Question Paper2018

(Conducted on 29.12.2019)

General Engineering Paper II

Mechanical Engineering

1. (*a*) Draw the phase equilibrium diagram for a pure substance on p-T coordinates and explain. Why does the fusion line for water have negative slope? **(15)**

(*b*) Show that the efficiency of reversible heat engine operating between two given constant temperatures is the maximum. **(15)**

(*c*) A fluid system undergoes a non-flow frictionless process following the pressure-volume relation as $p = (5/V) + 1.5$ where p is in bar and V is in m^3. During the process the volume changes from 0.15 m^3 to 0.05 m^3 and the system rejects 45 kJ of heat. Determine:

(i) Change in internal energy

(ii) Change in enthalpy **(15)**

(*d*) A reversible heat pump is used to maintain a temperature of 0°C in a refrigerator when it rejects the heat to the surroundings at 25°C.

(i) If the heat removal rate from the refrigerator is 1440 kJ/min, determine the C.O.P. of the machine and work input required.

(ii) If the required input to run the pump is developed by a reversible engine which receives heat at 380°C and rejects heat to atmosphere, then determine the overall C.O.P. of the system. **(15)**

2. (*a*) Give the flow and T-s diagrams of ideal regenerative Rankine cycle. Why is the efficiency of this cycle equal to Carnot efficiency? Why is this cycle being not practicable? **(15)**

(*b*) Show that the efficiency of Otto cycle depends on only on compression ratio. **(15)**

(*c*) A diesel cycle has a compression ratio of 16. The temperature before compression is 300 K and after expansion it is 900 K. Determine :

(i) Network input per unit mass of air,

(ii) the air standard efficiency and

(iii) MEP if the minimum pressure in the cycle is 1 bar. **(15)**

(*d*) In an air refrigerating machine, the compressor takes in air at 1 bar and 10°C. After compression to 5.5 bar, the air is cooled to 30°C before expanding it back to 1 bar. Assuming ideal conditions, determine :

(i) refrigeration effect per unit mass of air,

(ii) heat rejected by air per unit mass in the intercooler, and

(iii) COP of the cycle, in an actual plant using the above cycle, the air flow rate is 1700 kg/hour and the relative COP of the actual plant is 0.65.

Determine the power required for the actual plant for the same refrigeration. **(15)**

3. (*a*) Derive the Bernoulli's equation for the flow of incompressible frictionless fluid from the considerations of momentum. **(15)**

(*b*) A rectangular plate 1.5 m × 3.0 m is submerged in water and makes an angle of 60° with the horizontal, the 1.5 m sides being horizontal. Calculate the magnitude of the force on the plate and the location of the point of application of the force, with reference to the top edge of the plate, when the top edge of the plate is 1.2 m below the water surface. **(15)**

(*c*) With a neat sketch explain the principle and working of a centrifugal pump. **(15)**

(*d*) A pelton wheel has a mean bucket speed of 10 m/sec with a jet of water flowing at a rate of 700 litres/sec under a head of 30 m. It gets deflected through an angle 160° after flowing past buckets. Calculate power given by water to runner and hydraulic efficiency of turbine. Take coefficient to velocity as 0.98. **(15)**

4. (*a*) Explain atleast eight casting defects along with remedies. **(15)**

(*b*) With neat sketch, explain the working of Tungsten Inert Gas Welding (TIG). **(15)**

(*c*) Describe the nomenclature of a single point cutting tool using a neat sketch. **(15)**

(*d*) Briefly explain different operation performed on milling machine. **(15)**

5. (*a*) Show that if three coplanar forces, acting at a point be in equilibrium, then, each force is proportional to the sine of the angle between the other two. **(15)**

(*b*) A body, resting on a rough horizontal plane, required a pull of 180 N inclined at 30º to the plane just to move it. It was found that a push of 220 N inclined at 30º to the plane just moved the body. Determine the weight of the body and the coefficient of friction. **(15)**

(*c*) A compound bat of length 600 mm consists of a strip of aluminium 40 mm wide and 20 mm thick and a strip of steel 60 mm wide × 15 mm thick rigidly joined at the ends. If elastic modulus of aluminium and steel are 1×10^5 N/mm^2 and 2×10^5 N/mm^2, determine the stresses developed in each material and the extension of the compound bar when axial tensile force of 60 kN acts. **(15)**

(*d*) Explain the assumptions made in Euler's column theory. How far the assumptions are valid in practice? **(15)**

6. (*a*) The turning moment diagram for a multicylinder engine has been drawn to a scale 1 mm = 600 Nm vertically and 1 mm = 3 horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows : +52, –124, +92, –140, +85, –72 and +107 mm^2, when the engine is running at a speed of 600 r.p.m. If the total fluctuation of speed is not to exceed 1.5% of the mean, find the necessary mass of the flywheel of radius 0.5 m. **(15)**

(*b*) Derive the condition for transmitting the maximum power in a flat belt drive. **(15)**

(*c*) A cam is to give the following motion to a knife-edged follower :

(i) Outstroke during 60º of cam rotation,

(ii) Dwell for the next 30º of cam rotation

(iii) Return stroke during next 60º of cam rotation and

(iv) Dwell for the remaining 210º of cam rotation.

