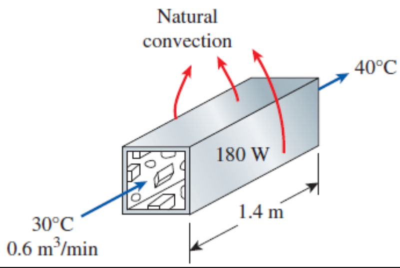
Name: Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Course : Thermodynamics and Heat transfer **Semester : III**
Program : B.tech ASE, ASE+AVE **Time :03 hrs.**
Course Code: MECH 2022 **Max. Mark : 100**

1. **Instructions: The Question paper has three sections: Section A, B and C.**
2. **Section B and C have internal choices.**
3. **Assume the suitable data if needed**

	SECTION A [4 x 5]		
Q. No.		**Marks**	**CO**
1	Draw the ideal and real Brayton cycle also discuss the isentropic efficiency of compressor and turbine.	**04**	**CO2,CO4,CO5**
2	Discuss the application of first law and explain why it is called as quantitative law.	**04**	**CO1,CO2**
3	Compare the Clausius inequality for reversible and irreversible cycle.	**04**	**CO1,CO2**
4	Explain the Newton's law of cooling and discuss the physical significance of dimensionless no in convection heat transfer.	**04**	**CO1,CO3**
5	Analyze and compare out of following case a given heat flow and for the same thickness the temperature drop across the material will be maximum. a. Copper b. Steel c. Glass wool d. Refractory bricks	**04**	**CO1,CO3**
	SECTION B [8 x 5]		
6	Derive the efficiency of Otto cycle through P-V and T-S plot.	**08**	**CO2,CO4,CO5**
7	A 1-m^3 tank containing air at 10°C and 350 kPa is connected through a valve to another tank containing 3 kg of air at 35°C and 200 kPa. Now the valve is opened, and the entire system is allowed to reach thermal equilibrium with the surroundings, which are at 20°C. Determine the volume of the second tank and the final equilibrium pressure of air.	**08**	**CO1,CO2**
8	An ideal gas expands in an adiabatic turbine from 1200 K and 900 kPa to 800 K. Determine the turbine inlet volume flow rate of the gas, in m^3/s, required to produce turbine work output at the rate of 650 kW. The average values of the specific heats	**08**	**CO1,CO2**

	for this gas over the temperature range and the gas constant are Cp = 1.13 kJ/kg·K, Cv = 0.83 kJ/kg·K, and R = 0.30 kJ/kg·K. **Or** The components of an electronic system dissipating 180 W are located in a 1.4-m-long horizontal duct whose cross section is 20 cm X 20 cm. The components in the duct are cooled by forced air that enters the duct at 30°C and 1 atm at a rate of 0.6 m^3/min and leaves at 40°C. Determine the rate of heat transfer from the outer surfaces of the duct to the ambient.  		
9	A 4-m x 5-m x 7-m room is heated by the radiator of a steam-heating system. The steam radiator transfers heat at a rate of 10,000 kJ/h, and a 100-W fan is used to distribute the warm air in the room. The rate of heat loss from the room is estimated to be about 5000 kJ/h. If the initial temperature of the room air is 10 ^{0}C, determine how long it will take for the air temperature to rise to 20 ^{0}C. Assume constant specific heats at room temperature. Consider the same question if the heat is transferred through 4 side of the wall, what will be thickness of wall if the outside temperature is 5°C having thermal conductivity is 0.8 W/m-K and inside convection heat transfer coefficient is 2 W/m^2-K. Take wall area 5 x 7 m^2.	**08**	**CO1,CO2,CO3**
10	Derive the equation of heat transfer for the following cases under the steady state, uniform thermal conductivity and 1 dimensional conduction condition. a. Conduction heat transfer through a slab b. Conduction heat transfer through hollow cylinder **Or** Consider a cicular pipe in which hot gas passed inside and outside area cover through insulation and their radius is R_1, R_2 and R_3 at inner, outer and insulation respectively. Define the overall heat transfer coeffiecnt for following condition and compare the maximum heat transfer coefficient a. Based on inside convection area (U_i) b. Based on outside convection area (Uo)	**08**	**CO1,CO3**
SECTION-C [20 x 2]			
11	a) A heat pump supplies heat energy to a house at the rate of 140,000 kJ/h when the house is maintained at 25°C. Over a period of one month, the heat pump operates for 100 hours to transfer energy from a heat source outside the house to inside the house. Consider a heat pump receiving heat from two different outside energy sources. In one application, the heat pump receives heat from the outside air at 0°C. In a second application, the heat pump receives heat from a lake having a water temperature of 10°C. If electricity costs rupees 8	**20**	**CO1,CO2**

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/kWh, determine the maximum money saved by using the lake water rather than the outside air as the outside energy source. **[10]**

b) Air enters a nozzle steadily at 280 kPa and 77°C with a velocity of 50 m/s and exits at 85 kPa and 320 m/s. The heat losses from the nozzle to the surrounding medium at 20°C are estimated to be 3.2 kJ/kg. Determine (a) the exit temperature and (b) the total entropy change for this process. **[10]**

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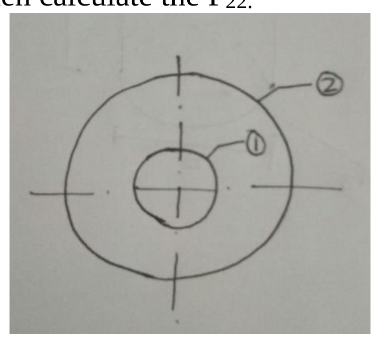
A commercial airplane is modelled as a flat plate, which is 1.5 m wide, and 8 m long in size. It is maintained at 20°C. The airplane is flying at a speed of 800 Km/hr in air at 0°C and 60 cm of Hg pressure. Calculate the heat loss from wing if the flow is made to flow parallel to the width of the wing. The properties of air at avg temp. 10°C, conductivity (K) = 2.511×10^{-2} W/m-K and Kinematics viscosity = 14.16×10^{-6} m^2/ sec. Pr = 0.705

Or

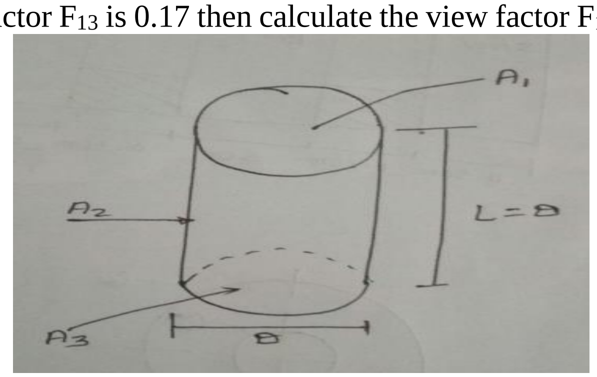
a. The cross section of very long black body enclosures consists of a semicircle with its diameter D as base. The temperature of a semi-circle is 1000K and that of diameter is 500 K. determine the shape factors for diameter-semicircle combinations and the radiation heat transfer rate per unit width (in terms of D). Take Stephan Boltzmann constant = 5.64×10^{-8} W/m^2-K. **[10]**

b. Derive the shape factor for the following cases.

i. Consider two infinitely long thin concentric tubes of circular cross section as shown in fig. if the D_1 and D_2 are the dia of inner and outer tube respectively then calculate the F_{22}. **[05]**



ii. Consider tube of equal length and diameter shown in the figure below the view factor F_{13} is 0.17 then calculate the view factor F_{12}. **[05]**



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