II B.Tech. II Semester Regular Examinations, April/May -2005
MECHANICAL ENGINEERING
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. A system receives 180 kJ of heat at constant volume process and rejects 200 kJ of heat at constant pressure and 40 kJ of work is done on the system. The system is brought to its original state by an adiabatic process. Calculate the adiabatic work. If the initial internal energy is 220 kJ, then calculate the value of internal energy at all points.

2. (a) Explain the term 'entropy'. What is its difference with the temperature?
   (b) A Carnot engine operates in series between two reservoirs maintained at 500^0C and 40^0C respectively. The energy rejected by the first engine is utilized as energy input to the second engine. Determine the temperature of this intermediate reservoir between the two engines if the efficiencies of both engines are the same.

3. (a) Derive the expression for an ideal efficiency of Diesel cycle engine.
   (b) An oil engine works on Diesel cycle with a temperature of 27^0C at the beginning of the compression. If the ratio of adiabatic compression is 14 and that of the adiabatic expansion is 8, find the thermal efficiency of the cycle. Assume $\gamma = 1.41$.

4. (a) Describe with a neat sketch a water tube boiler showing its path of flue gas and that of the flow of water.
   (b) Find the enthalpy required to produce 5 kg of dry saturated steam at a pressure of 700 kN/m^2 abs from water at 30^0C . Take specific heat of water as 4.1868 kJ/kgK.

5. (a) Describe the operation of a two stroke cycle IC engine with neat sketches.
   (b) The indicated power of a two cylinder four stroke cycle petrol engine is 15 kW when it runs at a speed of 1000 rpm. If the mean effective pressure is 600 kN/m^2, determine the necessary bore and stroke assuming the stroke is 1.2 times the bore.

6. (a) Derive an expression for the isothermal efficiency of a compressor in terms of the pressure ratio.
   (b) An ideal compressor receives 100 m^3/min of atmospheric air at 10^0C and delivers it at 20 MPa. Determine the mass flux and the power required.

7. (a) Explain the different types of belt drives with the help of neat sketches.

(b) A flat belt running over a pulley of 800mm diameter running at 240rpm is having a coefficient of friction between the belt and the pulley 0.28 and angle of lap is 165^0. If the maximum tension in the belt is 3kN, determine the power transmitted by the belt drive.

8. (a) With the help of neat sketch explain the following terms in connection with spur gear.
   i. Crest
   ii. Flank
   iii. Root
   iv. Face

   (b) What are thrust bearings? Explain the advantages and disadvantages of thrust bearings.

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1. (a) Define the following terms:
   i. System
   ii. Surroundings
   iii. Boundary of a system
   (b) Differentiate between the flow work and non flow work with the help of neat drawing of PV diagram.

2. (a) Draw neatly the sequences of operation of Carnot engine on p-v and T-s diagrams. Show that the entropy change during the cycle is zero
   (b) Two kg of superheated steam at 400^0C and 600 kPa is cooled at constant pressure by transferring heat from a cylinder until the steam is completely condensed. The surroundings are at 25^0C . Determine the net entropy change of the universe due to this process.

3. A Carnot piston engine operates with air between 20^0C and 600^0C with a low pressure of 100 kPa. If it is to deliver 800 kJ/kg of work calculate
   (a) the thermal efficiency
   (b) the compression ratio, and
   (c) the MEP

4. (a) Distinguish between impulse turbine and reaction turbine
   (b) A boiler supplies steam 0.2 m^3/sec at a pressure of 1100 kN/m^2 and 0.8 dry through a pipe. Determine the mass of the steam passing through the pipe per second and its diameter if the velocity of steam is limited to 5 m/sec.

5. (a) What do you understand by four stroke cycle and two stroke cycle engine?
   (b) A four stroke cycle petrol engine has a stroke volume of 5.7 litres. Its mean effective pressure is 600 kN/$m^2$and rpm is 800. Find the indicated power of the engine.

6. (a) Explain the terms effective swept volume and displacement volume of the compressor.
   (b) A compressor draws 42.5 m^3 of air per minute into the cylinder at a pressure of 105 kN/m2 and delivers at 420 kN/m^2. The compression follows the law $pv^{1.3}$= C. Neglect frictional losses. Assume mechanical efficiency of 80

7. (a) Enumerate the advantages and disadvantages of chain drive over belt drive.

   (b) A flat belt is required to transmit 35kW from a pulley of 1.5m effective diameter running at 300rpm. The angle of contact is spread over 11/24 of the circumference and the coefficient of friction between belt and pulley surface is 0.3. Determine taking centrifugal tension into account, width of the belt required. It is given that belt thickness is 9.5mm, density of its material is 1.1 Mg.m^3 and the related permissible working stress is 2.5N/mm^2.

8. (a) Two parallel shafts are to be connected by spur gearing. The velocity ratio should be exactly 11:3 while the centre to centre distance should be 6mm. Determine the number of teeth on each wheel and the exact centre distance between two shafts.