The stroke of the follower is 40 mm and the minimum radius of the cam is 50 mm. The follower moves with uniform velocity during both the outstroke and return strokes. Draw the profile of the cam when the axis of the follower passes through the axis of the cam shaft. **(15)**

(*d*) Mention nomenclature of gear and explain terminology of gears. **(15)**

Question Paper2017

Mechanical Engineering

(Paper II)

1. (*a*) Define the following:

(*i*) Reversible and Irreversible process

(*ii*) External and Internal irreversibility

(*iii*) Intensive and Extensive properties

(*b*) Describe the following:

(*i*) Clausius Statement

(*ii*) Kelvin-Planck Statement

(*iii*) Perpetual motion machine of the second kind

(*c*) Volume of 0.1 m^3 of an ideal gas at 300 K and 1 bar is compressed adiabatically to 8 bar. It is then cooled at constant volume and further expanded isothermally so as to reach the condition from where it started. Determine:

(*i*) Pressure at the end of constant volume cooling

(*ii*) Change in internal energy during constant volume process

(*iii*) Net work done and heat transferred during the cycle.

Take c_p = 14.3 kJ/kg K and c_v = 10.2kJ/kg K.

(*d*) A reversible heat engine operates between two reservoirs at temperatures 700°C and 50°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 50°C and – 25°C. The heat transfer to the engine is 2500 kJ and the net work output of the combined engine refrigerator plant is 400 kJ

(*i*) Calculate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 50°C.

(*ii*) Reconsider (i) given that the efficiency of the heat engine and the C.O.P. of the refrigerator are each 45 percent of their maximum possible values.

2. (*a*) Give the comparisons between Otto cycle, Diesel cycle and Dual cycle.

(*b*) An air standard Otto cycle is to be designed according to the following specifications. Pressure at the start of the compression process = 101 kPa; Temperature at the start of the compression process = 300 K; Compression ratio = 8; Maximum pressure in the cycle = 8.0 MPa. Find

(*i*) the net work output per unit mass of air

(*ii*) cycle efficiency

(*iii*) MEP

(*c*) Explain the effect of Superheating and Sub-cooling on vapour compression refrigeration cycle.

(*d*) An air standard Brayton cycle has air entering the compressor at 100 kPa and 27°C. The pressure ratio is 10 and the maximum allowable temperature in the cycle is 1350 K. Determine.

(*i*) temperatures at salient points of the cycle

(*ii*) compressor and turbine work per unit mass of air

(*iii*) net work output and work ratio

(*iv*) thermal efficiency of the cycle

(*v*) specific air consumption in kg/KWh

(*vi*) improvement in the thermal efficiency of the cycle if a regenerator with 100% effectiveness is incorporated in the cycle

3. (*a*) Define density, specific volume, weight density, specific gravity and Bulk Modulus.

(*b*) A ship weighing 4000 tons and having an area of 465 m^2 at water line submerging to a depth of 4.5 m in sea water with a density of 1024 kg/m^3 moves to fresh water. Determine the depth of submergence in fresh water. Assume that the sides are vertical at the water line.

(*c*) What is cavitation? How does it affect the performance of hydraulic machines?

(*d*) The following details refer to a centrifugal pump:

Outer diameter : 30 cm, Eye diameter : 15 cm, Blade angle at inlet : 30°, Blade angle at outlet : 25°, Speed 1450 rpm. The flow velocity remains constant. The whirl at inlet is zero.

Determine the work done per kg. If the manometric efficiency is 82%, determine the working head. If width at outlet is 2 m, determine the power η_0 = 76%.

4. (*a*) Write short notes on the following :

(*i*) Stainless steel

(*ii*) High speed steel

(*iii*) High carbon steel

(*b*) With the help of figure, describe the Shielded Metal Arc Welding process.

(*c*) Explain the different operations performed in grinding machine.

(*d*) Mention the differences between shaper and planer machine tools.

5. (*a*) Give the classification of kinematic pairs.

(*b*) An engine, running at 150 r.p.m., drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft being 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Calculate the speed of the dynamo shaft, when (i) there is no slip, and (ii) there is a slip of 2% at each drive.

(*c*) Mention the comparison between involute and cycloidal gears.

