Roll No.

Candidate should write his/her Roll No. here.

Total No. of Questions : **5**

No. of Printed Pages : **12**

M1112012

MECHANICAL ENGINEERING

First Paper

Time : 3 Hours]

[Total Marks : 300

Instructions to the candidates :

1. There are *five* questions in this question paper. *All* the five questions have to be answered. Question Nos. **2** to **5** have an internal choice.
2. The total number of marks is **300** and the time allotted is **3** hours. *All* questions carry equal marks, unless specifically stated.
3. The first question will be of short answer type consisting **20** questions, each one is to be answered in *one* or *two* lines.
4. Questions should be answered exactly in order in which they appear in the question paper. Answers to the various parts of the same question should be written together compulsorily and no answers of other questions should be inserted between them.
5. Assume suitable data wherever required.
6. All symbols have their usual meanings.
7. Give neat sketches or diagrams wherever necessary.
8. Where word limit has been given it must be adhered to.
9. Use of I.S. codes is permitted.

1. Answer all the following questions in brief (in **3** to **4** lines each) : 20×3=60

(*a*) Differentiate between 'Thick' and 'Thin' wall cylinders.

(*b*) Write importance of proportionality limit for a ductile material.

(*c*) What is 'Wahl' factor ? Why is it used ?

(*d*) Differentiate between ultimate strength and fracture strength.

(*e*) Why is a 'V' belt drive preferred over flat belt drive in many engineering applications ?

(*f*) What is the difference between Double-Helical and Herringbone gears ?

(*g*) What types of stresses are induced in shafts ?

(*h*) Mention use of a brake dynamometer.

(*i*) Differentiate between temporary and permanent fastenings.

(*j*) Write assumptions for "Wilson Inventory Model".

(*k*) Define control charts. List the types of control charts.

(*l*) What do you mean by a balanced transportation problem ?

(*m*) What is characteristic feature of Hung erian Technique for solving an assignment problem ?

(*n*) How are project completion time and time of completion of critical path correlated in C.P.M. ?

(*o*) Define MRP of a production system. State the objectives of it.

(*p*) Differentiate between Total and Free float related to C.P.M.

(*q*) Enlist criterias for judging machinability.

(*r*) What are comparators ? State the applications of it.

(*s*) What are effects of E.D.M. on metal surface ?

(*t*) How do cutting fluids affect machining process ? Explain.

2. (*a*) A band and block brake has '*n*' number of blocks. Each block subtends an angle 2θ at the centre of drum. The brake is applied by applying load 'P' in downward direction. If μ is the coefficient of friction between block and drum and radius of drum is 'R', show that the ratio of tension on tight and slack side of band is :

$$\frac{T_1}{T_2} = \left(\frac{1 + \mu \tan\theta}{1 - \mu \tan\theta}\right)^n .$$ 20

(*b*) A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio. 20

(*c*) A single cylinder reciprocating engine has speed of 240 rpm. Stroke 300 mm. Mass of reciprocating parts is 50 kg and mass of revolving parts at 150 mm radius is 37 kg. If 2/3 of reciprocating parts and all revolving parts are to be balanced, calculate balance mass at a radius of 400 mm and the residual unbalanced force when crank has rotated through 60° from top dead centre. 20

Or

(*a*) The valve of an IC engine is operated by providing cam and follower. The follower moves with SHM. Draw displacement, velocity and acceleration diagrams of follower and derive expressions for maximum acceleration on outstroke and return stroke and maximum velocity on return stroke. Make suitable assumptions. 20

(*b*) Calculate the magnitude and direction of principal stresses for the state of stress given below :

σ_x = 16 MPa, σ_y = 80 MPa and Z_{xy} = –24 MPa. 20

(*c*) Determine minimum number of teeth required on pinion to avoid interference having given gear ratio 3 : 1, pr. angle 20°, standard addendum is 1 module for wheel. 20

3. (*a*) What is E.C.M. ? Discuss electrochemistry of E.C.M. process and derive expression for volumetric removal rate of material during E.C.M. 20

(*b*) An automatic lathe is to be used to machine brass components 75 mm long × 50 mm diameter using a depth a cut of 1.25 mm. Select the speed that minimizes the machining cost and calculate the corresponding tool life. Also estimate the cutting speed for minimum time of production. Assume that :

Labour + overhead rate = Rs. 5 per hr.

Reconditioning cost of tool edge = Re. 0.25 per edge

Loading and unloading time of workpiece = 15 sec.

Tool change time = 5 min

Feed = 0.2 mm/rev

Tool life relationship = VT^n = 300. 20

(*c*) In an ECM process with puré iron workpiece a removal rate of 5 cm^3/min is desired. Determine the current required. Make suitable assumptions. 20

Or

(*a*) A seamless tubing 35 mm outside diameter is turned orthogonally on a lathe. The following data available :

Rake angle = 35°,

Cutting speed = 15 m/min,

Feed = 0.10 mm/rev,

Length of continuous chip in one revolution = 50.72 mm,

Cutting force = 200 kg,

Feed force = 80 kg.

Calculate the coefficient of friction shear plane angle, velocity of chip along tool face and chip thickness. 20

(*b*) Explain surface finish and hence differentiate between ideal and natural roughness. How tool nose radius and maximum height of unevenness can be correlated ? Explain. 20

(*c*) A cylindrical workpiece is being turned by two different tools. One tool has no nose radius but side cutting and end cutting edge angles are 30° and 7° respectively. Other tool has nose radius of 0.7 mm. The feed used in both the cases is 0.125 mm. Calculate maximum height of unevenness for two cases. 20

4. (*a*) Derive strength equations for the following types of failures in a single riveted lap joint :

