Name: _____ **Index No:** _____/_____

1501/102
MECHANICAL SCIENCE I AND
ELECTRICAL PRINCIPLES
Oct/Nov 2012
Time: 3 hours

Candidate's Signature: _____

Date: _____

THE KENYA NATIONAL EXAMINATIONS COUNCIL

CRAFT CERTIFICATE IN MECHANICAL ENGINEERING (PRODUCTION OPTION) MODULE I

MECHANICAL SCIENCE I AND ELECTRICAL PRINCIPLES

3 hours

INSTRUCTIONS TO CANDIDATES

Write your name and index number in the spaces provided above.
Sign and write the date of examination in the spaces provided above.
You should have a non-programmable scientific calculator and drawing instruments for this examination.
*This paper consists of **EIGHT** questions in **TWO** sections **A** and **B**.*
*Answer **FIVE** questions, choosing **TWO** questions from section **A**, **TWO** questions from section **B** and **ONE** question from either section in the space provided from page 7 of this paper.*

For Examiner's Use Only

Section A

Question	1	2	3	4	TOTAL
Marks					

Section B

Question	5	6	7	8	TOTAL
Marks					

GRAND TOTAL _____

This paper consists of 28 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

Turn over

SECTION A

*Answer at least **TWO** questions from this section.*

1. (a) State the following laws of forces:

(i) triangle law;
(ii) polygon law.

(4 marks)

(b) **Figure 1** shows a load of mass 100 kg suspended by two chains from a crane rail. Determine the tension in each chain. Take g = 10 m/s^2. (6 marks)

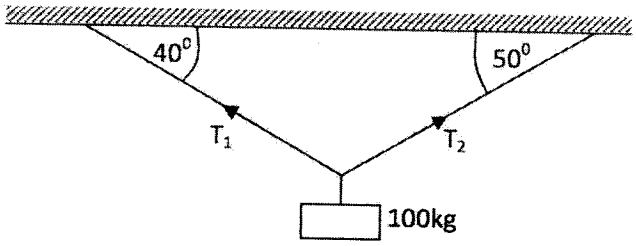

Figure 1

(c) **Figure 2** shows a system of four coplanar forces. Determine the:

(i) magnitude of the resultant force;
(ii) inclination of the resultant force to the horizontal.

(10 marks)

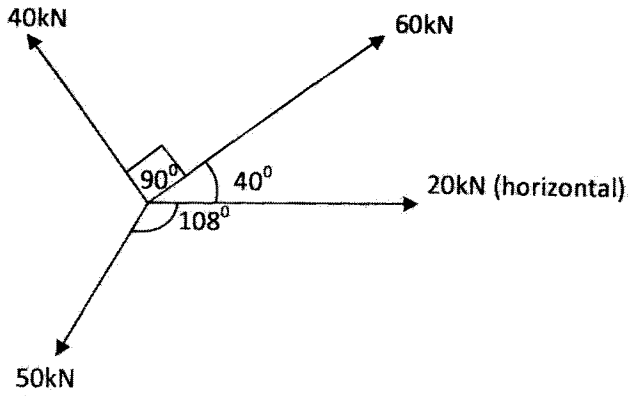

Figure 2

2. (a) State any:

(i) **three** engineering applications of friction;
(ii) **two** methods of reducing friction in machines.

(5 marks)

(b) Explain the term 'angle of friction'. (2 marks)

(c) A body of mass 100 kg rests on a plane inclined at 20° to the horizontal. Taking $\mu = 0.34$, determine the magnitude of the force **P** acting parallel to the plane, required to:

(i) cause upward motion;
(ii) prevent downward motion.

(13 marks)

3. (a) State the following Newton's laws of motion:

(i) first law;
(ii) third law.

(4 marks)

(b) A locomotive starts from rest, accelerates uniformly for 10 seconds, continues at a uniform velocity for 30 seconds. It then retards uniformly to rest in 5 seconds. The total distance travelled is 800 metres.

(i) Sketch the velocity-time graph.
(ii) Determine the:

(I) maximum velocity attained.
(II) acceleration and retardation.
(III) distance travelled in the first 20 seconds.

