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/mm² and 2×10^5 N/mm², 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 mm², 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 m³ 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 m² at water line submerging to a depth of 4.5 m in sea water with a density of 1024 kg/m³ 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 $\eta_0 = 76\%$.

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 m³ against an atmosphere of 1.2×10^5 N/m² 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)

Question Paper 2015

Mechanical Engineering
(Paper II)

1. (*a*) Derive the thermal efficiency and mean effective pressure expressions for air standard diesel engine. (15)

(*b*) Describe the processes involved in a simple Rankine cycle with relevant diagrams. Also, explain the effect of pressure and temperature on simple Rankine cycle. (15)

(*c*) A single-acting two-stage reciprocating air compressor with complete intercooling delivers 6 kg/min at 15 bar pressure. Assume an intake condition of 1 bar and 15°C. The compression and expansion processes are assumed polytropic with n = 1.3.

Determine (15)

(*i*) the power required

(*ii*) isothermal efficiency

(*d*) In a stage of reaction turbine, the mean diameter of the rotor is 1.4 m. The speed ratio is 0.7. Determine the blade inlet angle, if the blade outlet angle is 20°. The rotor speed is 3000 rpm. Also find the diagram efficiency and work done per kg of steam. (15)

2. (*a*) Draw the Phase diagram on p-v coordinates for a substance which shrinks in volume on melting. Explain the relevant constant property lines. (15)

(*b*) Prove that a system which violates the kelvin-Planck statement of second law also violates the Clausius statement of the second law. (15)

(*c*) A centrifugal pump delivers 2730 kg/min water by increasing the pressure from 0.8 bar to 2.8 bar. The suction is 2 m below the centre of the pump and delivery is 5 m above the centre of the pump. The suction and delivery pipe diameters are 15 cm and 10 cm respectively. Find the power required to run the pump. (15)

(*d*) A reversible heat engine operates between two reservoirs at temperatures of 600°C and 40°C. The engine drives a reversible refrigerator which operates between the reservoirs at temperatures of 40°C and – 20°C. The heat transfer to the heat engine is 2000 kJ and net work output of the combined engine refrigerator plant is 360 kJ. (15)

(*i*) Determine the heat transfer to the refrigerant and the- net heat transfer to the reservoir at 40°C.

(*ii*) Also determine the same parameters as given in (i) when the efficiency of the heat engine and COP of the refrigerator are each 40% of their maximum possible.

3. (*a*) Explain the performance characteristics of centrifugal pumps with the help of figures. (15)

(*b*) Deduce an expression for the specific speed of a hydrodynamic machine and point out how the classification of turbines is based on specific speed. (15)

(*c*) A 2 m long pipeline tapers uniformly from 10 cm diameter to 20 cm diameter at its upper end. The pipe centre line slopes upwards at an angle of 30° to the horizontal and the flow direction is from smaller to bigger cross-section. If the pressure gauges installed at the lower and upper ends of the pipeline read 200 kPa and 230 kPa respectively, assume that no energy loss occurs. Calculate the flow rate and the fluid pressure at the mid-length of the pipeline. (15)

(*d*) An inclined rectangular sluice gate. 4 m wide × 1 m deep, has been installed to control the discharge of water. The upper end A is hinged and lies at a distance of 2 m from the free surface of water. What force normal to the gate should be applied at the lower end B to open it? (15)

4. (*a*) Differentiate between up-milling and down-milling. Also explain their applications. (15)

(b) Describe with figure the constructional features of a twist drill and label the features. (15)

(c) Explain the different types of mild steel. Give two applications for each. (15)

(d) Explain the TIG welding process. Mention the applications. (15)

5. (a) Derive an expression for all minimum number of teeth required on the pinion in order to avoid interference in involute gear teeth when it meshes with the wheel. (15)

(b) Determine the width of a 9.75 mm thick belt required to transmit 15 kW from a motor running at 900 rpm. The diameter of the driving pulley of the motor is 300 mm. The driven pulley runs at 300 rpm and the distance between the centre of the two pulleys is 3 metres. The density of the belt material is 1000 kg/m^3 . The maximum allowable stress in the leather is 2.5 MPa. The coefficient of friction between the leather and the pulley is 0.3. Assume open belt drive and neglect the sag and slip of the belt. (15)

(c) Define and explain the following terms relating to governors. (15)

(i) Sensitiveness

(ii) Stability

(iii) Isochronism

(iv) Hunting

(d) Define the terms coefficient of fluctuation of energy and speed in the case of flywheels.