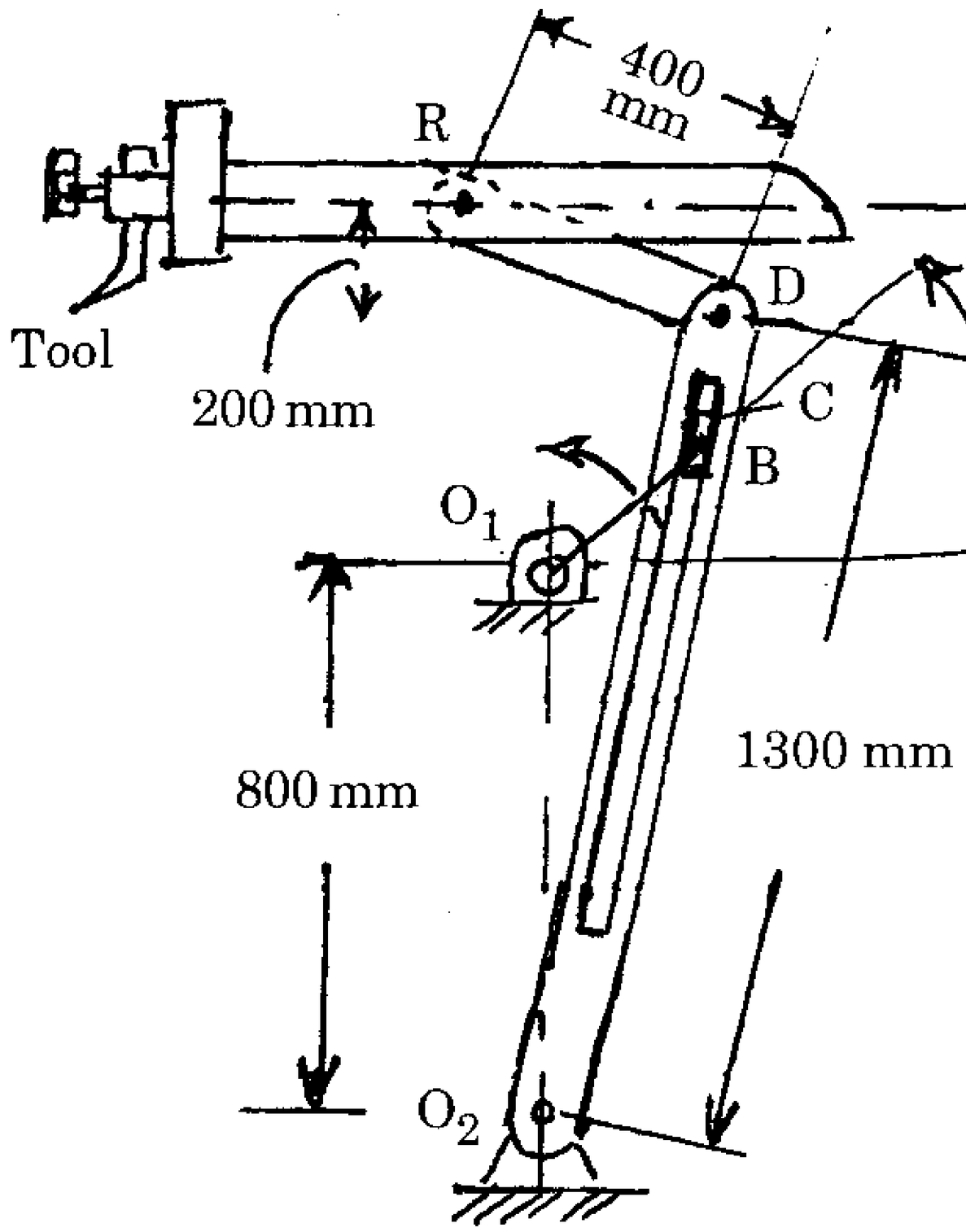
(*i*) Shear failure of rivet

(*ii*) Tensile failure of rivet

(*iii*) Crushing failure of rivet

and hence define efficiency of such a joint. 20

(*b*) A quick return mechanism of crank and slotted lever type shaping machine is shown in Fig. 1. The crank O_1B makes an angle of 45° with vertical and rotates at 40 rpm in counterclockwise direction. Find velocity of ram and angular velocity of link O_2D. 20



$O_1O_2 = 800$ mm $\quad O_2D = 1300$ mm

$O_1B = 300$ mm $\quad DR = 400$ mm

Fig. 1

(*c*) A simply supported beam AB of span 9 m carrying a uniformly distributed load 1800 N per meter run on the part CD of the span so that AC = 2 m, CD = 4 m and DB = 3 m. Draw the shear force and Bending moment diagram. 20

Or

(*a*) Power between two shafts is transmitted by an open flat belt drive. The two pulleys on shafts are of diameters D_1 and D_2. Pulley of diameter D_1 is larger than D_2. If L is the distance between centres of two pulleys, show that the length of belt is :

$$\frac{\pi}{2}(D_1 + D_2) + 2L + \frac{(D_1 - D_2)^2}{4L}.$$ 20

(*b*) Two shafts A and B are made of same material. Each shaft transmits the same power. Shaft A running at 200 rpm, while the Shaft B running at 20000 rpm. Find the ratio of diameters of the two shafts, if same maximum shear stress is developed in each shaft. 20

(c) In the toggle mechanism shown in Fig. 2 the slider 'D' is constrained to move horizontally. Crank OA rotates in counterclockwise direction at a speed of 180 rpm. The dimensions of links are :

OA = 180 mm, CB = 240 mm, AB = 360 mm, BD = 540 mm.

