Date of Examination :09/12/2019

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Mechanical and Production Engineering
Program: B.Sc. in Computer Science and Engineering
Semester Final Examination, Spring-2019

Year: 1st **Semester: 2nd**

Course No: ME 1211 **Course Name: Basic Mechanical Engineering**

Time: 3 (Three) hours **Full marks: 210**

Use separate answer script for each section

Section-A

Instructions:
i) There are **4 (Four) Questions, Answer any 3 (Three)**
ii) Marks allotted are indicated in the **right margin**
iii) Assume any reasonable data if needed
iv) Symbols and characters have their usual meaning

Question 1. [Marks: 35]

a) Define system, boundary and surroundings. [6]

b) What are the key requirements for a system to be in thermodynamic equilibrium? [6]

c) What is Zeroth law of thermodynamics? What do you understand by the path function and point function? [6]

d) Show that for a quasi-static process in which $pV^n = C$ *(where n is a constant)*, $W_{1-2} = p_1V_1 - p_2V_2$ where symbols have their usual meaning. [7]

e) At the beginning of the compression stroke of a two cylinder internal combustion engine the air is at a pressure of 101.325 kPa. Compression reduces the volume to 1/5 of its original volume, and the law of compression is given by $pV^{1.2} = constant$. If the bore and stroke of each cylinder is 100mm and 200mm respectively, determine the power absorbed in kW by compression strokes when the engine speed is such that each cylinder undergoes 500 compression strokes per minute. [10]

Question 2. [Marks: 35]

a) State the 1st law of thermodynamics. [3]

b) A gas undergoes a thermodynamic cycle consisting of following processes: [14]
(i) Process 1-2: constant pressure; p = 1.4 bar, V_1 = 1.5 m^3, W_{1-2} = 10.5 kJ
(ii) Process 2-3: Compression with pV = constant; U_3=U_2
(iii) Process 3-1: constant volume; U_1-U_3 = -26.4 kJ
There are no significant changes in KE and PE. Show that $\sum_{cycle} Q = \sum_{cycle} W$

c) Define heat engine and heat pump. Show that, $COP_{HP} = COP_R + 1$. [5]

d) State the Kelvin Planck statement of the 2nd law of thermodynamics. Briefly describe the perpetual motion machine of second kind. [5]

e) A steam power plant generates 310,000 kg/h of steam and has an output of 95,000kW of power. The plant consumes 34,000 kg/h of coal, which has an energy content of 30,000 kJ/kg. Determine: [8]

(i) the overall plant thermal efficiency, (ii) if the energy added to the steam from the combustion of coal in the steam generation unit is 2730 kJ/kg, what fraction of the energy released from the coal is added to the steam.

Question 3. [Marks: 35]

a) Define mean effective pressure and brake power of an IC engine. [4]

b) With necessary sketches, describe the working principle of a four stroke internal combustion engine. [6]

c) Discuss the comparison between two stroke and four stroke internal combustion engine. [5]

d) State the four processes of diesel cycle. Show that the efficiency of the Otto cycle depends only on the compression ratio. [8]

e) In an air standard diesel cycle, the compression ratio is 15. Compression begins at 0.1 MPa, 40°C. The heat as added 1.675 MJ/kg. Determine: (i) the maximum temperature of the cycle, (ii) the cycle efficiency, (iii) the cut off ratio and (iv) the mep of the cycle. [12]

Question 4. [Marks: 35]

a) Define thermal conductivity? [3]

b) Discuss the mechanism of heat convection. [6]

c) A composite wall is formed of a 2.5 cm copper plate, a 3.2 mm layer of asbestos, and a 5 cm layer of fiber glass. The wall is subjected to an overall temperature difference of 560°C. Calculate the heat flow per unit area through the composite structure. [12]

d) Describe the working principle of the vapor compression refrigeration system with flow chart and T-s diagram. [9]

e) What is throttling? Write down the limitations of reverse Carnot cycle. [5]

Section B

Instructions: i) There are **4 (Four) Questions** in this section, **Answer any 3 (Three)**
ii) **Marks** allotted are **indicated in the margin**
iii) Necessary **Figures** are **attached at the end of the question paper**
iv) Assume any reasonable data if needed
v) Symbols and characters have their usual meaning

Question 5. [35 marks]

a) A frame ABC is supported in part by cable DBE that passes through a frictionless ring at B as shown in **Figure Q 5(a)**.Knowing that the tension in the cable is 385 N, determine the components of the force exerted by the cable on the support at D & E. **(20)**

