Name: Enrolment No:	UPES

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

Course: Engineering Thermodynamics (GNEG234) **Semester: III**
Programme: B.Tech-ADE, Mechanical, Mechatronic
Time: 03 hrs. **Max. Marks: 100**
Instructions:

- ***i.*** *There are three sections viz. Section A, Section B and Section C. Section A carries 20 marks, Section B carries 40 marks and Section C carries 40 marks*
- ***ii.*** *Attempt all the questions in Section A, B and C*
- **iii.** *Make appropriate assumptions wherever required*

SECTION A (20 Marks)

S. No.		Marks	Cos
Q 1	Explain how the quality at turbine exhaust gets restricted.	**5**	**CO3**
Q.2	An inventor claims to have developed a device that executes a power cycle while operating between reservoirs at 800 and 350 K that has a thermal efficiency of (a) 56%, (b) 40%. Evaluate the claim for each case.	**5**	**CO2**
Q.3	Using P-v and T-s diagram compare Otto, Diesel and Duel cycles for: (a) Same Compression Ratio and Heat Addition	**5**	**CO3**
Q.4	A rigid tank contains 100 m^3 of air at 2 MPa and 20 ^{0}C. If the environment conditions are 100 kPa and 20 ^{0}C, determine how much work can be obtained from this compressed air.	**5**	**CO3**
	SECTION B (40 Marks)		
Q.5	Water vapor is heated in a closed, rigid tank from saturated vapor at 160 ^{0}C to a final temperature of 400 ^{0}C. Determine the initial and final pressures, in bar, and sketch the process on T–v and p–v diagrams.	**10**	**CO1**
Q.6	A 0.3 kg metal bar initially at 1200 K is removed from an oven and quenched by immersing it in a closed tank containing 9 kg of water initially at 300 K. Each substance can be modeled as incompressible. An appropriate constant specific heat value for the water is c_w = 4.2 kJ/kg K, and an appropriate value for the metal is c_m = 0.42 kJ/kg K. Heat transfer from the tank contents can be neglected. Determine (a) the final equilibrium temperature of the metal bar and the water, in K, and (b) the amount of entropy produced, in kJ/K.	**10**	**CO4**
Q.7	Steam flows through an adiabatic steady flow turbine. The enthalpy at entrance is	**10**	**CO4**

	4142 kJ/kg and at exit 2585 kJ/kg. The values of flow availability of steam at entrance and exit are 1787 kJ/kg and 140 kJ/kg, respectively. If the dead state temperature To is 300 K, determine, per kg of steam, the actual work, the maximum possible work for the given change of state of steam, and the change in entropy of steam. Neglect changes in kinetic and potential energy.		
Q.8	At the beginning of the compression process of an air-standard Diesel cycle operating with a compression ratio of 18, the temperature is 300 K and the pressure is 0.1 MPa. The cutoff ratio for the cycle is 2. Determine (a) the temperature and pressure at the end of each process of the cycle, (b) the thermal efficiency, (c) the mean effective pressure, in MPa.	**10**	**CO3**
	SECTION-C (40 Marks)		
Q.9	A 50-kg iron block and a 20-kg copper block, both initially at 80 °C, are dropped into a large lake at 15°C. Thermal equilibrium is established after a while as a result of heat transfer between the blocks and the lake water. Determine the total entropy change for this process. Assuming the surroundings to be at 20 °C, determine the amount of work that could have been produced if the entire process were executed in a reversible manner. Specific heat of iron block and copper block is 0.45 and 0.38 J/g ^{0}C respectively.	**20**	**CO4**
Q.10	Steam is the working fluid in an ideal Rankine cycle with superheat and reheat. Steam enters the first-stage turbine at 8.0 MPa, 480 ^{0}C, and expands to 0.7 MPa. It is then reheated to 440 ^{0}C before entering the second-stage turbine, where it expands to the condenser pressure of 0.008 MPa. The net power output is 100 MW. Determine (a) the thermal efficiency of the cycle, (b) the mass flow rate of steam, in kg/h, (c) the rate of heat transfer from the condensing steam as it passes through the condenser, in MW. Discuss the effects of reheat on the vapor power cycle. ***OR***	**20**	**CO3**
	An industrial process discharges gaseous combustion products at 478 K, 1 bar with a mass flow rate of 69.78 kg/s. As shown in Figure, a proposed system for utilizing the combustion products combines a heat-recovery steam generator with a turbine. At steady state, combustion products exit the steam generator at 400 K, 1 bar and a separate stream of water enters at 0.275 MPa, 38.9 ^{0}C with a mass flow rate of 2.079 kg/s. At the exit of the turbine, the pressure is 0.07 bars and the quality is 93%. Heat transfer from the outer surfaces of the steam generator and turbine can be ignored, as can the changes in kinetic and potential energies of the flowing streams. There is no significant pressure drop for the water flowing through the steam generator. The combustion products can be modeled as air as an ideal gas. (a) Determine the power developed by the turbine, in kJ/s.	**20**	**CO2**

(b) Determine the turbine inlet temperature, in ^{0}C.