6. (a) A metallic bar, 300 mm × 100 mm × 40 mm, is subjected to a force of 5 kN, 6 kN and 4 kN (all are tensile) along x, y and z directions respectively. Determine the change in the volume of the block. Take E = 2 × 10^5 N/mm^2 and Poisson's ratio = 0.25. (15)

(b) Derive the bending moment equation of a beam with the usual notations. (15)

(c) Define the term Polar modulus. Find the expression for polar modulus for a solid shaft and for a hollow shaft. Also give the expression for torsional rigidity of a shaft. (15)

(d) A simply supported beam AB of length 6 m is hinged at A and B. It is subjected to a clockwise couple of 24 kNm at a distance of 2 m from the left end A. Draw the shear force and bending moment diagrams. (15)

Question Paper 2014

Mechanical Engineering
(Paper II)

1. (*a*) Differentiate between single point and multipoint cutting tool. (15)

(*b*) Find the speed of a shaft which is driven with the help of a belt by an engine running at 300 rpm. The diameter of the engine pulley is 60 cm and that of the shaft is 40 cm. (15)

(*c*) Explain the role of cutting fluid in machining. (15)

(*d*) Explain the following terms : (15)
(*i*) Module
(*ii*) Pressure angle
(*iii*) Addendum

2. (*a*) Define the following terms : (15)
(*i*) Angle of friction
(*ii*) Coefficient of friction
(*iii*) Angle of repose
(*iv*) Poisson's ratio
(*v*) Elastic limit

(*b*) A cantilever beam of 8 m length is subjected to point loads of 10 kN, 15 kN, 25 kN, and 20 k N at distances of 2 m, 4 m, 6 m and 8 m respectively from the fixed end as shown in Figure 1. Draw the shear force diagram and bending moment diagram. (15)
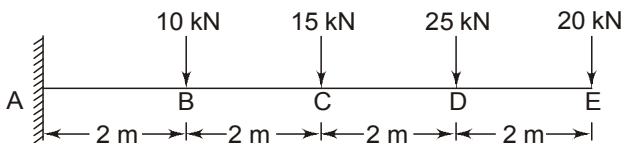

Figure : 1

(*c*) Find the lowest speed at which 250 kW could be transmitted through a shaft of diameter 63 mm. The maximum shear stress is limited to 50 MPa. If length of the shaft is 6 m, find the angle of twist. Take G = 80 GPa. (15)

(*d*) In separate experiments, Young's Modulus and Modulus of Rigidity of a material have been determined as 120 GPa and 50 GPa respectively. Calculate the Poisson's Ratio and Bulk Modulus of the material. (15)

3. (*a*) Compare the working principle of 4-stroke and 2-stroke cycle of internal combustion engines. (15)

(*b*) State and explain the Clausius statement of the second law of themodyynamics. (15)

(*c*) A mixture of gases expands at constant pressure from 1 MPa, 0.03 m³ to 0.06 m³ with 90 kJ heat transfer to the system. There is no work other than 'work done' on a piston. Find the change in internal energy of the mixture. (15)

(*d*) The properties of a certain fluid are related as follows: (15)

$$u = 196 + 0.718\ t$$
$$pv = 0\text{-}287\ (t + 273)$$

where u is the specific internal energy (kJ/kg), t is in °C, p is pressure (kN/m²), and v is specific volume (m³/kg). For this fluid, find C_u and C_p.

4. (*a*) A tank contains a liquid of specific gravity 0.80. Find the absolute pressure and gauge pressure at a point which is 2m below the, free surface of the liquid. The atmospheric pressure head is equivalent to 760 mm of mercury. (15)

(*b*) Define the following and give one practical example of each : (15)
(*i*) Laminar flow
(*ii*) Turbulent flow
(*iii*) Steady flow
(*iv*) Uniform flow
(*v*) Unsteady flow

(c) What is a centrifugal pump ? Explain the working of a single-stage centrifugal pump with sketches. (15)

(d) Derive the expression: (15)

$$C_d = C_v \times C_c$$

where C_d = co-efficient of discharge

C_v = co-efficient of velocity

C_c = co-efficient of contraction

5. (a) What is the difference between soldering and brazing ? (15)