Find velocity of slider 'D' and angular velocity of BD. 20

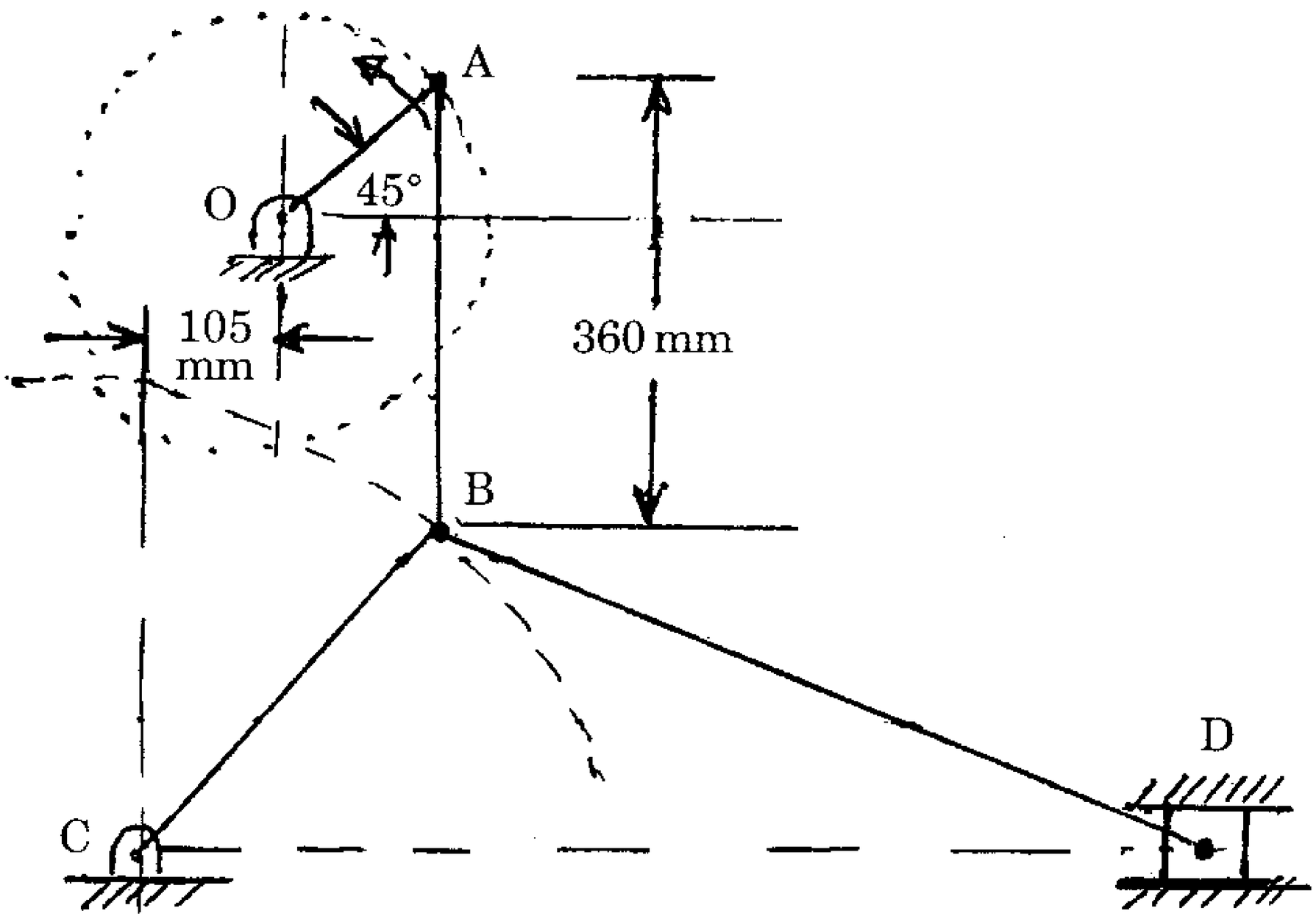


Fig. 2

5. Write short notes on the following (any *four*) : 4×15=60

(*a*) End conditions of a column

(*b*) Natural frequency of compound pendulum

(*c*) Stress strain diagram

(*d*) Jigs and fixtures

(*e*) ABC Analysis and its importance

(*f*) Aggregate production planning.

Roll No.

Candidate should write his/her Roll No. here.

Total No. of Questions : **5** No. of Printed Pages : **8+2**

M1122012

MECHANICAL ENGINEERING

Second Paper

Time : 3 Hours] [Total Marks : 300

Instructions to the candidates :

1. There are *five* questions in this question paper. *All* the five questions have to be answered. Each question has internal choice, except question no. **1**.
2. The total number of marks is **300** and the time allotted is **3** hours. *All* questions carry equal marks, unless specifically stated.
3. The first question will be of short answer type consisting **20** questions, each **one** is to be answered in *two* or *three* lines.
4. Questions should be answered exactly in order in which they appear in the question paper. Answers to the various parts of the same question should be written together compulsorily and no answers of other questions should be inserted between them.
5. Assume suitable data wherever required.
6. All symbols have their usual meanings.
7. Give neat sketches or diagrams wherever necessary.
8. Wherever word limit has been given, it must be adhered to.
9. Use of I.S. codes is permitted.

1. Answer the following short answer type questions in *two* or *three* lines each : 20×3=60

(A) For a thermodynamic process, what is the relationship between the degree of irreversibility and associated availability ?

(B) Mention the thermodynamic processes associated with the Carnot cycle.

(C) Mention the thermodynamic processes associated with the Rankine cycle.

(D) Draw the velocity diagram of an impulse turbine.

(E) Define specific speed of a turbine.

(F) Define Entropy with its characteristics.

(G) Define Mach number.

(H) Differentiate between sensible heat and total heat.

(I) What is relative humidity ? Mention the range of relative humidity that is good for human health.

(J) State the fundamental difference between vapour compression and vapour absorption systems.

(K) What is coefficient of performance of a refrigerant ?

(L) Mention the basic thermodynamic cycles for spark ignition and compression ignition engines.

(M) What is Octane number ?

(N) Give the classification of steam turbine on the basis of direction of flow.

(O) What is Draft Tube ? Name its different types.

(P) FMS is best suited for which type of production ?

(Q) Mention the various vehicle guiding systems used for automated guided vehicles.

(R) Enlist the various types of material handling conveyor systems.

(S) Sketch the Cartesian and Polar robotic configurations.

(T) For a 3-joint robot, determine the number of possible configuration if any of the 5 joint-types can be selected for each joint.

2. (*a*) Derive the general equation for steady flow process. Explain the physical significance of several terms of the equation. 20

(*b*) Derive an expression for the efficiency of the ideal cycle for Diesel engine in terms of the compression ratio, r, the cut-off ratio αc and γ. 20

(*c*) 0.56 cubic metre of gas at an atmospheric pressure of 2 kgf/cm^2 and temperature of 30°C is compressed to 21 kgf/cm^2, its temperature

rising to 400°C. Determine its final volume. Suppose the gas considered above is nitrogen for which the characteristic gas constant R is 30.26 kgf-m/kg°K, determine the mass of gas involve. 20

Or

(*a*) Express the various kinds of flexibilities and their applicability for various tests in the context of flexible manufacturing system (FMS). 20

(*b*) What is Vapour Absorption System ? Explain briefly with a neat diagram "Practical Vapour Absorption System". 20

(*c*) A F-12 vapour compression refrigeration system has a condensing temperature of 50°C and evaporating temperature of 0°C. The refrigeration capacity is 7 tons, the liquid leaving the condenser is saturated liquid and compression is isentropic. Determine :

(*i*) The refrigeration flow rate

(*ii*) The power required to run the compressor

(*iii*) The heat rejected in the plant

(*iv*) COP of the system.

The properties of F-12 are :

Temperature (°C)	**Pressure** (bar)	h_f (kJ/kg)	h_g (kJ/kg)	S_f (kJ/kg°K)	S_g (kJ/kg°K)
50	12.199	84.868	206.298	0.3034	0.6792
0	3.086	36.022	187.397	0.1418	0.6960

Take enthalpy at the end of isentropic compression = 210 kJ/kg. 20

3. (*a*) Draft tubes are applied for which types of turbines ? Explain their theory with the help of a suitable diagram. 20

(*b*) Derive the expression for efficiency of a free jet impulse turbine (Pelton wheel). Also state the runner speed that will give maximum efficiency. 20

(c) The impeller of a centrifugal pump is of 30 cm diameter and 5 cm width at the periphery, and has blades whose tip angles incline backward 60° from the radius. The pump delivers 17 m^3/min and the impeller rotates at 1000 rpm. Assuming that the pump is designed to admit radially, calculate :

(*i*) Speed and direction of water as it leaves the impeller

(*ii*) Torque exerted by the impeller on water

(*iii*) Shaft power required

(*iv*) Lift of the pump.