(14 marks)

(c) A 300 mm diameter pulley rotates at 360 rev/min. Determine the linear velocity of a point on the pulley rim. (2 marks)

4. (a) Define the following terms:

(i) potential energy;
(ii) power.

(2 marks)

(b) A body of mass 20 kg falls freely from a height of 100 metres. Determine the:

(i) velocity of the body on hitting the ground;
(ii) kinetic energy of the body after falling through 20 metres;
(ii) potential energy of the body after falling for 3 seconds.

(12 marks)

(c) A crane raises a load of 800 kg vertically through a height of 15 metres in 8 seconds. The efficiency of the crane is 75%. Determine the:

(i) work done;
(ii) power developed by the crane;
(iii) energy used.

(6 marks)

SECTION B

*Answer at least **TWO** questions from this section.*

5. (a) State any **four** factors which affect the electrical resistance of a wire. (4 marks)

(b) An electrical conductor has a resistance of 250Ω at 15°C, and 280Ω at 45°C. Determine the:

(i) temperature coefficient of resistance;
(ii) resistance of the conductor at:

(I) 0°C;
(II) 100°C.

(6 marks)

(c) **Figure 3** shows an electrical circuit. Using Kirchoff's laws, determine the:

(i) current through the 10Ω resistor;
(ii) voltage across the 10Ω resistor.

(10 marks)

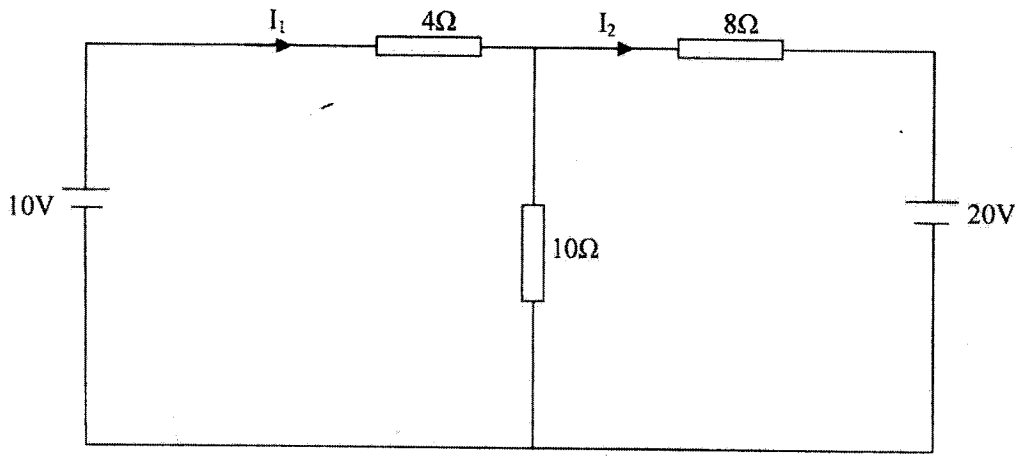

Figure 3

6. (a) State Faraday's laws of electrolysis. (4 marks)

(b) With the aid of a labelled diagram, describe the construction of a lead-acid cell. (8 marks)

(c) **Two** cells **P** and **Q** are connected in series as shown in figure 4. The power dissipated in cell **P** is 80 watts. Determine the:

(i) internal resistance of each cell;
(ii) power dissipated in cell **Q**.

(8 marks)