(b) Describe with the help of neat sketches, TIG welding and MIG welding (15)

(c) What are the common defects of casting ? State their causes and remedies. (15)

(d) What are the advantages of centreless grinding ? (15)

6. (a) Explain the various safety precautions associated with lathe. (15)

(b) Define tool life and name the variables which affect tool life. (15)

(c) What is a syphon ? Where is it used ? Explain its working principle. (15)

(d) Sketch a schematic diagram of a steam power plant and explain the various processes of Rankine cycle on T-S or p-v diagram. (15)

Question Paper 2013

Mechanical Engineering
(Paper II)

1. (*a*) Define four bar chain mechanism and state the Grashof's Law for the four bar chain linkage. (15)

(*b*) Compare the functions of flywheel and mechanical governor. (15)

(*c*) Determine power lost in overcoming friction and number of collars required for the thrust bearing whose contact surfaces have 20 cm and 15 cm as external and internal radius. The coefficient of friction is 0.08 between the surfaces. The total axial load is 30 kN. The intensity of pressure cannot exceed 3.5 bar and the shaft rotates with 420 rpm. (15)

(*d*) With the help of neat sketch define pressure angle for gear train and cam follower mechanisms. (15)

2. (*a*) A cantilever beam of length 5 m is loaded as shown in figure below. Draw the shear force and bending moment diagrams for the cantilever beam. (15)
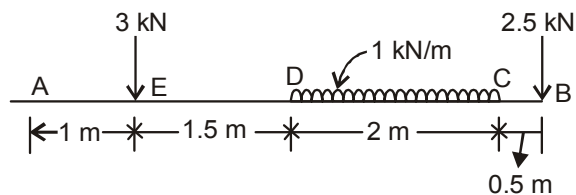
(*b*) Determine the maximum shear stress induced in a solid circular shaft of diamater 15 cm when the shaft transmits 150 kW power at 180 rpm. (15)

(*c*) A thin walled pressure cylinder of internal diameter 1.25 m contains a fluid at an internal pressure of 2 N/mm^2. Determine the maximum thickness of the cylinder if: (15)

(*i*) The longitudinal stress is not to exceed 30 N/mm^2

(*ii*) The circumferential stress is not to exceed 45 N/mm^2

(*d*) Write the assumptions made in the Euler's column theory and define slenderness ratio. (10 + 5)

3. (*a*) With the help of P – V and T – s diagrams, describe Diesel Cycle. (15)

(*b*) Explain the vapour compression cycle with the help of flow, T – s and p – h diagrams. (15)

(*c*) Compare the fire tube and water tube boilers. (15)

(*d*) A cyclic heat engine operates between a source temperature of 723ºC and sink temperature of 23ºC. What is the least rate of heat rejection per kW net output of the engine? Also show the block diagram. (15)

4. (*a*) An inverted U-tube has been used to determine the difference of pressure in two pipes carrying water as shown in figure.
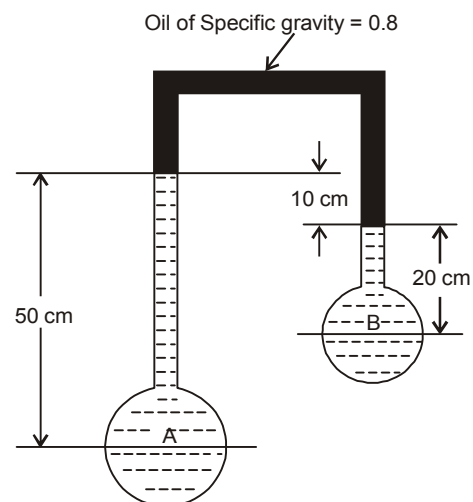

Determine the difference of pressures in the two pipes in terms of head of water and N/cm^2, if the difference of liquid level in inverted U-tube be 10 cm. (15)

(b) A venturimeter has an area ratio of 9 to 1, the larger diameter being 30 cm. During the flow, the recorded pressure head in the larger section is 6.5 meters and that at the throat 4.25 meters. If the meter coefficient, C is 0.99, compute the discharge through the meter. (15)

(c) Differentiate between impulse turbine and reaction turbine. (15)

(d) State the Bernoulli's theorem and write its limitations. (15)

