Fundamentals of Electrical Engineering (EEL 101)
Major Test

Time: 2 Hours. Max. Marks 30

1. (a) A balanced Δ-connected load contains a 10 Ω resistor in series with a 20 mH inductor in each phase. The voltage source is an *abc*-sequence three-phase 60 Hz balanced wye with a voltage $V_{an} = 120\angle 30°$ rms. Determine all Δ-currents and line currents. (3)

(b) A three-phase balanced Y-Δ system has a line voltage of 208 V rms. The total real power absorbed by the load is 1200 W. If the power factor of the load is 20° lagging, determine the value of the line current and the value of the load impedance per phase in the delta. (3)

2. A 12 kW shunt-connected dc generator is rated at 240V, 50A, and 1000 rpm. Under no-load conditions, the generated voltage is 255 V. For full load conditions, neglect the field current compared with the armature current and calculate the armature resistance. (3)

3. Show that when the secondary of a transformer is connected to an impedance Z_L, an equivalent model can be obtained as shown in Fig. P3 by referring all quantities to the primary side. Also find the values of R_{E1} and X_{E1} in this model. (3)

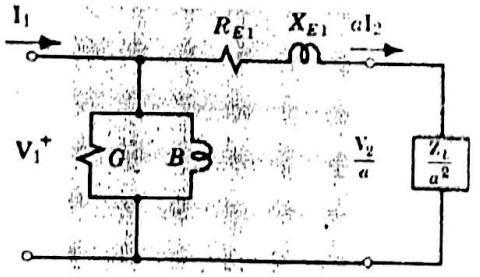


Fig. P3

4. The core of Fig. P4 is Armco iron with a = c = 15 cm and b = d = 35 cm; the current in the 350-turn coil is 15 A. Estimate the allowable air-gap length for a magnetic flux of 12 mWb. Also estimate the error in percent that result from neglecting the mmf drop in the iron. Assume that a flux density of B = 0.53 T requires a field intensity H = 80 A.t/m. (4)

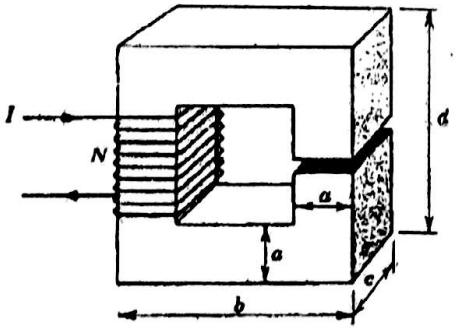


Fig. P4

5. The circuit of Fig. P5 is called a General Impedance Converter. Develop an expression for the equivalent impedance Z_{eq} ($= V_{in}/I_{in}$) in terms of Z_1, Z_2, Z_3, Z_4 and Z_5. Based on the resulting expression, use resistors of equal

value and a 1-μF capacitor, to realize an inductance of 1 H. Can you see a purpose to go to all this trouble for realizing an inductor? Explain briefly. *Hint: Assuming ideal op-amps, voltages at nodes E, C and A are each equal to V_{in}.* (6)

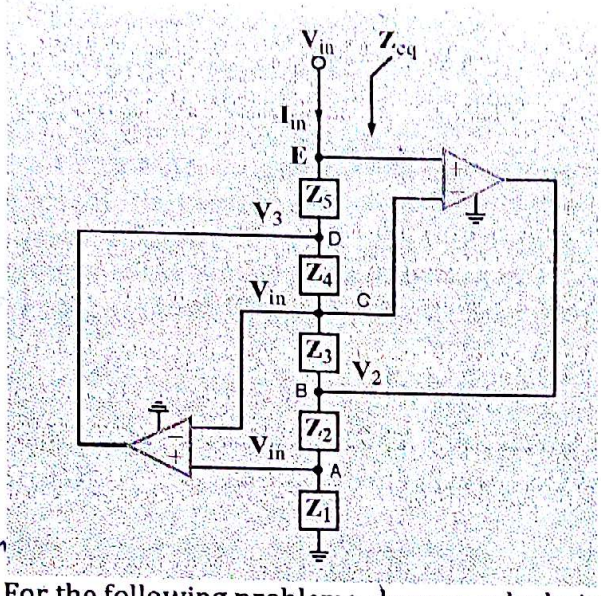
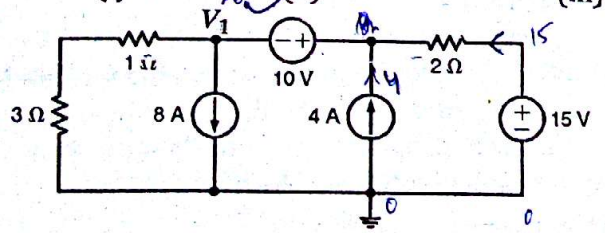


Fig. P5

6. For the following problems, do your calculations as required on a rough page. Only indicate the correct solution by writing the correct choice together with the answer. Thus, the answer should be written in the form: (i) 10A, etc., as applicable in each case. Clearly designate one of the pages of your answer sheet for rough work for Question 6 to check that the answers have been calculated by you. (8)

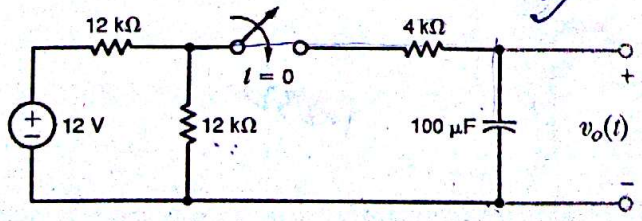
(a) What is the value of the voltage V_1 in the circuit shown below.

(i) -7V (ii) -2V (iii) 5V (iv) 4V



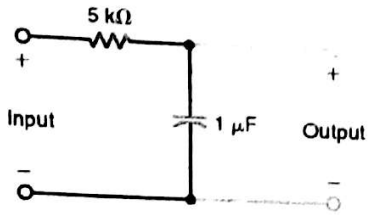
(b) In the network shown below, the switch closes at t = 0. Find $v_o(t)$ at $t = 1s$.

(i) 5.62 V (ii) 1.57 V (iii) 4.25 V (iv) 3.79 V



(c) Given the low-pass filter circuit shown below, find the frequency in Hz at which the output is down 3dB from the dc or very low-frequency output.

(i) 26 Hz (ii) 60 Hz (iii) 47 Hz (iv) 32 Hz.



(d) A two-port network is known to have the following parameters: $y_{11} = \frac{1}{14}S; y_{12} = y_{21} = -\frac{1}{21}S; y_{22} = \frac{1}{7}S$. If a 2A current source is applied at the input terminals as shown in the figure below, find the voltage across the current source.

(i) 36V (ii) 12V (iii) 24V (iv) 6V