Take mechanical efficiency 95% and hydraulic efficiency 75%. 20

Or

(*a*) What is meant by critical thickness of thermal insulation ? Obtain the condition for critical thickness of an insulating material in the form of a cylinder. 20

(*b*) Hot oil with a capacity rate of 2500 W/K flows through a double pipe heat exchanger. It enters at 360°C and leaves at 300°C. Cold fluid enters at 30°C and leaves at 200°C. If the overall heat transfer coefficient is 800 W/m^{2}K, determine the heat exchanger area required for :

(*i*) Parallel flow, and

(*ii*) Counterflow. 20

(*c*) One end of a long rod, 35 mm in diameter is inserted into a furnace with the other end projecting in the outside air. After the steady state is reached the temperature of the rod is measured at two points 180 mm apart and found to be 180°C and 145°C. The atmospheric air temperature is 25°C. If the heat transfer coefficient is 65 W/m^2 °C, calculate the thermal conductivity of the rod. 20

4. (*a*) Compare the performance characteristics of the Spark Ignition (SI) and Compression Ignition (CI) engines. 20

(*b*) What is the difference between pressure compounding and velocity compounding in the context of steam turbines ? 20

(*c*) A four cylinder two-stroke cycle petrol engine develops 40 hp at 2500 r.p.m. The mean effective pressure of each is 8 kgf/cm^2 and mechanical efficiency of piston is 80%. Calculate the diameter and stroke of each cylinder if stroke to bore ratio is 1.5. Also calculate the brake specific fuel consumption of the engine, if brake thermal efficiency is 28%. The calorific value of the fuel is 10,500 kcal/kg. 20

Or

(*a*) Explain the following types of lead-through robot programming techniques and their suitability for a particular control system :

(*i*) Power lead through

(*ii*) Manual lead through. 20

(*b*) Draw a block diagram of an expert system and briefly describe its scope and components. 20

(*c*) What are the different components used in a nuclear power plant ? Explain each in detail. 20

5. Write short notes in around **200** words on any *four* of the following : 4×15=60

(*a*) Reynolds Number

(*b*) Impulse and reaction turbines

(*c*) How are the refrigerants classified ?

(*d*) Renewable energy sources

(*e*) Deposition of ice inside carburettor (carburettor icing)

(*f*) Advantages of off-line programming of robots.

1. Answer all the following questions in brief (in **3** to **4** lines each) : 20×3=60

(*a*) Differentiate between 'Thick' and 'Thin' wall cylinders.

(*b*) Write importance of proportionality limit for a ductile material.

(*c*) What is 'Wahl' factor ? Why is it used ?

(*d*) Differentiate between ultimate strength and fracture strength.

(*e*) Why is a 'V' belt drive preferred over flat belt drive in many engineering applications ?

(*f*) What is the difference between Double-Helical and Herringbone gears ?

(*g*) What types of stresses are induced in shafts ?

(*h*) Mention use of a brake dynamometer.

(*i*) Differentiate between temporary and permanent fastenings.

(*j*) Write assumptions for "Wilson Inventory Model".

(*k*) Define control charts. List the types of control charts.

(*l*) What do you mean by a balanced transportation problem ?

(*m*) What is characteristic feature of Hung erian Technique for solving an assignment problem ?

(*n*) How are project completion time and time of completion of critical path correlated in C.P.M. ?

(*o*) Define MRP of a production system. State the objectives of it.

(*p*) Differentiate between Total and Free float related to C.P.M.

(*q*) Enlist criterias for judging machinability.

(*r*) What are comparators ? State the applications of it.

(*s*) What are effects of E.D.M. on metal surface ?

(*t*) How do cutting fluids affect machining process ? Explain.

2. (*a*) A band and block brake has '*n*' number of blocks. Each block subtends an angle 2θ at the centre of drum. The brake is applied by applying load 'P' in downward direction. If μ is the coefficient of friction between block and drum and radius of drum is 'R', show that the ratio of tension on tight and slack side of band is :

$$\frac{T_1}{T_2} = \left(\frac{1 + \mu \tan\theta}{1 - \mu \tan\theta}\right)^n .$$ 20

(*b*) A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio. 20

(*c*) A single cylinder reciprocating engine has speed of 240 rpm. Stroke 300 mm. Mass of reciprocating parts is 50 kg and mass of revolving parts at 150 mm radius is 37 kg. If 2/3 of reciprocating parts and all revolving parts are to be balanced, calculate balance mass at a radius of 400 mm and the residual unbalanced force when crank has rotated through 60° from top dead centre. 20

Or

(*a*) The valve of an IC engine is operated by providing cam and follower. The follower moves with SHM. Draw displacement, velocity and acceleration diagrams of follower and derive expressions for maximum acceleration on outstroke and return stroke and maximum velocity on return stroke. Make suitable assumptions. 20

(*b*) Calculate the magnitude and direction of principal stresses for the state of stress given below :

σ_x = 16 MPa, σ_y = 80 MPa and Z_{xy} = –24 MPa. 20

(*c*) Determine minimum number of teeth required on pinion to avoid interference having given gear ratio 3 : 1, pr. angle 20°, standard addendum is 1 module for wheel. 20

3. (*a*) What is E.C.M. ? Discuss electrochemistry of E.C.M. process and derive expression for volumetric removal rate of material during E.C.M. 20

(*b*) An automatic lathe is to be used to machine brass components 75 mm long × 50 mm diameter using a depth a cut of 1.25 mm. Select the speed that minimizes the machining cost and calculate the corresponding tool life. Also estimate the cutting speed for minimum time of production. Assume that :

Labour + overhead rate = Rs. 5 per hr.

Reconditioning cost of tool edge = Re. 0.25 per edge

Loading and unloading time of workpiece = 15 sec.

Tool change time = 5 min

Feed = 0.2 mm/rev

Tool life relationship = VT^n = 300. 20

(*c*) In an ECM process with puré iron workpiece a removal rate of 5 cm^3/min is desired. Determine the current required. Make suitable assumptions. 20

Or

(*a*) A seamless tubing 35 mm outside diameter is turned orthogonally on a lathe. The following data available :

Rake angle = 35°,

Cutting speed = 15 m/min,

Feed = 0.10 mm/rev,

Length of continuous chip in one revolution = 50.72 mm,

Cutting force = 200 kg,

Feed force = 80 kg.

