| Name: <br> Enrolment No: | |
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**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**End Semester Examination, Dec 2019**

**Course: Thermodynamics and phase behavior (MEPD2005)** **Semester: III**
**Program: APE UP**
**Time: 3 hrs.** **Max. Marks: 100**

**Instructions: answer all the questions. Internal choice is given.**

## SECTION A

| S. No. | | Marks | CO |
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| Q 1 | Is all the energy in the ocean available for extraction? Justify your answer. | **5** | **CO3** |
| Q 2 | Compare Otto and Diesel cycle based on working and performance. | **5** | **CO6** |
| Q 3 | Helium gas expands from 125 kPa, 350 K and 0.25 m3 to 100 kPa in a polytropic process with n = 1.667. Is the work positive, negative or zero? | **5** | **CO2** |
| Q 4 | Ice cubes in a glass of liquid water will eventually melt and all the water approach room temperature. Is this a reversible process? Why? | **5** | **CO3** |

## SECTION B

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| Q 5 | Prove that for an ideal gas $$S_2 - S_1 = C_p\, Log\left(\frac{V_2}{V_1}\right) + \ C_v\, Log(\frac{P_2}{P_1})$$ The terms have their usual meanings as 'S' is entropy, 'P' is pressure, 'V' is volume at thermodynamic state 1 and 2. Cp and Cv are the co-efficient at constant pressure and constant volume. | **10** | **CO3** |
| Q 6 | A reversible engine operates between temperatures $T_1$ and T ($T_1$ > T). A second reversible engine at the same temperature "T" receives the energy rejected from this | **10** | **CO3** |

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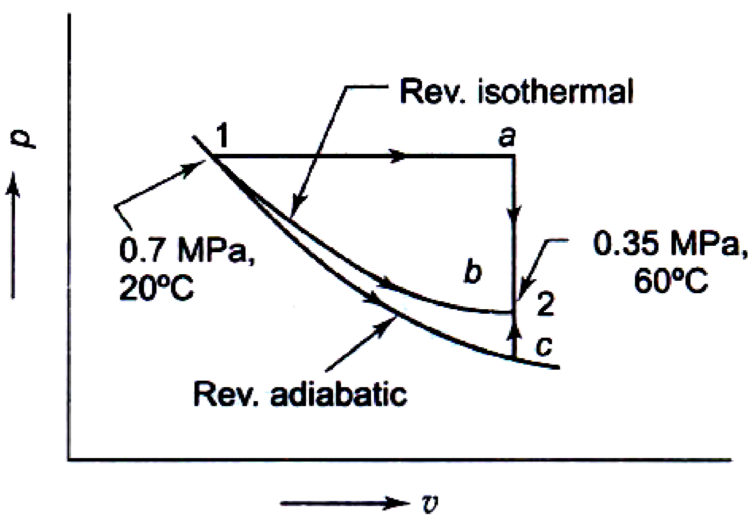
| | engine. The second engine rejects energy at temperature $T_2$ ($T_2 < T$). Show that temperature T is the arithmetic mean of temperatures $T_1$ and $T_2$ if the engines produce the same amount of work output.<br>**OR**<br>It is given that temperature of the source and sink are equal to $T_h$ and $T_L$. If the source and sink are finite i.e. as the heat engine operates the temperature of source fall and temperature of sink rises to an equilibrium temperature $T_f$. By the entropy principle prove that the $T_f$ is an geometric mean of $T_H$ and $T_L$. | | |
| Q 7 | Explain the following terms: (a) Kelvin-Plank statement (b) Clausius statement , (c) Carnot theorem, (d) Clausius inequality and (e) Perpetual motion machine of second kind. | **10** | **CO2** |
| Q 8 | 0.2 kg of air at 300°C is heated reversibly at constant pressure to 2066 K. Find the available and unavailable energies of the heat added. Take $T_0$ = 30°C and Cp = 1.0047 kJ/kg K. | **10** | **CO2** |
| | **SECTION-C** | | |
| Q 9 | One kg of air initially at 0.7 MPa, 20°C changes to 0.35 MPa, 60°C by the three reversible non-flow processes, as shown in Figure. Process 1: a-2 consists of a constant pressure expansion followed by a constant volume cooling, process 1: b-2 an isothermal expansion followed by a constant pressure expansion, and process 1: c-2 an adiabatic Expansion followed by a constant volume heating. Determine the change of internal energy, enthalpy, and entropy for each process, and find the work transfer and heat transfer for each process. Take Cp = 1.005 and Cv = 0.718 kJ/kg K and assume the specific heats to be constant. Also assume for air pv = 0.287 T, where p is the pressure in kPa, v the specific volume in $m^3$/kg, and T the temperature in K<br><br> | **20** | **CO3** |

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| Q 10. | A single cylinder engine with 0.25 liter swept volume and Compression Ratio =10, operates on a 4-stroke cycle. It is connected to a dynamometer, which gives a brake output torque reading of 15 N-m at 6000 rpm. The Air/Fuel=13, and mechanical efficiency of the engine is 98%. At the start of compression, the cylinder gas pressure is 100kPa, and temperature is 40℃. . Calculate (1) air consumption rate (kg/h); (2) fuel consumption rate (kg/h); (3) brake thermal efficiency; (4) bsfc (kg/kW-h). (Ideal gas constant, R=0.287kJ/kg-K, fuel calorific value ($Q_{LHV)}$ =43000kJ/kg)<br><br>**OR**<br>Following data is available for a four stroke petrol engine:<br>Air fuel ratio 15.5 : 1, Calorific value of fuel 16000 kJ/kg, Air Standard Efficiency: 53%, Mechanical Efficiency: 80 %, Indicated Thermal Efficiency: 37 %, Volumetric Efficiency: 80 %, Stroke/bore ratio: 1.25, Suction pressure: 1 bar, Suction Temperature: $27^0$C, RPM: 2000, Brake Power: 72 kW<br>Calculate the followings:<br>**(a)** Brake specific fuel consumption (b) Bore and stroke | **20** | **CO6** |