(*d*) Explain the term height of the governor. Derive an expression for the height in the case of a Watt governor.

6. (*a*) Three forces of 2P, 3P and 4P act along three sides of an equilateral triangle of side 100 mm taken in order. Find the magnitude and position of the resultant force.

(*b*) A body of weight 300 N is lying on a rough horizontal plane having a coefficient of friction as 0.3. Find the magnitude of the force, which can move the body, while acting at an angle of 25° with the horizontal.

(*c*) Derive the expression for the shear stress in a circular shaft subjected to torsion.

(*d*) Derive the expression for circumferential stress in a thin cylindrical vessel.

Question Paper2016

Mechanical Engineering

(Paper II)

1. (*a*) Draw and explain the P-T (Pressure-Temperature) diagram for a pure substance. (15)

(*b*) With the assumptions, derive the Steady Flow Energy Equation SFEE. (15)

(*c*) A system receives 50 kJ of heat while expanding with volume change of 0.14 m^3 against an atmosphere of 1.2×10^5 N/m^2 A mass of 90 kg in the surrounding is also lifted through a distance of 5.5 m.

(*i*) Calculate the change in energy of the system

(*ii*) The system is returned to its Initial volume by an adiabatic process which requires 110 kJ of work. Find the change in energy of the system.

(*iii*) For the combined processes of (i) and (ii), calculate the change in energy of the system. (15)

(*d*) (*i*) Define the second law of thermodynamics using Clausius and Kelvin-Planck statements.

(*ii*) Describe the working of the Carnot cycle. (15)

(*iii*) What do you mean by the term 'Entropy'? (15)

2. (*a*) With the help of P-V and T-S diagrams derive the thermal efficiency expression for air standard Otto cycle. (15)

(*b*) An air standard Diesel cycle has a compression ratio of 14. The air conditions before compression are 1 bar and 27°C. The maximum temperature of the cycle is 2500°C. Determine the

(*i*) temperature and pressure at salient points of the cycle.

(*ii*) network output per unit mass of air

(*iii*) thermal efficiency. (15)

(*c*) Derive the network output and thermal efficiency expressions for a simple Rankine cycle with schematic and T–S diagrams. (15)

(*d*) Give the differences between fire tube and water tube boilers with examples. (15)

3. (*a*) Define the following (15)

(*i*) Steady and Unsteady flow

(*ii*) Uniform and Non-uniform flows

(*iii*) Laminar and Turbulent flows

(*iv*) Compressible and Incompressible flows

(*v*) Rotational and Irrotational flows

(*b*) A U tube manometer is used to measure the pressure of water in a pipeline, which is in excess of atmospheric pressure. The right limb of the manometer contains mercury and is a open to the atmosphere. The contact of water and mercury is in the left limb. Calculate the pressure of water in the main line. If the difference in the level of mercury in the limbs of the U-tube is 10 cm and the free surface of mercury is in level with the centre of the pipe. (15)

(*c*) What is Euler's equation of motion' How will you obtain Bernoullis equation from it? (15)

(*d*) Give the differences between impulse turbine and reaction turbine. (15)

4. (*a*) Explain the following terms. (15)

(*i*) Angle of repose

(*ii*) Angle of friction

(*iii*) Cone of friction

(*b*) A specimen of steel 20 mm diameter with a gauge length of 200 mm is tested to destruction. It has an extension of 0.25 mm under a load of 80 kN and the load at elastic limit is 102 kN. The maximum load is 130 kN. The total extension at fracture is 56 mm and diameter at neck is 15 mm.

Calculate (15)

(*i*) Stress at elastic limit

(*ii*) Young's modulus

(*iii*) Percentage reduction in area

(*iv*) Percentage elongation

(*v*) Ultimate tensile stress

(*c*) Derive an expression for the shear stress produced in a circular shaft which is subjected to torsion. (15)

(*d*) A cantilever of length 2 m carries a uniformly distributed load of 2 kN/m length over the whole length and a point load of 3 kN at the free end. Draw the shear force and bending moment diagrams. (15)

5. (*a*) Derive the condition for transmitting the maximum power in a belt drive. (15)

(*b*) With the help of a diagram define the terminologies of a gear. (15)

(*c*) Explain the term height of the governor Derive an expression for the height in the case of watt governor. (15)

(*d*) Write short notes on cams and followers. (15)

6. (*a*) With the help of diagrams explain the different types of flames obtained in the oxy acetylene welding process. Also give the advantages and disadvantages of oxy acetylene gas welding.

(*b*) Briefly explain the different types in the casting process and their remedies. (15)

(*c*) Explain the different taper turning methods used in the Lathe machine tool. (15)

(*d*) With the help of a diagram, explain two different method of the milling process. (15)