No: XXXXX

CITY UNIVERSITY

SCHOOL OF ENGINEERING AND MATHEMATICAL SCIENCES

AERONAUTICAL ENGINEERING MEng/BEng (Hons)
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MECHANICAL ENGINEERING MEng/BEng (Hons)
ENGINEERING AND ENERGY MANAGEMENT MEng/BEng (Hons)

PART I EXAMINATION

Electrical Engineering

[EE1.15]

Date:(June 2003) Time:

Answer **THREE** out of **FIVE** Questions

Question 1

(a) State and discuss, using suitable illustrations, Kirchhoff's current and voltage laws for electric circuits.

[4 marks]

(b) For the circuit shown in Fig. Q1, find the current I using the principle of superposition.

[11 marks]

(c) If I_1, I_2 and I_3 are the mesh currents of the circuit shown in Fig. Q1, write down the network equations using mesh analysis (**DO NOT SOLVE**). What is the relationship between I_1, I_2, I_3 and I?

[5 marks]

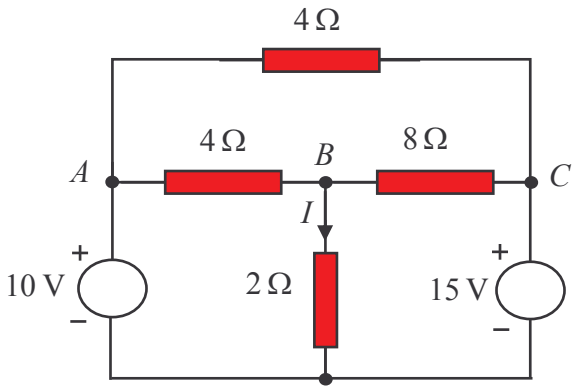


Fig. Q1

Question 2

(a) State Faraday's law for the induced electromotive force *(emf)* and describe two different ways by which induced *emf* can be produced.

[5 marks]

(b) An aircraft has a wingspan of $50\,\text{m}$ and flies at a speed of $1000\,\text{km/h}$. Given that the vertical component of the flux density of the Earth's magnetic field is $4\times10^{-5}\,\text{T}$, calculate the induced voltage between the wing tips. Does the induced voltage depend on the conductivity of the wings?

[8 marks]

(c) The coil of an electric bell has an effective inductance of $2\,\text{H}$. Calculate the *emf* induced in the coil when a current of 0.5 A is reduced to zero in 4 ms (state your assumptions for the derivation of your result).

[4 marks]

(d) If the number of turns of a coil is increased by 50%, determine the increase of the inductance of the coil assuming all other parameters (geometry and core material) remain unchanged.

[3 marks]

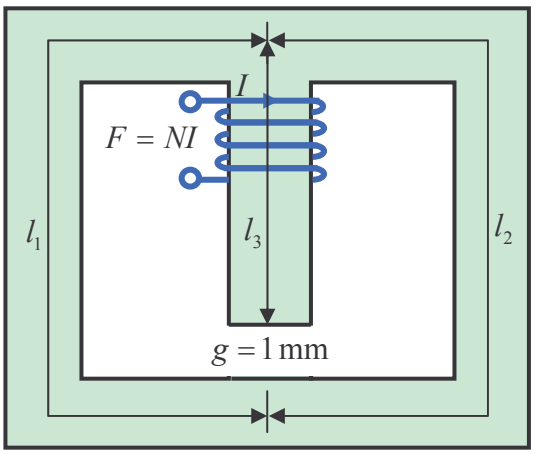
Question 3

(a) State, in the form of a table, the analogies between electric and magnetic circuits.

[5 marks]

(b) A magnetic circuit is arranged as shown in the Fig. Q3. The cross-sectional areas of the centre limb and each side limb are respectively $10\,\text{cm}^2$ and $7\,\text{cm}^2$. The winding on the centre limb has 1000 turns. Calculate the current required in the centre-limb winding to produce a flux of 1 mWb in the air gap. Neglect leakage and fringing. The magnetisation curve of the material of the limbs is as follows:

H (A/m)	150	260	390	550	850	1550
B (T)	0.2	0.4	0.6	0.8	1.0	1.2



$l_1 = l_2 = 40\,\text{cm}$
$l_3 = 10\,\text{cm}$

Fig. Q3

[15 marks]

Question 4

(a) What is meant by resonance in a.c. circuits? Show that the resonance frequency f_0 in an a.c. circuit possessing a resistance (R), inductance (L) and capacitance (C) in series is given by

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

[6 marks]

(b) A circuit having a resistance of $10\,\Omega$, an inductance of 1 H and a capacitance of $100\,\mu$F in series, is connected across a 400 V, 50 Hz supply. That is $v(t) = 400\sin(100\pi t)$.

Calculate:

(i) the impedance of the circuit
(ii) the current
(iii) the voltages across the resistance, inductance and capacitance.

[14 marks]

Question 5

(a) Define an electrical motor and give a brief classification of direct-current motors according to the method of excitation.

[4 marks]

(b) What is meant by the armature reaction in d.c. machines and what measures are taken to reduce it?

[4 marks]

(c) Discuss the speed-load characteristics of d.c. motors. Why should a series motor never be lightly loaded?

[6 marks]

(d) Describe various methods of speed control of d.c. motors.

[6 marks]

Examiner: Dr E Milonidis