Calculate the coefficient of friction shear plane angle, velocity of chip along tool face and chip thickness. 20

(*b*) Explain surface finish and hence differentiate between ideal and natural roughness. How tool nose radius and maximum height of unevenness can be correlated ? Explain. 20

(*c*) A cylindrical workpiece is being turned by two different tools. One tool has no nose radius but side cutting and end cutting edge angles are 30° and 7° respectively. Other tool has nose radius of 0.7 mm. The feed used in both the cases is 0.125 mm. Calculate maximum height of unevenness for two cases. 20

4. (*a*) Derive strength equations for the following types of failures in a single riveted lap joint :

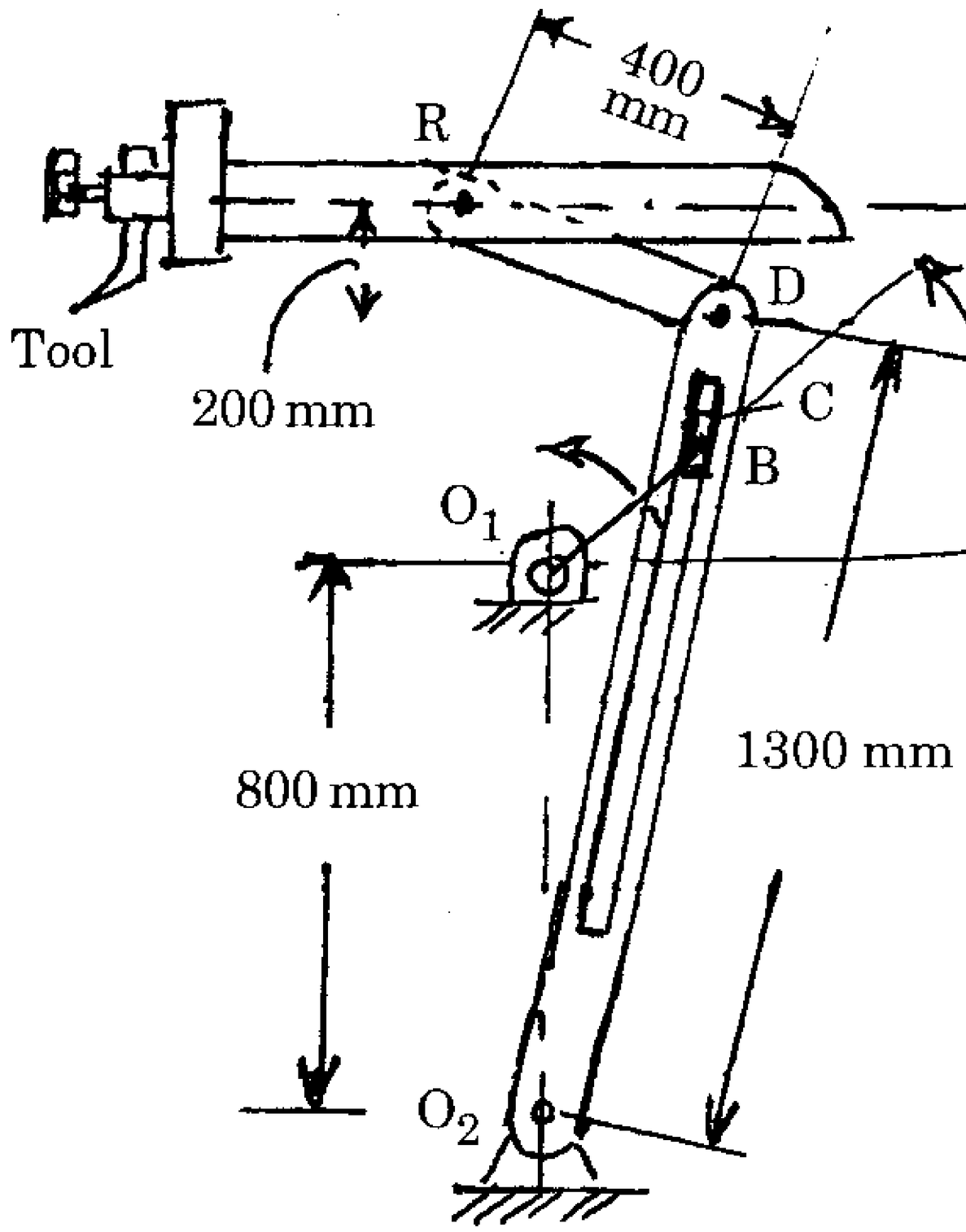
(*i*) Shear failure of rivet

(*ii*) Tensile failure of rivet

(*iii*) Crushing failure of rivet

and hence define efficiency of such a joint. 20

(*b*) A quick return mechanism of crank and slotted lever type shaping machine is shown in Fig. 1. The crank O_1B makes an angle of 45° with vertical and rotates at 40 rpm in counterclockwise direction. Find velocity of ram and angular velocity of link O_2D. 20



$O_1O_2 = 800$ mm $\quad O_2D = 1300$ mm

$O_1B = 300$ mm $\quad DR = 400$ mm

Fig. 1

(*c*) A simply supported beam AB of span 9 m carrying a uniformly distributed load 1800 N per meter run on the part CD of the span so that AC = 2 m, CD = 4 m and DB = 3 m. Draw the shear force and Bending moment diagram. 20

Or

(*a*) Power between two shafts is transmitted by an open flat belt drive. The two pulleys on shafts are of diameters D_1 and D_2. Pulley of diameter D_1 is larger than D_2. If L is the distance between centres of two pulleys, show that the length of belt is :

$$\frac{\pi}{2}(D_1 + D_2) + 2L + \frac{(D_1 - D_2)^2}{4L}.$$ 20

(*b*) Two shafts A and B are made of same material. Each shaft transmits the same power. Shaft A running at 200 rpm, while the Shaft B running at 20000 rpm. Find the ratio of diameters of the two shafts, if same maximum shear stress is developed in each shaft. 20

(c) In the toggle mechanism shown in Fig. 2 the slider 'D' is constrained to move horizontally. Crank OA rotates in counterclockwise direction at a speed of 180 rpm. The dimensions of links are :

OA = 180 mm, CB = 240 mm, AB = 360 mm, BD = 540 mm.

