The Open University of Sri Lanka
Department of Electrical and Computer Engineering

ECX3210 – Electro -Technique

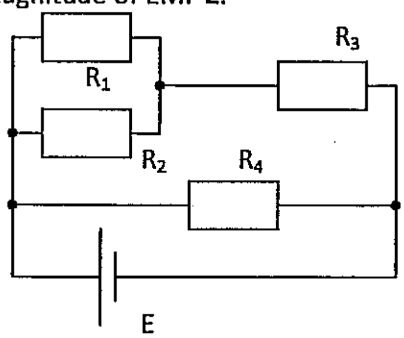
Final Examination 2010/2011 **Closed Book Test**

Date: 06th March 2011 Time: 13.30-16.30

Answer any 5 questions. All questions carry equal marks. Show all relevant steps of calculation.

1) a. What is the possible resistance range of a resistor displaying colour bands Green, Blue, Black, Gold?

b. In the circuit of fig. Q1 the current through R_1 is 4 A. Calculate the currents through the other branches, and the magnitude of EMF **E**.



$R_1 = 6\ k\Omega$ $R_2 = 8\ k\Omega$

$R_3 = 25\ k\Omega$ $R_4 = 20\ k\Omega$

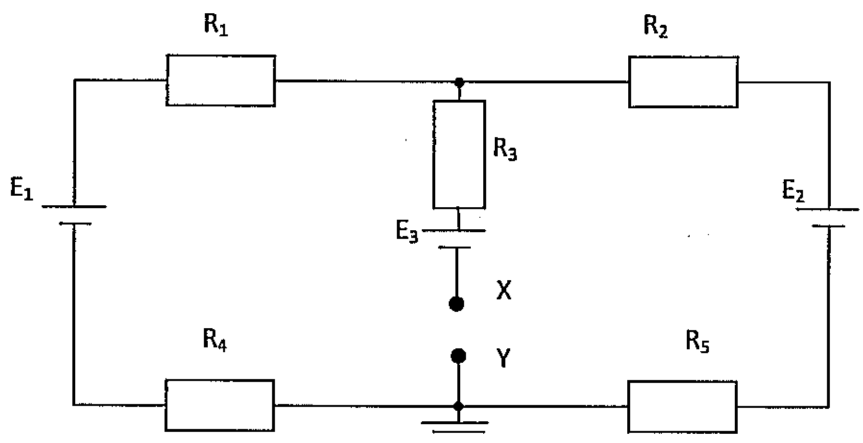
Figure Q1

c. A 400 Ω, 2.4 W resistor is needed, but only several 400 Ω, 1.2 W resistors are available.

i. What two different combinations of the available resistors give the required resistance and power rating? Sketch each circuit.

ii. For each of the resistor networks above, what power is dissipated in each resistor when 2.4 W is dissipated by the combination?

2) a. Describe briefly the two Kirchhoff's Laws of electric circuits, indicating the underlying conservation laws.



$R_1 = 12\ \Omega$; $R_2 = 22\ \Omega$; $R_3 = 36\ \Omega$;
$R_4 = 20\ \Omega$; $R_5 = 46\ \Omega$;

$E_1 = 12\ V$; $E_2 = 48\ V$; $E_3 = 24\ V$

Figure Q2

b. Calculate the potential difference between terminals X and Y in Figure Q2.

c. Now points XY are connected using a conductor (short circuit). **Write** three equations based on **superposition principle** so that the current flowing through XY can be calculated. (no calculations required!)

3) a. Describe Lenz's Law of induction.

b. The triangular loop of wire shown in Fig. Q3 carries a current I = 5 A in the direction shown. The loop is in a uniform magnetic field that has magnitude B = 3 T and the same direction as the current in side PQ of the loop. PQ = 0.6 m, PR = 0. 8m

i. Find the force exerted by the magnetic field on each side of the triangle.

ii. What is the net force on the loop?

