Name: **Enrolment No:**	UPES UNIVERSITY WITH A PURPOSE

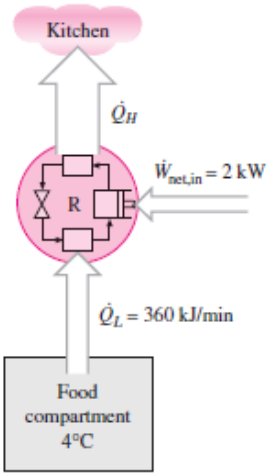
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2019

Program Name: M. Tech Rotating Equipment **Semester – I**
Course Name : Advanced Thermodynamics and heat transfer **Max. Marks : 100**
Course Code : MERE-7002 **Duration : 3 Hrs**
No. of page/s:

Instructions: All the questions are compulsory.
Steam table and heat and mass transfer data book is allowed

SECTION A (Attempt all of the following)

S. No.		Marks	CO
Q 1	A 1000-W iron is left on the ironing board with its base exposed to the air at 20°C. The convection heat transfer coefficient between the base surface and the surrounding air is 35 W/m² °C. If the base has an emissivity of 0.6 and a surface area of 0.02 m², determine the temperature of the base of the iron.	5	CO4
Q 2	An ice skater blows into cupped hands to warm them, yet at lunch blows across a bowl of soup to cool it. How can this be interpreted thermodynamically?	5	CO2
Q 3	Water is to be heated at constant pressure from 25°C to 80°C .If the heat source is at constant temperature of 500°C and the ambient temperature is 20°C, what would be the gain in availability of water and effectiveness of the heating process. For water C_p=4.187kj/kgK	5	CO2
Q 4	The food compartment of a refrigerator, shown in Figure is maintained at 4°C by removing heat from it at a rate of 360 kJ/min. If the required power input to the refrigerator is 2 kW, determine (*a*) The coefficient of performance of the refrigerator and (*b*) The rate of heat rejection to the room that houses the refrigerator.	5	CO1

			
SECTION B (Attempt all the following questions)			
Q 5	The engine cylinder of a motorcycle is constructed of 2024-T6 aluminum alloy and is of height H =0.15 m and outside diameter D=50 mm. Under typical operating conditions the outer surface of the cylinder is at a temperature of 500 K and is exposed to ambient air at 300 K, with a convection coefficient of 50 W/m² K. Annular fins are integrally cast with the cylinder to increase heat transfer to the surroundings. Consider five such fins, which are of thickness t =6 mm, length L=20 mm, and equally spaced. What is the increase in heat transfer due to use of the fins?	10	CO3
Q 6	Steam is to be condensed in the condenser of a steam power plant at a temperature of 60°C with cooling water from a nearby lake that enters the tubes of the condenser at 15°C at a rate of 140 kg/s and leaves at 25°C. Assuming the condenser to be perfectly insulated, determine (*a*) The rate of condensation of the steam (*b*) The rate of exergy destruction in the condenser. OR Air enters a 3600-kW turbine operating at steady state with a mass flow rate of 18 kg/s at 800°C, 3 bar and a velocity of 100 m/s. The air expands adiabatically through the turbine and exits at a velocity of 150 m/s. The air then enters a diffuser where it is decelerated isentropically to a velocity of 10 m/s and a pressure of 1 bar. Employing the ideal gas model, determine (a) the pressure and temperature of the air at the turbine exit, in bar and °C, respectively. (b) The rate of entropy production in the turbine, in kW/K. (c) Show the processes on a T–s diagram.	10	CO2
Q 7	Derive the heat conduction equation in one dimension steady state in Cartesian coordinates.	10	CO3

Q 8	Airflow through a long rectangular heating duct that is 0.75 m wide and 0.3 m high maintains the outer duct surface at 45°C. If the duct is uninsulated and exposed to air at 15°C in the crawlspace beneath a home, what is the heat loss from the duct per meter of length?	10	CO4
SECTION C(Attempt all of the following questions)			
Q 9	Explain the concept of reversible and useful work? Derive the expression for useful work for a closed system. **Or** A system consists of 2 m^3 of hydrogen gas (H_2), initially at 35°C, 215 kPa, contained in a closed rigid tank. Energy is transferred to the system from a reservoir at 300°C until the temperature of the hydrogen is 160°C. The temperature at the system boundary where heat transfer occurs is 300°C. Modeling the hydrogen as an ideal gas, determine the heat transfer, in kJ, the change in entropy, in kJ/K, and the amount of entropy produced, in kJ/K. For the reservoir, determine the change in entropy, in kJ/K. Why do these two entropy changes differ?	20	CO1
Q 10	A furnace cavity, which is in the form of a cylinder of 50-mm diameter and 150-mm length, is open at one end to large surroundings that are at 27°C. The bottom of the cavity is heated independently, as are three annular sections that comprise the sides of the cavity. All interior surfaces of the cavity may be approximated as blackbodies and are maintained at 1650°C. What is the required electrical power input to the bottom surface of the cavity? What is the electrical power to the top, middle, and bottom sections of the cavity sides? The backs of the electrically heated surfaces are well insulated. .	20	CO5