



SLIATE
SRI LANKA INSTITUTE OF ADVANCED TECHNOLOGICAL EDUCATION
(Established in the Ministry of Higher Education, vide in Act No. 29 of 1995)

Higher National Diploma in Engineering (Electrical & Electronic)
First Year, First Semester Examination – 2017
EE 1102 -Engineering Science

Instructions for Candidates:
Answer any **four (4)** questions.
All questions carry equal marks.

No. of questions: 5
No. of pages : 4
Time : Two (2) hours

1. (a) A crank lever ABC weighs 0.2 N/mm with a tension spring (T) as shown in Figure Q1a. Determine the tension developed in the spring, when a load of 100 N is applied at A.

[5 marks]

- (b) A uniform wheel of 600 mm diameter, weighing 5 kN rests against a rigid rectangular block of 150 mm height as shown in Figure Q1b. Considering all the surface to be smooth, Find,

i). The least pull, through the center of the wheel, required just to turn the wheel over the corner A of the block.

ii). The reaction on the block from wheel.

[10 marks]

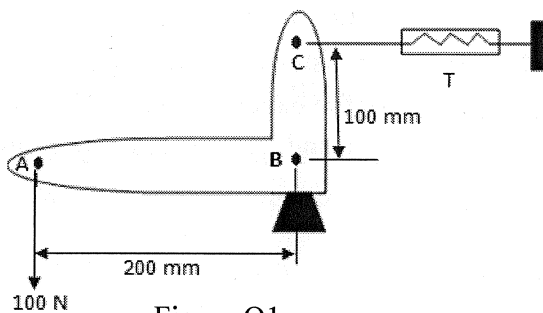


Figure Q1a

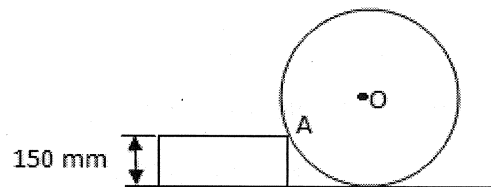


Figure Q1b

(c) A uniform ladder 3 m long weighs 200 N rests on a horizontal ground and leans against a vertical wall at an angle of 60° with the horizontal. The coefficient of friction between the wall and the ladder is 0.25 and that between the ground and the ladder is 0.35. The ladder, in addition to its own weight, has to support a man of 1000 N at its top end.

Calculate,

- i). The horizontal force P to be applied to ladder at the ground to prevent slipping.
- ii). If the force P is not applied, what should be the minimum inclination of the ladder with the horizontal, so that there is no slipping of it with the man at its top.

[10 marks]

2. (a). Two electric trains A and B leave the same station on parallel lines. First train A starts from rest with a uniform acceleration of 0.2 ms^{-2} and reaches a speed of 45 kmh^{-1} , which is maintained constant afterwards. The train B leaves 1 minute later, with a uniform acceleration of 0.4 ms^{-2} to reach a maximum speed of 72 kmh^{-1} , which is maintained constant afterward. Calculate,

- i). Time taken by the train A to reaches its maximum speed.
- ii). Distance travelled by the train B to reaches its maximum speed.
- iii). When will the train B overtake train A?

[15 marks]

(b). An aero plane is flying on a straight level at height of 1000 m and constant velocity of 200 kmh^{-1} above the ground. An anti-aircraft gun located on the ground fires a shell at an initial velocity of 300 ms^{-1} at the instant when the plane is vertically above it.

Calculate,

- i). The inclination of the gun to the horizontal to hit the plane.
- ii). Time taken to gun shell to hit the plane.
- iii). Horizontal distance to the plane from the gun at the target.

[10 marks]

3. (a). Two batteries A and B are joined in parallel and a 10Ω resistor is connected across the battery terminals. The emf and the internal resistance of the battery A are 12 V and 5Ω respectively and the corresponding values of battery B are 9 V and 3Ω respectively. Find,

- i). The value and direction of current in each battery
- ii). The terminal voltage
- iii). The rate of power loss in 10Ω resistor
- iv). The emf of a battery having internal resistance 2Ω for the above combination of two batteries.