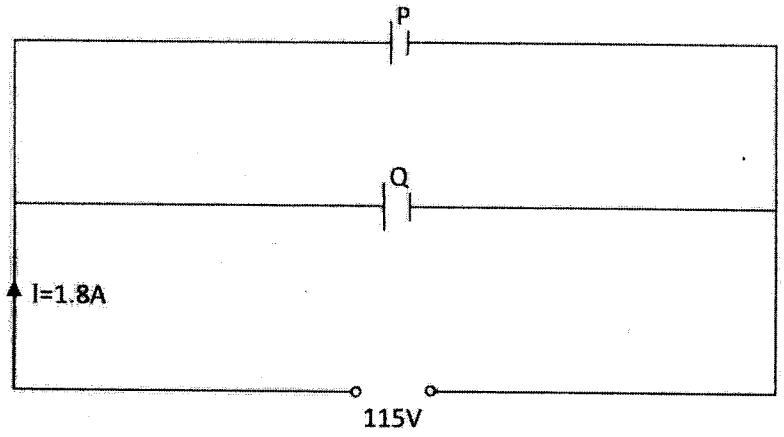

Figure 4

7. (a) Define the following terms as applied to magnetic circuits:

(i) magnetic flux;
(ii) reluctance.

(4 marks)

(b) (i) Distinguish between the following:

(I) intrinsic and extrinsic semiconductors;
(II) valence and conduction bands.

(ii) With the aid of diagrams, describe the following methods of biasing a **P-N** junction diode:

(I) forward bias;
(II) reverse bias.

(8 marks)

(c) **Figure 5** shows capacitors connected in series across a direct current supply. Calculate the:

(i) total charge;
(ii) voltage across the $2\mu F$ capacitor;
(iii) energy stored in the $5\mu F$ capacitor.

(8 marks)

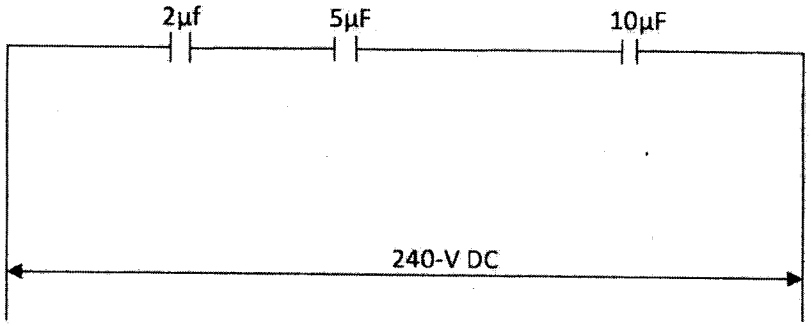

Figure 5

8. (a) State any **two** methods of improving power factor. (2 marks)

(b) Explain the following as applied to alternating current:

(i) amplitude;
(ii) phase angle;
(iii) root mean square value.

(6 marks)

(c) **Figure 6** shows an alternating current circuit. Determine the:

(i) total impedance;
(ii) current flowing in the circuit;
(iii) power factor;
(iv) voltage drop across the inductor;
(v) power dissipated in the resistor.

(12 marks)

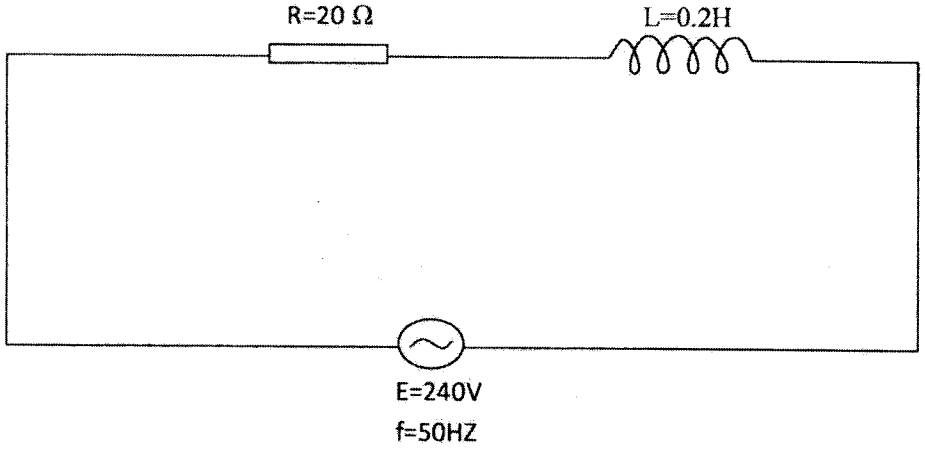

Figure 6