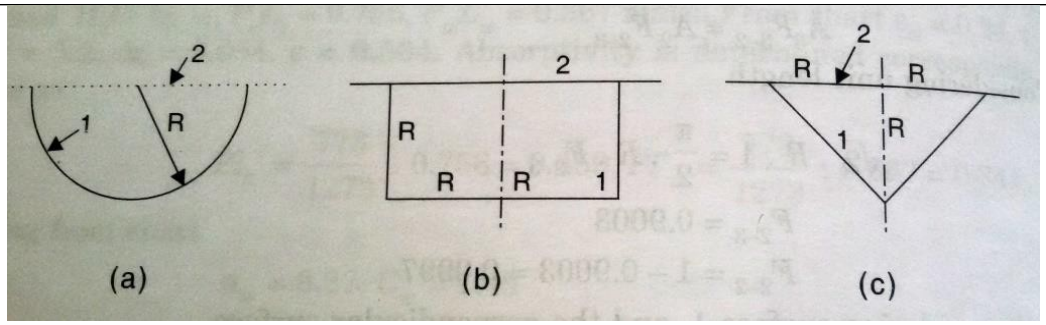
Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: Advanced thermodynamics and heat transfer **Semester: I**
Programme : M. Tech RE (MERE-7002)
Time: 03 hrs. **Max. Marks: 100**
Instructions: Use of heat transfer Data book is allowed

SECTION A

S. No.		Marks	CO
1	Apply Reynold number, Prandtl number and Nusselt number in heat transfer applications.	**4**	**CO3**
2	Under what conditions can a counter flow heat exchanger have an effectiveness of one?	**4**	**CO4**
3	Define view factor .When the view factor from a surface to itself is not zero.	**4**	**CO5**
4	3 kg of air kept at an absolute pressure of 100kPa and a temperature of 300K is compressed polytropically ,until the pressure and temperature becomes 1500 kPa and 500 K respectively. Evaluate the polytrophic exponent, the final volume, the work of compression and the heat interaction .Take gas constant R=287J/kg K	**4**	**CO1**
5	Explain Clausius inequality for reversible and irreversible engine.	**4**	**CO1**
	SECTION B		
6	The flow rates of hot and cold water streams running through a parallel flow heat exchanger are 0.2kg/s and 0.5 kg/s respectively .the inlet temperatures on the hot and cold sides are 70℃ and 20℃ respectively .The exit temperature of hot water is 45℃ if the individual heat transfer coefficients on both sides are 650W/m²C, calculate the area of the heat exchanger. .	**8**	**CO4**
7	A fin in the form of a ring of 0.25 mm thickness and 15 mm OD and 15 mm long is used on an electric device to dissipate heat .Consider the outer surface alone to be effective and exposed to air at 25 °C with a convection coefficient of 40 W/m²K .The conductivity of material is 340 W/mK .If the heat output is 0.25W and if the device is also of the same OD. Determine the device temperature with and without the fin. OR An aluminum alloy fin (k=200W/m K) 3.5mm thick and 2.5 cm long protrudes from a wall .The base is at 420°C and ambient air temperature is 30°C.The heat transfer coefficient may be taken as 11W/m²K .Find the heat loss and fin efficiency, if the heat loss from the fin tip is negligible.	**8**	**CO2**
8	Considering the following long grooves of width 2R determine the shape factors from the groove to outside and also the grooves to themselves.	**8**	**CO5**

			
9	Air at 100 kPa and 290 K flows steadily through a compressor at a rate of 5m³/s. During the compression process the pressure and temperature of air are respectively raised to 250 kPa and 400 K. There is also a heat loss of 15kJ/s to the cooling water. Determine the power required to drive the compressor .Presume that air behaves as a perfect gas and neglect the changes in K.E and P.E	**8**	**CO1**
10	A reversible heat engine is supplied 900 kJ of heat from a heat source at 500K.The engine develops 300 kJ of network and rejects heat to two heat sinks at 400 K and 300 K. Determine the engine thermal efficiency and magnitude of heat interaction with each of the sink.	**8**	**CO1**
	SECTION-C		
11	A flat plate 1m wide and 1.5m long is maintained at 90°C in air with free stream temperature of 10°C flowing along 1.5m side of the plate. Determine the velocity of air required to have rate of energy dissipation as 3.75 kW. Use correlations $Nu_L = 0.664 (\Re)^{\frac{1}{2}} (Pr)^{\frac{1}{3}}$ $Nu_L = ¿$ The following properties of air may be used: ρ = 1.0877kg/m³, k=0.02894 W/m K, Pr= 0.703 C_p=1.007 kJ/kg K, μ= 2.029 x10^{-5} kg/m s	**20**	**CO3**
12	A furnace wall is of three layers, first layer of insulation brick of 12cm thickness of conductivity of 0.6W/mK. The face is exposed to the gases at 870°C with a convection coefficient of 110 W/m²K .This layer is backed by a 10 cm layer of firebrick of conductivity 0.8W/mK .There is a contact resistance between the layers of 2.6 X 10^{-4} m ² °C/W. The third layer is the plate backing of 10mm thickness of conductivity 49W/m K .The contact resistance between the second and third layer is 1.5 X 10^{-4} m ² °C/W .The plate is exposed to air at 30 °C with a convection	**20**	**CO2/ CO5**

	coefficient of 15 W/ m²K .Determine the heat flow ,the surface temperature and the overall heat transfer coefficient. OR Steam enters a turbine steadily at 3 MPa and 450°C at a rate of 8kg/s and exits at 0.2 MPa and 150°C .The steam is losing heat to the surrounding air at 100kPa and 25°C at a rate of 300 KW and kinetic and potential energy changes are negligible. Determine (a) The actual power output (b) the maximum power output (c) the second law efficiency (d) the exergy destroyed (e) the exergy of the steam at inlet condition.		