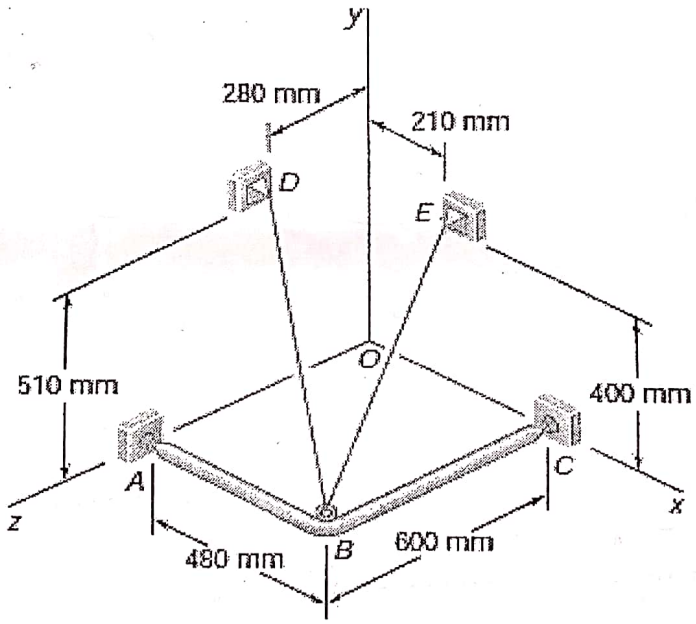

Figure: Q 5 (a)

b) Two cables are tied together at C and loaded as shown in **Figure Q 5 (b)** Determine the range of values of P for which both cables remain taut. **(15)**

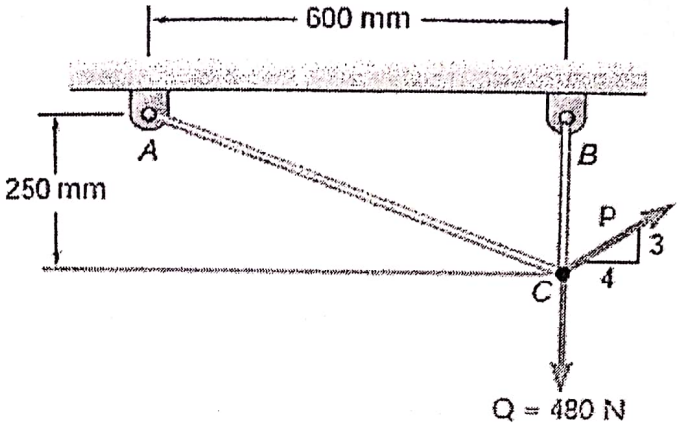

Figure: Q 5 (b)

Question 6. [35 marks]

a) A lever AB is hinged at C and attached to a control cable at A as shown in **Figure Q 6 (a)**If the lever is subjected to a 75-lb vertical force at B, determine **(15)**
(i) The tension in the cable
(ii) The reaction at C.

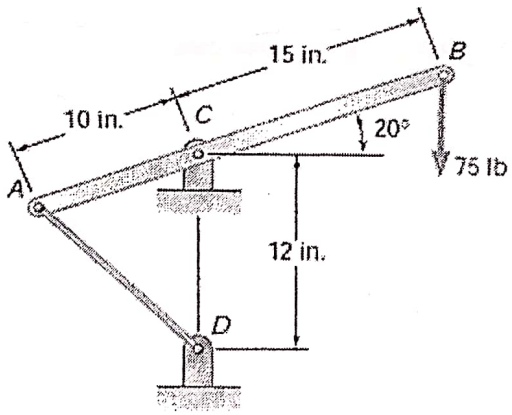

Figure: Q 6 (a)

b) In the frame shown in **Figure Q 6 (b)** members ACE and BCD are connected by a pin at C and by the link DE. For the loading shown, determine the force in link DE and the components of the force exerted at C on member BCD. **(20)**

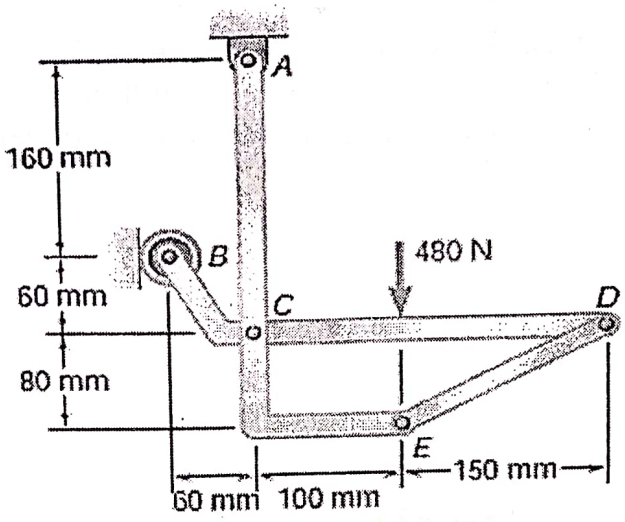

Figure: Q 6 (b)

Question 7. [35 marks]

a) Block B starts from rest and moves downward with a constant acceleration as shown in **Figure Q 7 (a).** Knowing that after slider block A has moved 9 in. its velocity is 6 ft/s, determine **(20)**

(i) The accelerations of A and B

(ii) The velocity and the change in position of B after 2 s.