   (b) Explain with the help of sketches, the working of different types of thrust bearings

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Code No: RR220801 **Set No.3**

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1. (a) State the first law of thermodynamics and prove that for non-flow process, it leads to the energy equation $Q = W + \Delta U$.
   (b) Explain the following terms related to the thermodynamic concept:
      i. System
      ii. Surroundings
      iii. Boundary of a system

2. (a) A heat pump is to maintain a house at 20^0C when the outside air is at -25^0C . It is determined that 1800 kJ is required each minute to accomplish this. Calculate the minimum horsepower required.
   (b) The temperature of a quantity of a gas is increased from 27^0Cto 147^0C at constant volume and the increase in entropy during the time is 1.5 kcal/K. Then there is again an increase in entropy of 1.7 kcal/K at constant pressure. Find the final temperature. Assume c_v =0.17 kcal/kgK.

3. (a) Prove that the efficiency of an Otto cycle depends upon its compression ratio.
   (b) A spark ignition engine operates on an Otto cycle with a compression ratio of 9 and temperature limits of 30^0C and 1000^0C . If the power output is 500kW, calculate the thermal efficiency and the mass flux of air.

4. (a) What are the different methods of governing of steam turbines? Explain any one method with the help of neat sketches.
   (b) Determine the enthalpy required to produce 6 kg of dry saturated steam at a pressure of 750 kN/m^2 from water at 30^0C . Take specific heat of water as 4.2 kJ/kgK.

5. A four cylinder four stroke cycle petrol engine has 100 mm bore and 120 mm stroke. It consumes 3.7 kg of fuel per hour having a calorific value of 9800 kcal/kg and its indicated thermal efficiency is 41 percent. The mean effective pressure is 700 kN/m^2. Fine the crank shaft speed.

6. (a) Explain the terms 'effective swept volume' and 'displacement volume' of the compressor.
   (b) A double acting compressor takes in air at 100kPa and delivers it to the receiver at 1000kPa. The speed is 200rpm, diameter is 150mm and stroke length is 220mm. Calculate the capacity of the motor required.

7. (a) Explain the terms slip and creep as referred to belt drive. On what factors does it depend.

   (b) A flat belt 8mm thick and 100mm wide transmits power between two pulleys running at 1600m/min. the mass of the belt is 0.9 kg/m length. The angle of lap in the smaller pulley is 1650 and the coefficient of friction between the belt and the pulley is 0.3. If the maximum permissible stress in the belt is $2MN/m^2$, find maximum power transmitted by the belt.

8. (a) Explain any one type of thrust bearing with the help of neat sketch.

   (b) In a compound train of wheels the numbers of teeth on the wheels 1,2,3,4,5 and 6 are 80,40,50,25,30 and 12 respectively. Find the speed of wheel 6 when the wheel 1 is running at 20 rpm.

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1. (a) Define 'Temperature'. Differentiate between heat and temperature.
   (b) Discuss the concept of continuum in thermodynamics.

2. (a) One kg of water at 30^0C is converted into steam at a pressure of 10 kgf/cm^2 abs. Calculate the change of entropy if it is
      i. dry saturated,
      ii. 80 percent dry,
      iii. superheated to 300^0C , assuming c_p =0.54 kcal/kgK
   (b) Air is contained in an insulated, rigid volume at 20^0C and 200 kPa. A paddle wheel, inserted in the volume, does 720 kJ of work on the air. If the volume is 2 m^3 , calculate the entropy increase assuming variable specific heats.

3. (a) Derive the expression for an ideal efficiency of Diesel cycle engine.
   (b) An oil engine works on Diesel cycle with a temperature of 27^0C at the beginning of the compression. If the ratio of adiabatic compression is 14 and that of the adiabatic expansion is 8, find the thermal efficiency of the cycle. Assume $\gamma = 1.41$.

4. (a) What are the different methods of compounding of steam turbine stages? Describe any one method briefly.
   (b) A power plant operating on an ideal Rankin cycle has steam exiting the turbine at 500^0C and 2 MPa. If the steam enters the pump at 10 kPa, calculate
      i. the thermal efficiency with pump work included,
      ii. the thermal efficiency neglecting pump work, and
      iii. the percentage error in efficiency neglecting pump work

5. (a) Draw a neat diagram of an IC engine and explain the functions of different parts.
   (b) A two stroke cycle internal combustion engine has a piston diameter of 110 mm and a stroke length of 140 mm. The mean effective pressure exerted on the head of the piston is 600 kN/m^2. If it runs at a speed of 1000 rpm, find the indicated power developed.

6. (a) Explain the working of a single acting compressor with a neat sketch showing all basic components.

(b) A single acting compressor has zero clearance, stroke of 20cm and piston diameter 15cm. When the compressor is operating at 235rpm and compressing air from 10N/cm^2, 25^{o}C to 41N/cm^2, find

i. the volume rate of air handled and

ii. the ideal power required.

7. (a) Explain the different methods by which power from one shaft to another is transmitted.

(b) A belt embraces the shorter pulley 165^0 and runs over at a speed of 1700 m/min. Dimensions of the belt are: width = 20cm, thickness = 10mm, density is 1 g/cm^3. Determine the maximum power that can be transmitted at the above speed if maximum permissible stress in the belt is not to exceed 20 bar, $\mu = 0.3$.

8. (a) Explain any one type of thrust bearing with the help of neat sketch.

(b) In a compound train of wheels the numbers of teeth on the wheels 1,2,3,4,5 and 6 are 80,40,50,25,30 and 12 respectively. Find the speed of wheel 6 when the wheel 1 is running at 20 rpm.

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