5. (a) Describe the following heat treatment processes of steel: (15)

    (i) Annealing

    (ii) Normalizing

    (iii) Case hardening

(b) With the help of neat sketch, describe a single point cutting tool and its signature according to American Standard System. (15)

(c) With the help of neat sketch, describe TIG and MIG. (15)

(d) Discuss various defects in castings based on

    (i) Melting and pouring of molten metals and

    (ii) Gating and risering of mould. (15)

6. (a) Briefly discuss the grinding wheel characteristics. (15)

(b) Compare the involute and cycloidal profiles of gear tooth. (15)

(c) Draw and briefly describe the Mollier's Chart. (15)

(d) State Kelvin – Planck and Clausius statement of 2nd Law of thermodynamics. (15)

Mechanical Engineering
(Paper II)

1. (*a*) What is Law of Machine ? Also find out relationship between Load, Mechanical Advantage and Efficiency. (15)

(*b*) Explain the different design considerations, on which the design of Disc clutch is based. Also find out the relationship for Torque capacity of the Clutch, in each case. (15)

(*c*) Find out the condition for Constant velocity ratio between two Gear wheels. (15)

(*d*) What is Hydrodynamic Bearing? Explain Hydrodynamic lubrication theory, with assumptions and variables involved. (15)

2. (*a*) A body is dropped from rest at height h. It covers a distance of $\dfrac{9h}{25}$ in the last second. Determine the height h.

Take g = 10 m/s² . (15)

(*b*) Consider a system of three blocks resting upon one another as shown below. The block A weighs 150 N, B weighs 50 N and *C* weighs 100 N. The coefficients of friction are 0.3 between A and B, 0.2 between B and C and 0.1 between C and the ground. Determine the least horizontal force P necessary to start motion of any part of the system. (15)
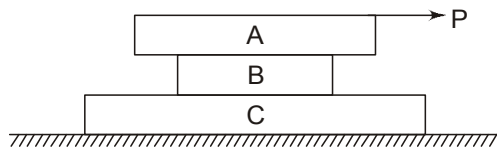
(*c*) A solid shaft of 80 mm diameter is transmitting 100 kW power at 200 rpm. Calculate the maximum shear stress induced in the shaft and the angle of the twist in degrees for length of 6 m. Take Modulus of Rigidity of the material = 8 × 10⁴ N/mm². (15)

(*d*) A steel rod of cross sectional area 2000 mm² and two brass rods each of cross sectional area of 1200 mm² together support a load of 500 kN as shown in the following figure. Find the stresses in the rods. Take E for Steel = 2 × 10⁵ N/mm² and E for Brass = 1 × 10⁵ N/mm². (15)
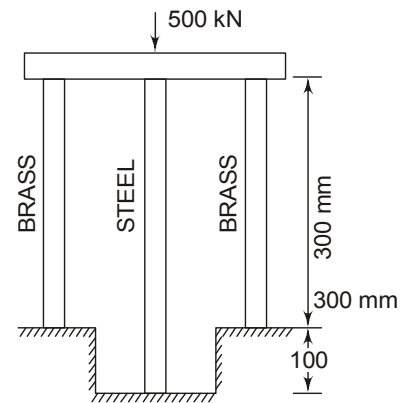
3. (*a*) 0.3 kg of Nitrogen gas at 100 kPa and 40°C is contained in a cylinder. The piston is moved compressing Nitrogen until the pressure becomes 1 MPa and temperature becomes 160°C. The work done during the process is 30 kJ. Calculate the heat transferred from Nitrogen to the surroundings. C_v for Nitrogen = 0.75 kJ/kg – K. (15)

(*b*) Find the coefficient of performance and Heat transfer rate in the condenser of a refrigerator in kJ/h, which has a refrigeration capacity of 12000 kJ/h when power input is 0.75 kW. (15)

(*c*) Determine the amount of heat, which should be supplied to 2 kg of water at 25°C to convert it into steam at 5 bar and 0.9 dry. (15)

(*d*) Differentiate between Impulse and Reaction Steam Turbines. (15)

4. (a) Showing Otto cycle on P-V and T-S diagram, find out Air standard efficiency of the cycle. (15)

(b) Explain normal Combustion phenomenon in SI Engine. (15)

(*c*) How reverse Carnot cycle can be used in achieving Refrigeration ? Explain and also find out COP of the cycle. (15)