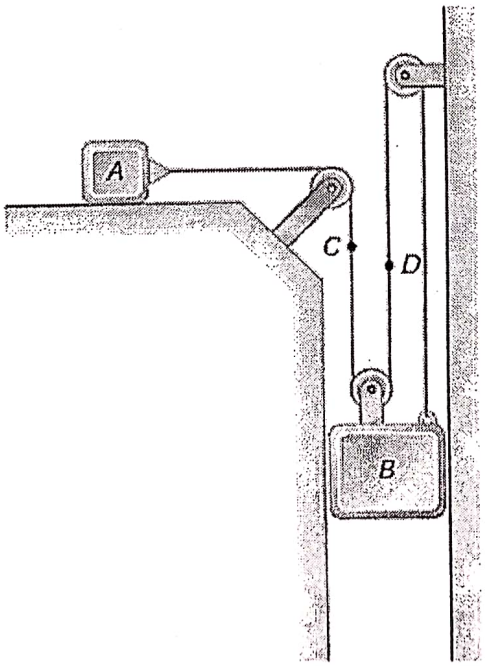

Figure: Q 7 (a)

b) A small package is released from rest at A and moves along the skate wheel conveyor ABCD as shown in **Figure Q 7 (b).** The package has a uniform acceleration of 4.8 m/s^2 as it moves down sections AB and CD, and its velocity is constant between B and C. If the velocity of the package at D is 7.2 m/s, determine **(15)**

(i) The distance d between C and D

(ii) The time required for the package to reach D.

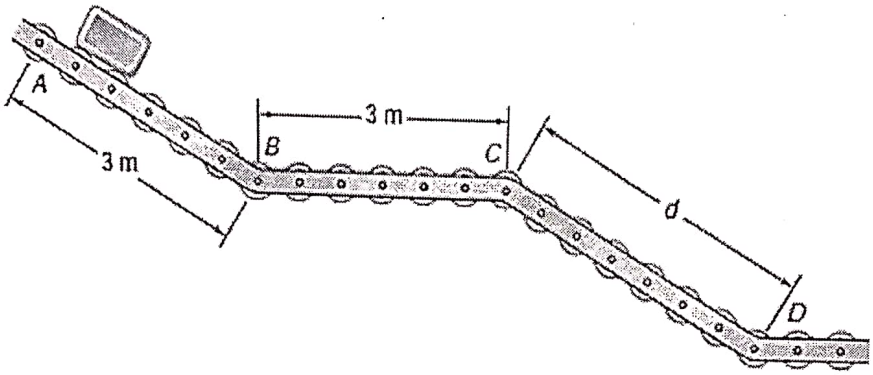

Figure: Q 7 (b)

Question 8. [35 marks]

a) The two blocks shown in **Figure Q 8 (a)** start from rest. The horizontal plane and the pulley are frictionless and the pulley is assumed to be of negligible mass. Determine (i) The acceleration of each block (ii) The tension in each cord. **(15)**

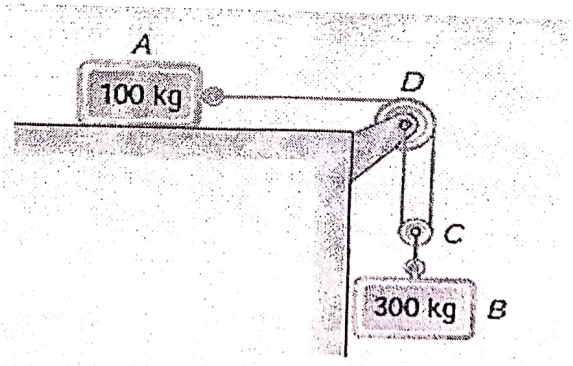

Figure: Q 8 (a)

b) The bob of a 2-m pendulum describes an arc of circle in a vertical plane. If the tension in the cord is 2.5 times the weight of the bob for the position shown in **Figure Q 8 (b)** find the velocity and the acceleration of the bob in that position. **(10)**

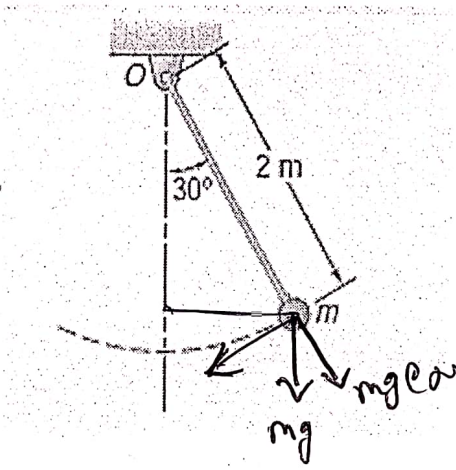

Figure: Q 8 (b)

$mg\cos\theta = 2.5\ m$

$mg\sin\theta =$

c) Write short notes on (i) SCARA Robot
(ii) Articulated (3R) Robot **(10)**

$a = \frac{1}{2}$