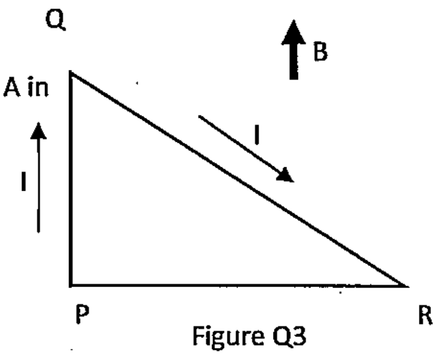


Figure Q3

c. The loop is pivoted about an axis that lies along the side PR. What is the magnitude of the net torque on the loop?

d. When released from rest, under the influence of above torque, it was observed that after sometime the loop reached a constant angular velocity. Explain this observation.

4) a. State the formula for the Capacitance of a parallel-plate capacitor, and discuss briefly how a change in each parameter value affects the capacitance.

b. When a 360 nF air-filled capacitor is connected to a power supply, the energy stored in the capacitor is 1.85×10^{-5} J. While the capacitor is kept connected to the power supply, a slab of dielectric is inserted that completely fills the space between the plates. This increases the stored energy by 2.32×10^{-5} J.

i. What is the potential difference between the capacitor plates?

ii. What is the dielectric constant of the slab?

c. An identical 360 nF air-filled capacitor is connected to an identical power supply as in b. This time an identical dielectric slab is inserted after the capacitor is disconnected from the supply.

iii. What is the voltage across this capacitor when the slab completely fills the space between the plates?

iv. Explain the reason for this change.

5) a. A student using an ammeter comments that two AC branch currents, of 3 A and 5 A respectively, combine together at a point to give a total current of 6.6 A. She states that this is a violation of Kirchhoff's current law. What is your opinion? Explain.

b. For circuit in fig Q5, given L = 250 mH, C = 1.25 μF, and R = 300 Ω. It is found that voltage across the capacitor $e_C(t) = 17 \sin 2000t$ V.

i. Sketch the phasor diagram for the circuit using minimum calculations. (qualitative only)

ii. Based on the phasor diagram, or otherwise, calculate the currents through all the components.

iii. Calculate the value of e(t).

iv. What is the power factor of the circuit?

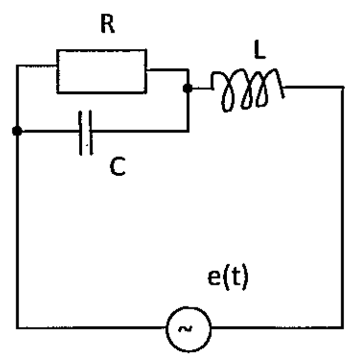


Figure Q5

6) a. What is the characteristic of a (portion of a) circuit at resonance?

b. The circuit in fig. Q5 is brought to resonance with R = 500 Ω and the other components remaining unchanged. The amplitude of the input voltage is fixed at 34 V. Calculate currents through all the components in this situation.

7) a. Sketch and explain the principles of operation of a simple AC generator (dynamo).
b. How can you transform this (without the help of electronic components/circuits) to a DC generator? Explain.
c. What is a simple method of increasing the smoothness of the generated DC output?

d. Go back to simple AC generator. What is the output of a simple half-wave rectifier when it is connected across the output terminals of the simple AC generator?
e. Describe the functioning of the bridge rectifier, and compare this to the half-wave rectifier.

8) a. Describe the Zener breakdown of a pn-junction, and compare this to the avalanche breakdown.

b. Describe how the zener stabiliser circuit reacts when :
i. there is a fluctuation of the source (input) voltage.
ii. there is a fluctuation of the output resistance (load).

c. A zener diode of a stabiliser circuit is given as 8 V / ½ W. I_{Zmin} is given as 250 µA. What is a suitable series resistor value, for this resistor to stabilise a fluctuation of the load between the values 10 kΩ – 20 kΩ? The source voltage is fixed at 20 V.