Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2018

Course: Thermodynamics and Heat Engines-MEPD2002 **Semester: III**
Programme: B.TECH ASE, ASE +AVE
Time: 03 hrs. **Max. Marks: 100**
Instructions: Steam Table can be allowed

SECTION A

S. No.		Marks	CO
Q 1	Explain the concept of flow work, explain the difference with displacement work using control volume concept?	**4**	**CO1**
Q 2	On a hot summer day, a student turns his fan on when he leaves his room in the morning. When he returns in the evening, will the room be warmer or cooler than the neighboring rooms? Why? Assume all the doors and windows are kept closed. Explain the concept using thermodynamics laws	**4**	**CO3**
Q 3	Explain the concept of ideal and real gases and their behavior? An ideal gas at a given state expands to a fixed final volume first at constant pressure and then at constant temperature. For which case is the work done greater?	**4**	**CO2**
Q 4	Explain the significance of First law of thermodynamics in case of flow systems, express the steady flow energy equation?	**4**	**CO1**
Q 5	In an effort to conserve energy in a heat-engine cycle, somebody suggests incorporating a refrigerator that will absorb some of the waste energy Q_L and transfer it to the energy source of the heat engine. Is this a smart idea? Explain the concept using second law of thermodynamics?	**4**	**CO4**

SECTION B

Q 6	A gas of 4 kg is contained within a piston-cylinder machine. The gas undergoes a process for which $pV^{1.5}$=constant. The initial pressure is 3 bar and the initial volume is 0.1 m^3, and the final volume is 0.2 m^3. The specific internal energy of the gas decreases by 4.6 kJ/ kg. There are no significant changes in KE, PE. Determine the net heat transfer for the process	**10**	**CO3**
Q 7	Two tanks are connected by a valve. One tank contains 2 kg of CO_2 gas at 77^0 C and 0.2 bar. The other tank holds 8 kg of the same gas at 27^0 C and 1.2 bar. The valve is	**10**	**CO2**

	opened and the gases are allowed to mix while receiving energy by heat transfer from the surroundings. The final equilibrium temperature is 42^0 C. Determine the final equilibrium pressure and the heat transfer for the process?		
Q 8	It is proposed that solar energy be used to warm a large collector plate. This energy would, in turn, be transferred as heat to a fluid within a heat engine, and the heat engine would reject energy as heat to the atmosphere. Experiments indicate that about 1880 kJ/m^2 h of energy can be collected when the plate is operating at 90^0C. Estimate the minimum collector area that would be required for a plant producing 1 kW of useful shaft power. The atmospheric temperature may be assumed to be 20^0 C.	**10**	**CO3**
Q 9	Water is heated at a constant pressure of 0.7 MPa. The boiling point is 164.97^0 C. The initial temperature of water is 0^0 C. The latent heat of evaporation is 2066.3 kJ/kg. Find the increase of entropy of water, If the finial state is steam. If the ambient temperature is 30^0 C, what is the entropy increase of the universe? (OR) Air expands through a turbine from 500 kPa, 520^0 C to 100 kPa, 300^0 C. During expansion 10 kJ/kg of heat is lost to the surroundings which is ta 98 kPa, 20^0 C. Neglecting the K.E and P. E changes, determine per kg of air (i). the decrease in availability (ii) the maximum work and (iii) the irreversibility. For air take c_p=1.005 kJ/kg K.	**10**	**CO2**
	SECTION-C		
Q 10	(a). Consider a simple Rankine cycle and an ideal Rankine cycle with three reheat stages. Both cycles operate between the same pressure limits. The maximum temperature is 700°C in the simple cycle and 450°C in the reheat cycle. Which cycle do you think will have a higher thermal efficiency? Explain the concept using Schematic diagram? (5 Marks) (b). In a steam power plant the condition of steam at inlet to the steam generator is 20 bar and 300^0 C and the condenser pressure is 0.1 bar. Two feed water heaters operate at optimum temperature. Determine (i). The quality of steam at turbine exhaust, (ii) Net work per kg of steam. (iii). cycle efficiency, and (iv) the stream rate. Neglect pump work (15 marks)	**20**	**CO5**
Q 11	(a). Explain the effect of pressure ratio on the net output and efficiency of a Bryton cycle? (5 marks)	**20**	**CO1, CO4**

	(b). In an ideal Bryton cycle, air from the atmosphere at 1 atm, 300 K is compressed to 6 atm and the maximum cycle temperature is limited to 1100 k by using a large air-fuel ratio. If the heat supply is 100 MW, find (i) the thermal efficiency of the cycle (ii). Work ratio, (iii). Power output (iv). Exergy Flow rate of the exhaust gas leaving the turbine (15 Marks)		
	(OR) (a). For the same compression ratio and heat rejection, which cycle is most efficient: Otto, Diesel or Duel? Explain with p-v and T-s diagram(5 marks) (b). An engine operating on the air standard Otto cycle. The conditions at the start of the compression are 27^0 C and 100 kPa. The heat added is 1840 kJ/kg. The compression ratio is 8. Determine the temperature and pressure at each point in the cycle, the thermal efficiency and the mean effective pressure?		