(*d*) What are the factors on which selection of Boiler is done ? Also, differentiate between Fire tube and Water tube Boiler? (15)

5. (*a*) What is the Newton's law of Viscosity? A plate 0.025 mm distant from a fixed plate, moves at 60 cm/sec and requires a force of 2 N/m² to maintain this speed. Determine the viscosity of the fluid between the plates. (15)

(*b*) Differentiate between (15)

(*i*) Laminar and Turbulent flow

(*ii*) Compressible an Incompressible flow

(*iii*) Rotational and Irrotational flow

(*c*) What is the principle on which pitot tube works? Also, show the arrangements, adopted with Pitot tube, in order to get the velocity of flow in a pipe at any pipe. (15)

(*d*) What are the various considerations, based on which, Turbines can be classified ? (15)

6. (*a*) What are the important properties of Moulding sand ? (15)

(*b*) Describing Oxy Acetylene welding process, also explain the types of flames used in it. (15)

(*c*) What do you understand by Forging process? Also discuss its types. (15)

(*d*) What is Milling Operation ? Also describe differences between Up and Down Milling. (15)

Question Paper 2011

Mechanical Engineering
(Paper II)

1. (*a*) The gas in a system receives heat which causes expansion against a constant pressure of 2 bar. An agitator in the system is driven by an electric motor using 100 W. For 4 kJ of heat supplied the volume increase of the system in 30 sec is 0.06 m^3. Estimate net change in the energy of the system. (15)

(*b*) Find the coefficient of performance and heat transfer rate in the condenser of a refrigerator in kJ/h which has a refrigeration capacity of 12000 kJ/h when power input is 0.75 kW. (15)

2. (*a*) What is Air standard cycle? Define, Air standard efficiency and, mention the assumptions involved with Air standard cycle. (15)

(*b*) Explain the purpose of Cooling system in 1C engines. Also mention different types of Cooling systems in brief. (15)

3. (*a*) What is the principle on which manometer works ? Also explain its various types, with their use in brief. (15)

(*b*) What is Bernoulli's Theorem ? Also mention its assumptions.

The diameter of a pipe at the section 1 and 2 are 10 cm and 15 cm respectively. Find the discharge through the pipe if the velocity of water flowing through the pipe at section 1 is 5 m/sec. Determine the velocity at section 2. (15)

4. (a) A thick cylinder 125 mm inside diameter and 250 mm outside diameter is subjected to an internal fluid pressure of 50 N/mm^2. Determine the maximum and minimum intensities of circumferential stress and sketch the distribution of circumeferential stress intensity and radial pressure intensity across tne section. (15)

(*b*) Determine the maximum torque that can be safely applied to a shaft of 200 mm diameter if the permissible angle of twist is 1° for a length of 5 m and the permissible shear stress is 45 N/mm^2. Take Modulus of Rigidity = 0.8×10^5 N/mm^2. (15)

5. (*a*) Explain Tempering process and its classification (Austempering/Isothermal quenching and Martempering/Stepped quenching). (15)

(*b*) With the help of neat sketch describe arc welding with coated electrode in detail. (15)

6. (*a*) The total tension on the two sides of a belt connecting two pulleys is 2 kN. The minimum angle of embrace of the belt is 150° and coeficient of friction between the belt and the pulley rim is 0.25. Determine the value of the tension on both the tight and the slack side of the belt. Also calculate the power transmitted if the speed of the belt is 600 m/minute. (15)

(*b*) Draw roller follower – cam mechanism and describe the terminology

(*i*) base circle

(*ii*) pitch curve

(*iii*) prime circle

(*iv*) pressure angle and pitch point. (15)

Question Paper 2010

Mechanical Engineering
(Paper II)

1. (*a*) With the help of figure, explain the working of Babcock and Wilcox boiler. (15)

(*b*) List out the differences between : (15)

(*i*) Two stroke and Four stroke IC engines

(*ii*) Petrol and Diesel engines

2. (*a*) Explain different properties of moulding sand. (10)

(*b*) With the help of figure explain different types of gas flames produced in oxy-acetylene welding process. (5)

(*c*) With the help of neat figure explain the different nomenclature of twisted drill bit used in drilling machine. (15)

3. (*a*) What is indexing in milling machine ? Explain the procedure used in compound indexing. (10)

(*b*) Mention at, least five differences between shaper and slotting machines. (10)

(*c*) With the help of figure explain centerless grinding process. (10)

4. (*a*) Derive the continuity equation in differential form. (10)

(*b*) Calculate the maximum allowable discharge of water through a venturimeter throat 5 cm, fitted in a 10 cm diameter line with its inlet at an open channel.