Find velocity of slider 'D' and angular velocity of BD. 20

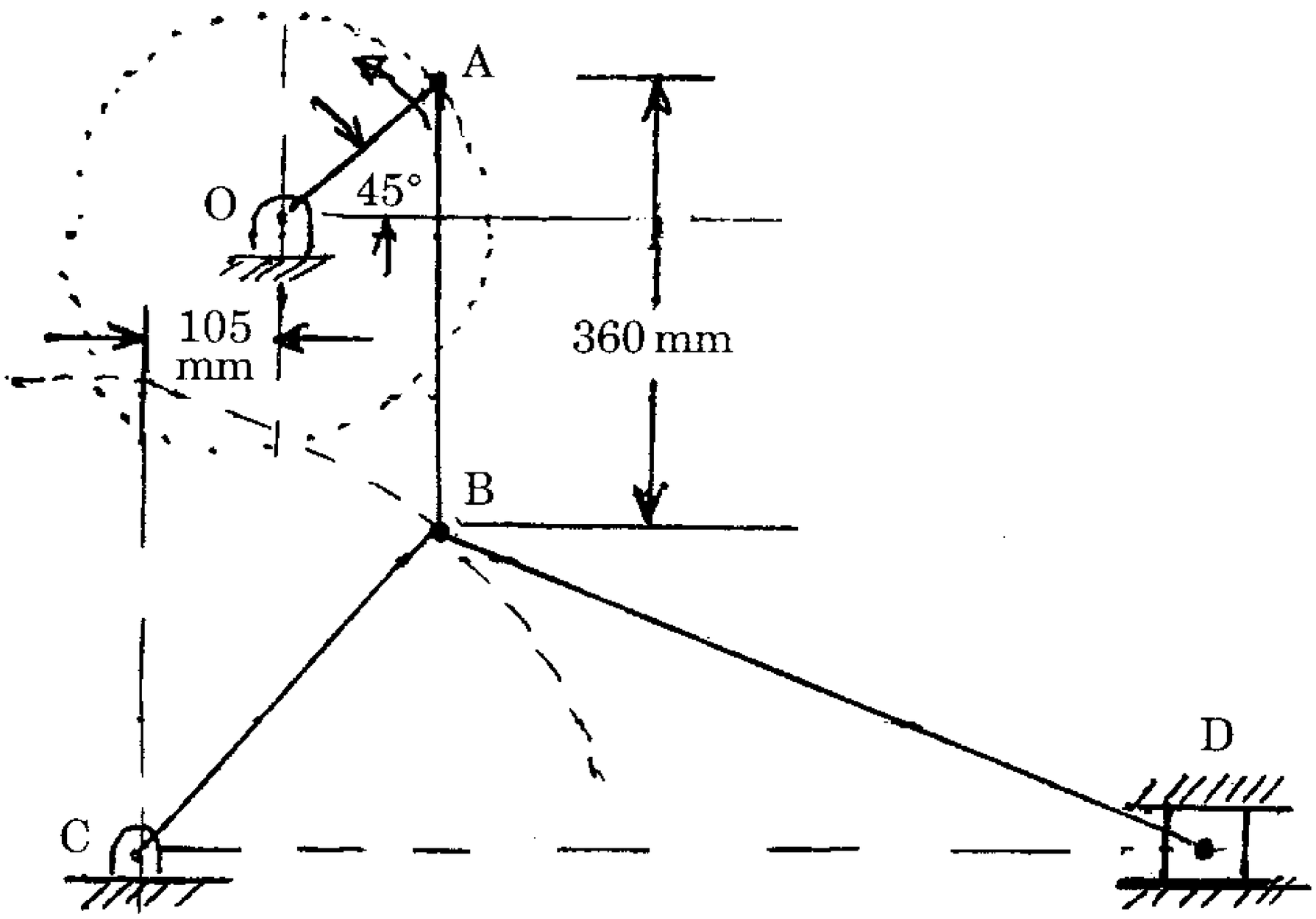


Fig. 2

5. Write short notes on the following (any *four*) : 4×15=60

(*a*) End conditions of a column

(*b*) Natural frequency of compound pendulum

(*c*) Stress strain diagram

(*d*) Jigs and fixtures

(*e*) ABC Analysis and its importance

(*f*) Aggregate production planning.

Roll No.

Candidate should write his/her Roll No. here.

Total No. of Questions : **5** No. of Printed Pages : **8+2**

M1122012

MECHANICAL ENGINEERING

Second Paper

Time : 3 Hours] [Total Marks : 300

Instructions to the candidates :

1. There are *five* questions in this question paper. *All* the five questions have to be answered. Each question has internal choice, except question no. **1**.
2. The total number of marks is **300** and the time allotted is **3** hours. *All* questions carry equal marks, unless specifically stated.
3. The first question will be of short answer type consisting **20** questions, each **one** is to be answered in *two* or *three* lines.
4. Questions should be answered exactly in order in which they appear in the question paper. Answers to the various parts of the same question should be written together compulsorily and no answers of other questions should be inserted between them.
5. Assume suitable data wherever required.
6. All symbols have their usual meanings.
7. Give neat sketches or diagrams wherever necessary.
8. Wherever word limit has been given, it must be adhered to.
9. Use of I.S. codes is permitted.

1. Answer the following short answer type questions in *two* or *three* lines each : 20×3=60

(A) For a thermodynamic process, what is the relationship between the degree of irreversibility and associated availability ?

(B) Mention the thermodynamic processes associated with the Carnot cycle.

(C) Mention the thermodynamic processes associated with the Rankine cycle.

(D) Draw the velocity diagram of an impulse turbine.

(E) Define specific speed of a turbine.

(F) Define Entropy with its characteristics.

(G) Define Mach number.

(H) Differentiate between sensible heat and total heat.

(I) What is relative humidity ? Mention the range of relative humidity that is good for human health.

(J) State the fundamental difference between vapour compression and vapour absorption systems.

(K) What is coefficient of performance of a refrigerant ?

(L) Mention the basic thermodynamic cycles for spark ignition and compression ignition engines.

(M) What is Octane number ?

(N) Give the classification of steam turbine on the basis of direction of flow.

(O) What is Draft Tube ? Name its different types.

(P) FMS is best suited for which type of production ?

(Q) Mention the various vehicle guiding systems used for automated guided vehicles.

(R) Enlist the various types of material handling conveyor systems.

(S) Sketch the Cartesian and Polar robotic configurations.

(T) For a 3-joint robot, determine the number of possible configuration if any of the 5 joint-types can be selected for each joint.

2. (*a*) Derive the general equation for steady flow process. Explain the physical significance of several terms of the equation. 20

(*b*) Derive an expression for the efficiency of the ideal cycle for Diesel engine in terms of the compression ratio, r, the cut-off ratio αc and γ. 20

(*c*) 0.56 cubic metre of gas at an atmospheric pressure of 2 kgf/cm^2 and temperature of 30°C is compressed to 21 kgf/cm^2, its temperature

rising to 400°C. Determine its final volume. Suppose the gas considered above is nitrogen for which the characteristic gas constant R is 30.26 kgf-m/kg°K, determine the mass of gas involve. 20

Or

(*a*) Express the various kinds of flexibilities and their applicability for various tests in the context of flexible manufacturing system (FMS). 20

(*b*) What is Vapour Absorption System ? Explain briefly with a neat diagram "Practical Vapour Absorption System". 20

(*c*) A F-12 vapour compression refrigeration system has a condensing temperature of 50°C and evaporating temperature of 0°C. The refrigeration capacity is 7 tons, the liquid leaving the condenser is saturated liquid and compression is isentropic. Determine :

(*i*) The refrigeration flow rate

(*ii*) The power required to run the compressor

(*iii*) The heat rejected in the plant

(*iv*) COP of the system.

