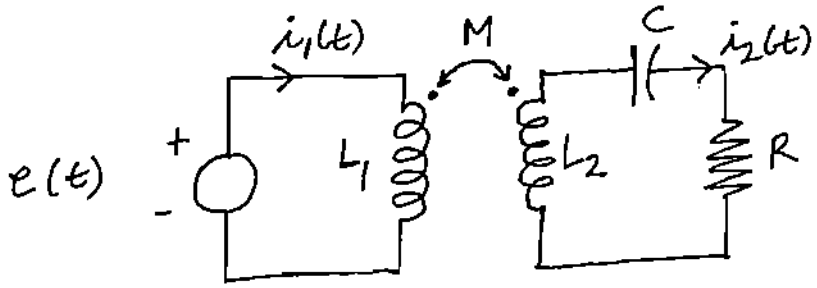
where a, b, $c > 0$ are constants. (9)

8. For the given circuit, find out the Thévenin's equivalent circuit between points A and B. Using this Thévenin's equivalent circuit, compute the current through an external load resistor of 10 Ω connected between A and B. (12)



9. A sine wave with peak to peak value of 10 V is clipped at -3.5 V while the positive half remains unchanged. Find the RMS (root mean square) value of the clipped sine wave. (10)

10. Write the differential equations for the mesh currents in the given circuit. (10)



11. A coil with terminals A and B has a self-inductance of 380 μH. Another coil with terminals C and D has a self-inductance of 640 μH. When B is joined with C, then the inductance between A and D is 1600 μH. Calculate (a) the mutual inductance between the coils and (b) the inductance between A and C when B is connected to D. (12)

Have a nice winter break!