II B.Tech II Semester Supplementary Examinations, November/December 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) 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 [10+6]

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. [8+8]

3. (a) In what respect diesel cycle differs from Otto cycle. Which cycle gives higher efficiency for the same compression ratio?
   (b) The maximum allowable pressure in an Otto cycle is 8 MPa. Conditions at the beginning of the air compression are 85kPa and 22^0C . Calculate the required heat addition and the MEP, if the compression ratio is 8. [6+10]

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. [10+6]

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. [10+6]

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. [16]

7. (a) With the help of neat sketches explain different types of chains used in power drive.

   (b) A flat belt 90mm wide and 8mm thick is transmitting power at 1000m/min. The net driving tension is 1.8 times the tension of the slack side. If the safe permissible stress on the belt section is 1.6N/mm^2, calculate the maximum power that can be transmitted at this speed. Assume density of leather as 1 Mg/m^3. [8+8]

8. (a) What do you understand by 'gear train'? Discuss the various types of gear trains.

   (b) Explain the principle, advantages and disadvantages of slipper bearings. [10+6]

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Code No: RR220801 **Set No. 2**

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1. (a) With a suitable example, explain the concept of 'cyclic process'. Indicate its importance in thermodynamics.
   (b) Derive the governing equation for the adiabatic process. [6+10]

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.[8+8]

3. (a) What will be the ideal efficiency of an Otto cycle petrol engine working at a compression ratio of 6:1.
   (b) A Carnot engine operates on air between high and low pressures of 3 MPa and 100 kPa with a low temperature of 20^0C . For a compression ratio of 15, calculate the thermal efficiency, the MEP and the work output. [6+10]

4. A small stem power plant works on basic Rankin cycle. The steam supplied to the turbine is at 1000 kN/m^2 and400^0C . The steam is condensed in the condenser where the pressure maintained is 10 kN/m^2. Neglecting the pump work, determine the Rankin efficiency of the cycle. Also, find the generating capacity if the steam flow is 100 kg/min through the turbine. [16]

5. (a) Describe the operation of a four stroke cycle diesel engine with a pressure-volume diagram and necessary sketches.
   (b) The indicated power of a six cylinder four stroke cycle IC engine is 150 kW at an average piston speed of 320 m/min. The stroke bore ratio is 1.2:1. If the mean effective pressure is 650 kN/m^2, determine the crank shaft speed. [8+8]

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. [8+8]

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. [6+10]

8. (a) With the help of neat sketch explain the following terms in connection with spur gear.

   i. Circular pitch

   ii. Dedendum circle

   iii. Addendum circle

   (b) What are the different types of thrust bearings? Explain? [6+10]

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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. [6+10]

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. [6+10]

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. [8+8]

4. (a) Explain the advantages of high pressure boilers.
   (b) A power plant operates on a Rankin cycle between temperatures of 600^0C C and 40^0C . The maximum pressure is 8 MPa and the turbine output is 20 MW. Determine the minimum mass flow rate of cooling water through the condenser if a maximum temperature differential of 10^0C is allowed. [6+10]

5. (a) Describe with a schematic diagram the working principle of turbo-jet propulsion.
   (b) The following observations were recorded during a trial on a single cylinder IC engine: Diameter = 10cm, stroke = 18cm, mean effective pressure = 650 kN/m^2, number of explosions = 250/min. Determine the IHP developed by the engine. [8+8]

6. (a) Discuss the effect of inter cooling in the compressors.
   (b) An adiabatic compressor receives 1.5 kg/s of atmospheric air at 25^0C and delivers it at 4 MPa. Calculate the required power and the exiting temperature if the efficiency is assumed to be

i. 100 percent and

ii. 80 percent [6+10]

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. [6+10]

8. (a) What are the different types of rolling contract bearings? Explain any two of them briefly with the help of neat sketches.

   (b) A simple train of wheels consists of three wheels having number of teeth 40,50 and 70 respectively. Find its velocity ratio. If the driving wheel having 40 teeth is rotating at 210 rpm, find the speed of the driven wheel. [8+8]

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1. (a) Justify the statement that 'work and heat' are not properties.
   (b) State the different forms of the first law and explain in detail the throttling process. [6+10]

2. (a) Water is maintained at a constant pressure of 400 kPa while the temperature changes from 20^0Cto400^0C . Calculate the heat transfer and the entropy change.
   (b) A closed system consists of 1kg of air which is initially at 1.6 bar and 67°C . The volume doubles as the system undergoes a process according to the law $pv^{1.2}$ = Constant. Find the work done, heat transfer and change in entropy [8+8]

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 [16]

4. (a) Describe with the help of neat sketch the construction and working of a Lancashire boiler.
   (b) Two boilers supply equal quantity of steam at 1400 kN/m^2 to a common main. The quality of steam from the first boiler is 0.92 dry and the temperature of steam from the other boiler at260^0C . Determine the condition of steam in the common main. [10+6]

5. (a) What are the advantages and disadvantages of closed cycle gas turbines?
   (b) The mean effective pressure of a single cylinder, two stroke cycle engine is 600kN/m^2. The bore and stroke of the engine are 11 cm and 14 cm respectively. If the engine is running at 1000 rpm, determine the IHP developed by the engine. [6+10]

6. (a) Describe with a neat sketch the working of a single acting, single stage compressor.
   (b) A reciprocating compressor is to deliver 20 kg/min of air at 1600 kPa. It receives atmospheric air at 20^0C. Calculate the required power if the compressor is assumed to be 90 percent efficient. No cooling is assumed. [8+8]

7. (a) Explain the advantages and disadvantages of chain drive over V belt drive.
   (b) A leather belting mass 1 g/cm^3 has a maximum permissible tension of 21bar. Determine the maximum power that can be transmitted by a belt 25cm 1.1cm, if the ratio of tension is 2. [6+10]

8. (a) Discuss the different types of ball bearings.
   (b) Two parallel shafts are to be connected by a gear drive. They are very nearly 1m apart and their velocity ratio is to be exactly 9:2. If the pitch of the gears is to be 50mm, find the number of teeth in each of the two wheels and the distance between the shafts. [8+8]

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