Assume C_d= 0.95. (10)

(*c*) Explain the performance of centrifugal pumps. (10)

5. (*a*) A steel bar of rectangular section 50 mm × 30 mm and length 1.5 m is subjected to a gradually applied load of 150 kN. Find the strain energy stored in the bar. If the elastic limit of the material of the bar is 150 N/mm^2, proceed to determine the proof resilience and modulus of resilience.

Take E = 2 × 10^5 N/mm^2. (7)

(*b*) A timber beam of rectangular section is to support a load of 20 kN uniformly distributed over a span of 4 metres. If the depth of the section is to be twice the breadth and the stress in the timber is not to exceed 7 MPa, find the dimensions of the cross-section. (8)

(*c*) Derive the torsion equation for a shaft subjected to pure torsion. (15)

6. (*a*) Explain: (15)

(*i*) Watt governor

(*ii*) Porter governor

(*b*) Explain about helical and bevel gears with applications. (10)

(*c*) Explain the Ackermann steering gear mechanism. (5)

Question Paper2009

Mechanical Engineering
(Paper II)

1. (*a*) List out the merits and demerits of water tube boilers over fire tube boilers. (10)

(*b*) With the help of neat skeches explain the working of a four stroke diesel engine. (20)

2. (*a*) Explain different types of patterns used in foundry. (15)

(*b*) Explain any five different operations that can be carried out in lathe. (15)

3. (*a*) Give the classification of milling machines. Also explain up and down milling. (10)

(*b*) Explain with figure the quick return mechanism used in shapers. (10)

(*c*) Explain various parametres in selection of grinding wheel? (10)

4. (*a*) Derive Bernoulli's equation from Euler's equation. (15)

(*b*) Define the following (15)

Density, Newton's law of viscosity, Compressibility, Surface tension, and Pressure.

5. (*a*) Explain the salient features and behaviour of stress-strain curve for a tensile material with the figure. (10)

(*b*) A rectangular beam with depth 150 mm and width 100 mm is subjected to a maximum bending moment of 300 kNm. Determine: maximum stress in the beam, radius of curvature when the bending is maximum and bending stress at a distance of 40 mm from the top surface of the beam. E for beam is 200 GPa. (10)

(*c*) A solid circular shaft transmits 80 kW of power while turning 200 revolutions per minute. Work out suitable diameter of the shaft if the shear is limited to 60 MN/m^2 and the twist in the shaft is not to exeed 1 degree in 2 metres of length.

Assume uniform turning moment and take modulus of rigidity of the shaft material C = 100 GN/m^2. (10)

6. (*a*) Write about Grubler's criteria for planar mechanism. (5)

(*b*) With neat sketch explain gear tooth nomenclature. (15)

(*c*) Explain: (10)

(*i*) Turning movement diagram

(*ii*) Flywheel of a punch press

Question Paper2008

Mechanical Engineering
(Paper II)

1. (*a*) What do you understand by characteristic curves of centrifugal pump?

Draw the figure. (10)

(*b*) What do you mean by specific speed of a turbine? Explain. (5)

(*c*) What will be the force exerted by

   (*i*) direct impact of a jet on a stationary flat plate?

   (*ii*) oblique impact of a jet on a stationary flat plate?

Explain with neat sketches. (15)

2. (*a*) Show that the air standard efficiency of Otto cycle depends on compression ratio only. (15)

(*b*) Describe working of a simple plain tube carburettor with the help of a neat sketch. (15)

3. (*a*) A load of 270 kN is applied on a short concrete column 250 mm × 250 mm. The column is reinforced with 8 bars of 16 mm diameter. If the modulus of elasticity for steel is 18 times that of concrete, find the stresses in concrete and steel.

If the stress in concrete shall not exceed 4 N/mm^2, find the area of steel required so that the column may support a load of 400 kN. (10)

(*b*) Draw the B.M. and S.F. diagrams for the overhanging beam carrying loads as shown in figure given below.