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Course: Thermodynamics and Heat Engines-GNEG 241 **Semester: III**

Programme: B.TECH ASE, ASE +AVE

Time: 03 hrs. **Max. Marks: 100**

Instructions: Steam Table can be allowed

SECTION A

S. No.		Marks	CO
Q 1	Explain the concept of system, and apply first law of thermodynamics for a closed system undergoing a change of state?	**4**	**CO1**
Q 2	Explain the kelvin-planks and Clausius statement of second law of thermodynamics? Also explain the equalence and violation of these statements?	**4**	**CO3**
Q 3	Consider the process of heating water on top of an electric range. What are the forms of energy involved during this process? What are the energy transformations that take place? What is the difference between the macroscopic and microscopic forms of energy?	**4**	**CO2**
Q 4	Express the Van der Waals Equation of state and explain the various terms and its application for gaseous mixtures?	**4**	**CO1**
Q 5	A fixed mass of an ideal gas is heated from 50 to 80°C (*a*) at constant volume and (*b*) at constant pressure. For which case do you think the energy required will be greater? Why?	**4**	**CO4**

SECTION B

Q 6	A piston-cylinder assembly contains 5 kg of steam. The steam having an internal energy of 2709.9 kJ/kg expands to a state where the internal energy is 2659.6 kJ/kg. During the process, there is heat transfer of 80 kJ to steam and also a paddle- wheel work transfer of 18.5 kJ. Neglecting KE and PE of the steam, Determine the amount of energy transfer by work from the steam to the piston and the decrease in the system energy	**10**	**CO3**
Q 7	Consider a gas mixture of molecular weight 33, initially at 3 bar, 300 K and occupying a volume of 0.1 m^3. The gas undergoes an expansion to 0.2 m^3 during which the pressure-volume relation is $PV^{1.3}$=constant. Assuming $c_v=0.6+2.5\times 10^{-4}$ T, where T is in K and c_v is in kJ/kg K, and neglect kinetic energy and potential energy effects, determine (i). the mass of gas, (ii). the final pressure (iii). The finial temperature and (iv). The work and heat transfer	**10**	**CO2**
Q 8	A heat engine operates between the maximum and minimum temperature of 671^0 C	**10**	**CO3**

	and 60^0 C Respectively, with an efficiency of 50% of the appropriate Carnot efficiency. It drives a heat pump which uses river water at 4.4^0 C to heat a block of flats in which the temperature is to be maintained at 21.1^0 C. Assuming that a temperature difference of 11.1^0 C exists between the working fluid and the river water, on the one hand, and the required room temperature on the other, and assuming the heat pump to operate on the reversed Carnot cycle, but with a COP of 50% of the ideal COP, find the heat input to the engine per unit heat output from the heat pump. Why is direct heating Thermodynamically more wasteful?		
Q 9	Air enters a compressor at ambient conditions of 96 kPa and 17^0 C with a low velocity and exits at 1 MPa, 327^0 , and 120 m/s. The compressor is cooled by the ambient air at 17^0 C at a rate of 1500 kJ/min. The power input to the compressor is 300 kW. Determine (i). The mass flow rate of air and (ii). The rate of entropy generation.	**10**	**CO2**
	(OR) Two kg of air at 500 kPa, 80^0C expands adiabatically in a closed system until its volume is doubled and its temperature becomes equal to that of the surroundings which is at 100 kPa, 5^0 C. For this process, Determine (i). The maximum work, (ii) the change in availability, and (iii). The irreversibility. For air, take c_v=0.718 kJ/kg K $u= c_v T$ where c_v is constant, and pV=mRT where p is pressure in kPa, V volume in m^3, R=0.287 kJ/kg K.		
SECTION-C			
Q 10	(a). Show the ideal Rankine cycle with three stages of reheating on a *T-s* diagram. Assume the turbine inlet temperature is the same for all stages. How does the cycle efficiency vary with the number of reheat stages? (5 Marks) (b).In a single-heater regenerative cycle the steam enters the turbine at 30 bar, 400^0 C and the exhaust pressure is 0.10 bar. The feed water heater is a direct-contact type which operates at 5 bar. Find (i). The efficiency and the steam rate of the cycle and (ii). The increase in mean temperature of heat addition, efficiency and steam rate as compared to the Rankine cycle (Without Regeneration). Neglect pump work. (15 Marks)	**20**	**CO5**
Q 11	(a). Explain the ideal Bryton Cycle using Schematic Diagram with P-V and T-S, and	**20**	**CO1,**

	also write the expression for efficiency in the form of compression ratio (5 marks)? (b).In an air standard Bryton cycle the compression ratio is 7 and the maximum temperature of the cycle is 800^0 C. The compression begins at 0.1 MPa, 35^0 C. Compare the maximum specific volume and the maximum pressure with the generation operation using a efficiency and compression ratio plot. Find (i). the heat supplied per kg of air (ii). the net work done per kg of air (iii). The cycle efficiency (iv). The temperature at the end of the expansion process. (15 Marks)		CO4
	(OR) In an air standard Diesel cycle, the compression ratio is 15. Compression begins at 0.1 MPa, 40^0C. the heat added is 1.675 MJ/kg. Find (i). the maximum temperature of the cycle (ii). The work done per kg of air (iii). The cycle efficiency (iv). the temperature at the end of the isentropic expansion (v). The cut-off ratio (vi). The maximum pressure of the cycle and (vii). the m.e.p of the cycle.		