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UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
DEHRADUN
End Semester Examination - December, 2020

Program/Course : B. Tech Chemical Engg. (Spl. in RP)
Subject: Transport Phenomena
Code: CHCE 2014
No. of pages: 2

Semester: III
Max. Marks: 100
Duration: 3 hrs

NOTE:

(A) **OPEN BOOKS and OPEN NOTES EXAMINATION**

(B) Assume all missing data. **State your assumptions clearly.** Sketch wherever necessary.

Section A **ANSWER ALL QUESTIONS** [2 x 30 marks = 60 marks]

1. Oil spills on water can be removed by lowering a moving belt of width W into the water. The belt moves upward and skims the oil into a reservoir aboard the ship as shown in the figure below (Fig. 1).

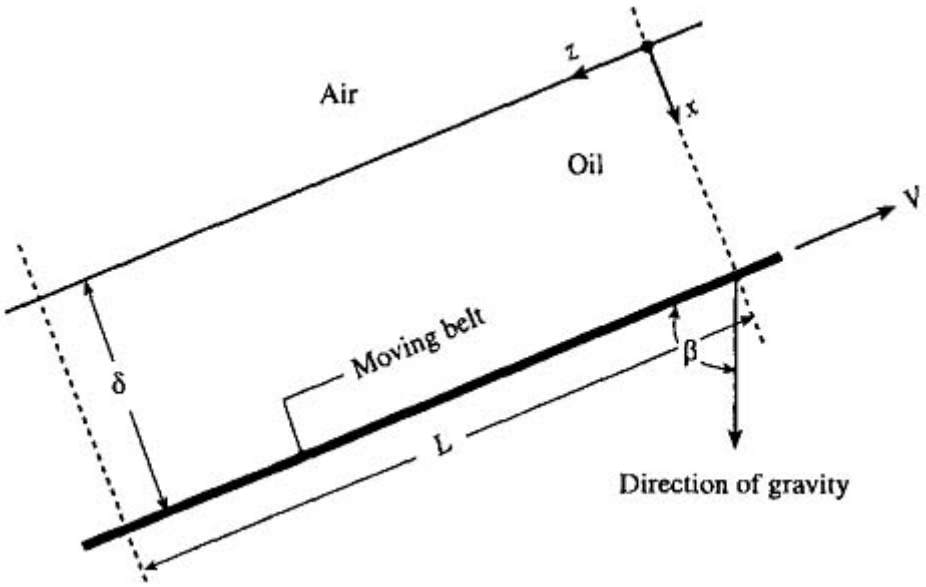

Figure 1: Schematic diagram for removal of oilspill using moving belt

(a) Derive the velocity profile equation and volumetric flow rate

(b) Determine the belt speed that will give a zero volumetric flow rate and specify the design criteria for positive and negative flow rates.

[30 marks]

2. A 3-mm-diameter and 5-m-long electric wire is tightly wrapped with a 2-mm thick plastic cover whose thermal conductivity is k=0.15 W/m °C. Electrical measurements indicate that a current of 10 A passes through the wire and there is a voltage drop of 8 V along the wire. If the insulated wire is exposed to a medium at T_∞ = 30°C with a heat transfer coefficient of h=**(Last two digits of your Roll No.)** W/m^2°C, determine the temperature at the interface of the wire and the plastic cover in steady operation. Also determine whether doubling the thickness of the plastic cover will increase or decrease this interface temperature.

[30 marks]

SectionB [1 x 40 marks = 40 marks]

1. Clothing made of several thin layers of fabric with trapped air in between, often called ski clothing, is commonly used in cold climates because it is light, fashionable, and a very effective thermal insulator. So it is no surprise that such clothing has largely replaced thick and heavy old-fashioned coats (Fig. 2).

   Consider a jacket made of five layers of 0.1-mm-thick synthetic fabric (k = **(Last two digits of your Roll No.)** $\times 10^{-2}$ **W/m**°C) with 1.5-mm-thick air space (k=0.026 W/m°C) between the layers. Assuming the inner surface temperature of the jacket to be 28°C and the surface area to be 1.1 m^2, determine the rate of heat loss through the jacket when the temperature of the outdoors is -5°C and the heat transfer coefficient at the outer surface is 25 W/m^2°C.

   What would your response be if the jacket is made of a single layer of 0.5-mm-thick synthetic fabric? What should be the thickness of a wool fabric (k=0.035 W/m°C) if the person is to achieve the same level of thermal comfort wearing a thick wool coat instead of a five-layer ski jacket?

Figure 2: Schematic for ski jacket

[40 marks]