Mark the value of principal ordinates and locate the point of contraflexure. (20)
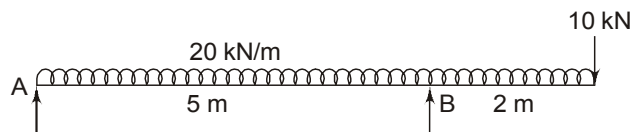
4. (*a*) Define inversion. Write its properties and importance. (15)

(*b*) A capstan and a rope are used in a railway goods yard for moving trucks. The capstan runs at 50 r.p.m. The rope from the line of trucks makes 2.75 turns around the capstan at a radius of 20 cm and the free end of the rope is pulled with a force of 147.15 N. Determine the pull on the trucks, the power taken by the trucks, and the power supplied by the capstan. Take μ = 0.25; (15)

5. (*a*) Define and explain with proper sketches, the following lathe operations:

   (*i*) Grooving

   (*ii*) Chamfering

(*b*) Explain Taper tuning on lathe in detail.

(*c*) Determine the angle at which the compound rest would be swivelled for cutting a taper on a workpiece having a length of 150 mm and outside diameter so mm. The smallest diameter on the tapered end of the rod should be 50 mm and the required length of the tapered portion is 80 mm. (5)
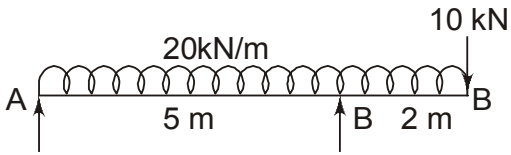
6. (*a*) Explain centreless grinders. Give sketches for external centreless grinding and write about

   (i) through feed

   (ii) infeed and

   (iii) end feed. (20)

(*b*) Calculate the time required to drill a 25 mm diameter hole in a workpiece having thickness of 60 mm to the complete depth. The cutting speed is 14 mm/min and fee is 0.3 mm/rev. Assume length of approach and overtravel as 5 mm. (10)

Question Paper2007

Mechanical Engineering
(Paper II)

1. (*a*) Describe about Francis turbine with respect to its component parts. construction and operation. (20)

(*b*) Establish the ratio of forces exerted by a water jet when it is made to strike.

(*i*) a stationary flat plate held normal to it;

(*ii*) a flat plate moving in the direction of jet at one third the velocity of jet:

(*iii*) a series of flat plates mounted on a wheel and moving at one third the velocity of jet. (10)

2. (*a*) Make a comparison of Otto, Diesel and Dual combustion cycle for–

(*i*) maximum compression ratio and same heat input;

(*ii*) constant maximum pressure and same heat input;

(*iii*) same maximum temperature and pressure. (20)

(*b*) Explain the function and working of a simple carburetor with a neat sketch. (10)

3. (*a*) What are the advantages of using taper turning attachment in lathe? (5)

(*b*) Explain cutting speed, feed and depth of cut in case of lathe. (10)

(*c*) With a neat sketch, show the details of a tail-stock. (15)

4. (*a*) What are the various operations performed on milling machine? Explain plain milling, face milling and side milling. (15)

(*b*) Explain tool head of a shaper with the help of a neat sketch. (10)

5. (*a*) Explain the function of Hartnell governor. (5)

(*b*) With the help of a neat sketch, describe crank and slotted lever mechanism. (10)

(*c*) The external and internal radii of a friction plate of single clutch are 120 mm and 60 mm, respectively. The total axial thrust with which the friction surfaces are held together is 1500 N. For uniform wear, find the maximum, minimum and average pressure on the contact surfaces. (15)

6. (*a*) What are the assumptions of Euler's theory?

(*b*) Draw the BM and SF diagrams for the overhanging beam carrying loads as shown in the figure. Mark the values of the principal ordinates and locate the point of contra-flexure. (10)

(*c*) Three vertical rods equal in length and each 12 mm in diameter are equispaced in a vertical plane and together support a load of 1000 N, the equispaced in a vertical plane and together support a load of 10000 N, the rods being so adjusted as to share the load equally. If now an additional load of 10000 N be added, determine the stress in each rod. The middle rod is of copper and the outer rods are of steel. take $E_s = 2 \times 10^5$ N/mm^2 and $E_c = 1 \times 10^5$ N/mm^2.