The properties of F-12 are :

Temperature (°C)	**Pressure** (bar)	h_f (kJ/kg)	h_g (kJ/kg)	S_f (kJ/kg°K)	S_g (kJ/kg°K)
50	12.199	84.868	206.298	0.3034	0.6792
0	3.086	36.022	187.397	0.1418	0.6960

Take enthalpy at the end of isentropic compression = 210 kJ/kg. 20

3. (*a*) Draft tubes are applied for which types of turbines ? Explain their theory with the help of a suitable diagram. 20

(*b*) Derive the expression for efficiency of a free jet impulse turbine (Pelton wheel). Also state the runner speed that will give maximum efficiency. 20

(c) The impeller of a centrifugal pump is of 30 cm diameter and 5 cm width at the periphery, and has blades whose tip angles incline backward 60° from the radius. The pump delivers 17 m^3/min and the impeller rotates at 1000 rpm. Assuming that the pump is designed to admit radially, calculate :

(*i*) Speed and direction of water as it leaves the impeller

(*ii*) Torque exerted by the impeller on water

(*iii*) Shaft power required

(*iv*) Lift of the pump.

Take mechanical efficiency 95% and hydraulic efficiency 75%. 20

Or

(*a*) What is meant by critical thickness of thermal insulation ? Obtain the condition for critical thickness of an insulating material in the form of a cylinder. 20

(*b*) Hot oil with a capacity rate of 2500 W/K flows through a double pipe heat exchanger. It enters at 360°C and leaves at 300°C. Cold fluid enters at 30°C and leaves at 200°C. If the overall heat transfer coefficient is 800 W/m^{2}K, determine the heat exchanger area required for :

(*i*) Parallel flow, and

(*ii*) Counterflow. 20

(*c*) One end of a long rod, 35 mm in diameter is inserted into a furnace with the other end projecting in the outside air. After the steady state is reached the temperature of the rod is measured at two points 180 mm apart and found to be 180°C and 145°C. The atmospheric air temperature is 25°C. If the heat transfer coefficient is 65 W/m^2 °C, calculate the thermal conductivity of the rod. 20

4. (*a*) Compare the performance characteristics of the Spark Ignition (SI) and Compression Ignition (CI) engines. 20

(*b*) What is the difference between pressure compounding and velocity compounding in the context of steam turbines ? 20

(*c*) A four cylinder two-stroke cycle petrol engine develops 40 hp at 2500 r.p.m. The mean effective pressure of each is 8 kgf/cm^2 and mechanical efficiency of piston is 80%. Calculate the diameter and stroke of each cylinder if stroke to bore ratio is 1.5. Also calculate the brake specific fuel consumption of the engine, if brake thermal efficiency is 28%. The calorific value of the fuel is 10,500 kcal/kg. 20

Or

(*a*) Explain the following types of lead-through robot programming techniques and their suitability for a particular control system :

(*i*) Power lead through

(*ii*) Manual lead through. 20

(*b*) Draw a block diagram of an expert system and briefly describe its scope and components. 20

(*c*) What are the different components used in a nuclear power plant ? Explain each in detail. 20

5. Write short notes in around **200** words on any *four* of the following : 4×15=60

(*a*) Reynolds Number

(*b*) Impulse and reaction turbines

(*c*) How are the refrigerants classified ?

(*d*) Renewable energy sources

(*e*) Deposition of ice inside carburettor (carburettor icing)

(*f*) Advantages of off-line programming of robots.

1. Answer all the following questions in brief (in **3** to **4** lines each) : 20×3=60

(*a*) Differentiate between 'Thick' and 'Thin' wall cylinders.

(*b*) Write importance of proportionality limit for a ductile material.

(*c*) What is 'Wahl' factor ? Why is it used ?

(*d*) Differentiate between ultimate strength and fracture strength.

(*e*) Why is a 'V' belt drive preferred over flat belt drive in many engineering applications ?

(*f*) What is the difference between Double-Helical and Herringbone gears ?

(*g*) What types of stresses are induced in shafts ?

(*h*) Mention use of a brake dynamometer.

(*i*) Differentiate between temporary and permanent fastenings.

(*j*) Write assumptions for "Wilson Inventory Model".

(*k*) Define control charts. List the types of control charts.

(*l*) What do you mean by a balanced transportation problem ?

(*m*) What is characteristic feature of Hung erian Technique for solving an assignment problem ?

(*n*) How are project completion time and time of completion of critical path correlated in C.P.M. ?

(*o*) Define MRP of a production system. State the objectives of it.

(*p*) Differentiate between Total and Free float related to C.P.M.

(*q*) Enlist criterias for judging machinability.

(*r*) What are comparators ? State the applications of it.

(*s*) What are effects of E.D.M. on metal surface ?

(*t*) How do cutting fluids affect machining process ? Explain.

2. (*a*) A band and block brake has '*n*' number of blocks. Each block subtends an angle 2θ at the centre of drum. The brake is applied by applying load 'P' in downward direction. If μ is the coefficient of friction between block and drum and radius of drum is 'R', show that the ratio of tension on tight and slack side of band is :

$$\frac{T_1}{T_2} = \left(\frac{1 + \mu \tan\theta}{1 - \mu \tan\theta}\right)^n .$$ 20

(*b*) A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio. 20

(*c*) A single cylinder reciprocating engine has speed of 240 rpm. Stroke 300 mm. Mass of reciprocating parts is 50 kg and mass of revolving parts at 150 mm radius is 37 kg. If 2/3 of reciprocating parts and all revolving parts are to be balanced, calculate balance mass at a radius of 400 mm and the residual unbalanced force when crank has rotated through 60° from top dead centre. 20

Or

(*a*) The valve of an IC engine is operated by providing cam and follower. The follower moves with SHM. Draw displacement, velocity and acceleration diagrams of follower and derive expressions for maximum acceleration on outstroke and return stroke and maximum velocity on return stroke. Make suitable assumptions. 20

(*b*) Calculate the magnitude and direction of principal stresses for the state of stress given below :

σ_x = 16 MPa, σ_y = 80 MPa and Z_{xy} = –24 MPa. 20

(*c*) Determine minimum number of teeth required on pinion to avoid interference having given gear ratio 3 : 1, pr. angle 20°, standard addendum is 1 module for wheel. 20

3. (*a*) What is E.C.M. ? Discuss electrochemistry of E.C.M. process and derive expression for volumetric removal rate of material during E.C.M. 20

(*b*) An automatic lathe is to be used to machine brass components 75 mm long × 50 mm diameter using a depth a cut of 1.25 mm. Select the speed that minimizes the machining cost and calculate the corresponding tool life. Also estimate the cutting speed for minimum time of production. Assume that :

Labour + overhead rate = Rs. 5 per hr.

Reconditioning cost of tool edge = Re. 0.25 per edge

Loading and unloading time of workpiece = 15 sec.