[15 marks]

(b). An electrical conductor is to be designed from nichrome ribbon so that power dissipation will be 60 W at 240 V main supply.

i). Calculate the resistance of the conductor.

ii). The nichrome ribbon is having 1mm width, 0.05 mm thickness and $1.2 \times 10^{-6} \Omega\text{m}$ resistivity. Calculate the length of the ribbon require for above conductor.

[10 marks]

4. (a). Write the Biot-Savart law in the form of mathematical expression. Clearly identify all symbols that you used and the direction with the help of diagram. [4 marks]

(b). Long, closely wound solenoid with n turns per unit length carries a current I . Write down an expression for the magnetic flux density B in the solenoid along its axis. [4 marks]

(c). A 2000 turn solenoid of length 40 cm and resistance 15Ω is connected to a 20 V supply. What is the flux density at the midpoint of the axis of the solenoid? [5 marks]

(d). A single turn of wire of cross sectional area 5 cm^2 is at perpendicular to the magnetic field of 0.05 T, which is reduced to 0 T within 10 s at a steady rate. What is the emf induced in the wire. [6 marks]

(e). A copper wire of cross sectional area $3 \times 10^{-6} \text{ m}^2$ carries a current of 10 A. Copper has a molecular weight $63.5 \times 10^{-3} \text{ kg}$ and density of 8920 kgm^{-3} . Find the drift velocity of the electrons in the wire assuming each copper atom contributes one free electron to the metal. [6 marks]

5.(a). Energy demand of a city is $6 \times 10^3 \text{ MWh}$ per year and wind mills are used to fulfill this requirement. Wind blows along a horizontal direction in an open space at a constant velocity V and density of air is ρ .

i). Calculate the above energy demand per year in Joules.

ii). Show that the rate at which the wind energy transferred to the windmill is $(\rho A V^3)/2$. Where the area swept by the rotating blade is A .

iii). If $\rho = 1.3 \text{ kg/m}^3$, $A = 20 \text{ m}^2$, $V = 10 \text{ ms}^{-1}$ and the efficiency of a mill is 20 %, calculate how many wind mills needed to satisfy the electrical energy requirement.

[15 marks]

(b). A string of electrical lamps for decorating a Vesak lanterns consist of 20, 12 V lamps connected in series across the 240 V main supply. Each has 120Ω resistances.

i). Calculate the power consumption of the whole string.

ii). Calculate the electricity bill for a day, if lamps are working 4 hours daily.

[10 marks]

Tariff block	1 - 30	31 - 60	61 - 90	90 - 120
Unit rate Rs/Wh	7.75	8.25	10.00	27.50

Table 1

2. (a) A single turn of wire of cross sectional area 2 cm^2 is at perpendicular to the magnetic field of 0.02 T , which is reduced to 0 T within 10 s at a steady rate. What is the emf induced in the wire. [15 marks]

(b) A train A starts from rest and reaches a speed of 10 m/s in 10 s . A train B starts from rest and reaches a speed of 20 m/s in 20 s . When will the train B overtake train A? [10 marks]

(c) A 2000 turn solenoid of length 40 cm and resistance 12Ω is connected to a 20 V supply. Calculate the magnetic flux density B in the solenoid along its axis. [5 marks]

(d) A copper wire of cross sectional area $3 \times 10^{-6} \text{ m}^2$ carries a current of 10 A . Copper has a molecular weight $63.5 \times 10^{-3} \text{ kg}$ and density of 8920 kg/m^3 . Find the drift velocity of the electrons in the wire assuming each copper atom contributes one free electron to the metal. [10 marks]

(e) The inclination of the gun to hit the plane. [10 marks]

(f) Time taken to gun shell to hit the plane. [10 marks]

(g) Horizontal distance to the plane from the gun at the target. [10 marks]

(h) Energy demand of a city is 0.1 MWh per year and wind mills are used to fulfill this requirement. Wind blows along a horizontal direction in an open space at a constant velocity V and density of air is ρ . [10 marks]

(i) Calculate the above energy demand per year in joules. [10 marks]

(ii) Show that the rate at which the windmill transfers energy to the windmill is $\frac{1}{2} \rho A V^3$. Where the area swept by the rotating blade is A . [10 marks]

(iii) The rate of power loss in the resistor. [10 marks]

(iv) emf of a battery having internal resistance r for the above combination of two batteries. [15 marks]