Tool change time = 5 min

Feed = 0.2 mm/rev

Tool life relationship = VT^n = 300. 20

(*c*) In an ECM process with puré iron workpiece a removal rate of 5 cm^3/min is desired. Determine the current required. Make suitable assumptions. 20

Or

(*a*) A seamless tubing 35 mm outside diameter is turned orthogonally on a lathe. The following data available :

Rake angle = 35°,

Cutting speed = 15 m/min,

Feed = 0.10 mm/rev,

Length of continuous chip in one revolution = 50.72 mm,

Cutting force = 200 kg,

Feed force = 80 kg.

Calculate the coefficient of friction shear plane angle, velocity of chip along tool face and chip thickness. 20

(*b*) Explain surface finish and hence differentiate between ideal and natural roughness. How tool nose radius and maximum height of unevenness can be correlated ? Explain. 20

(*c*) A cylindrical workpiece is being turned by two different tools. One tool has no nose radius but side cutting and end cutting edge angles are 30° and 7° respectively. Other tool has nose radius of 0.7 mm. The feed used in both the cases is 0.125 mm. Calculate maximum height of unevenness for two cases. 20

4. (*a*) Derive strength equations for the following types of failures in a single riveted lap joint :

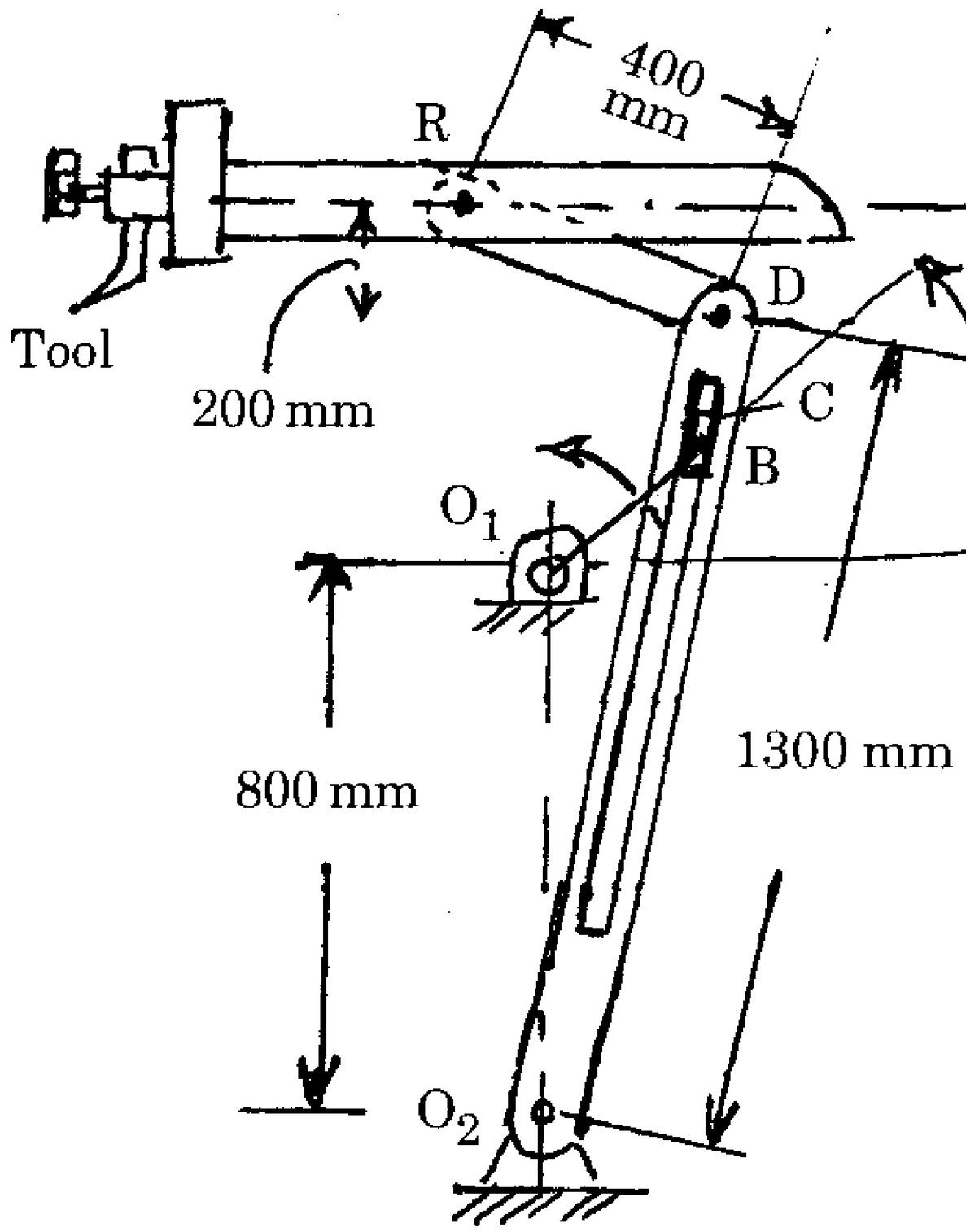
(*i*) Shear failure of rivet

(*ii*) Tensile failure of rivet

(*iii*) Crushing failure of rivet

and hence define efficiency of such a joint. 20

(*b*) A quick return mechanism of crank and slotted lever type shaping machine is shown in Fig. 1. The crank O_1B makes an angle of 45° with vertical and rotates at 40 rpm in counterclockwise direction. Find velocity of ram and angular velocity of link O_2D. 20



$O_1O_2 = 800$ mm $\quad O_2D = 1300$ mm

$O_1B = 300$ mm $\quad DR = 400$ mm

Fig. 1

(*c*) A simply supported beam AB of span 9 m carrying a uniformly distributed load 1800 N per meter run on the part CD of the span so that AC = 2 m, CD = 4 m and DB = 3 m. Draw the shear force and Bending moment diagram. 20

Or

(*a*) Power between two shafts is transmitted by an open flat belt drive. The two pulleys on shafts are of diameters D_1 and D_2. Pulley of diameter D_1 is larger than D_2. If L is the distance between centres of two pulleys, show that the length of belt is :

$$\frac{\pi}{2}(D_1 + D_2) + 2L + \frac{(D_1 - D_2)^2}{4L}.$$ 20

(*b*) Two shafts A and B are made of same material. Each shaft transmits the same power. Shaft A running at 200 rpm, while the Shaft B running at 20000 rpm. Find the ratio of diameters of the two shafts, if same maximum shear stress is developed in each shaft. 20

(c) In the toggle mechanism shown in Fig. 2 the slider 'D' is constrained to move horizontally. Crank OA rotates in counterclockwise direction at a speed of 180 rpm. The dimensions of links are :

OA = 180 mm, CB = 240 mm, AB = 360 mm, BD = 540 mm.

Find velocity of slider 'D' and angular velocity of BD. 20

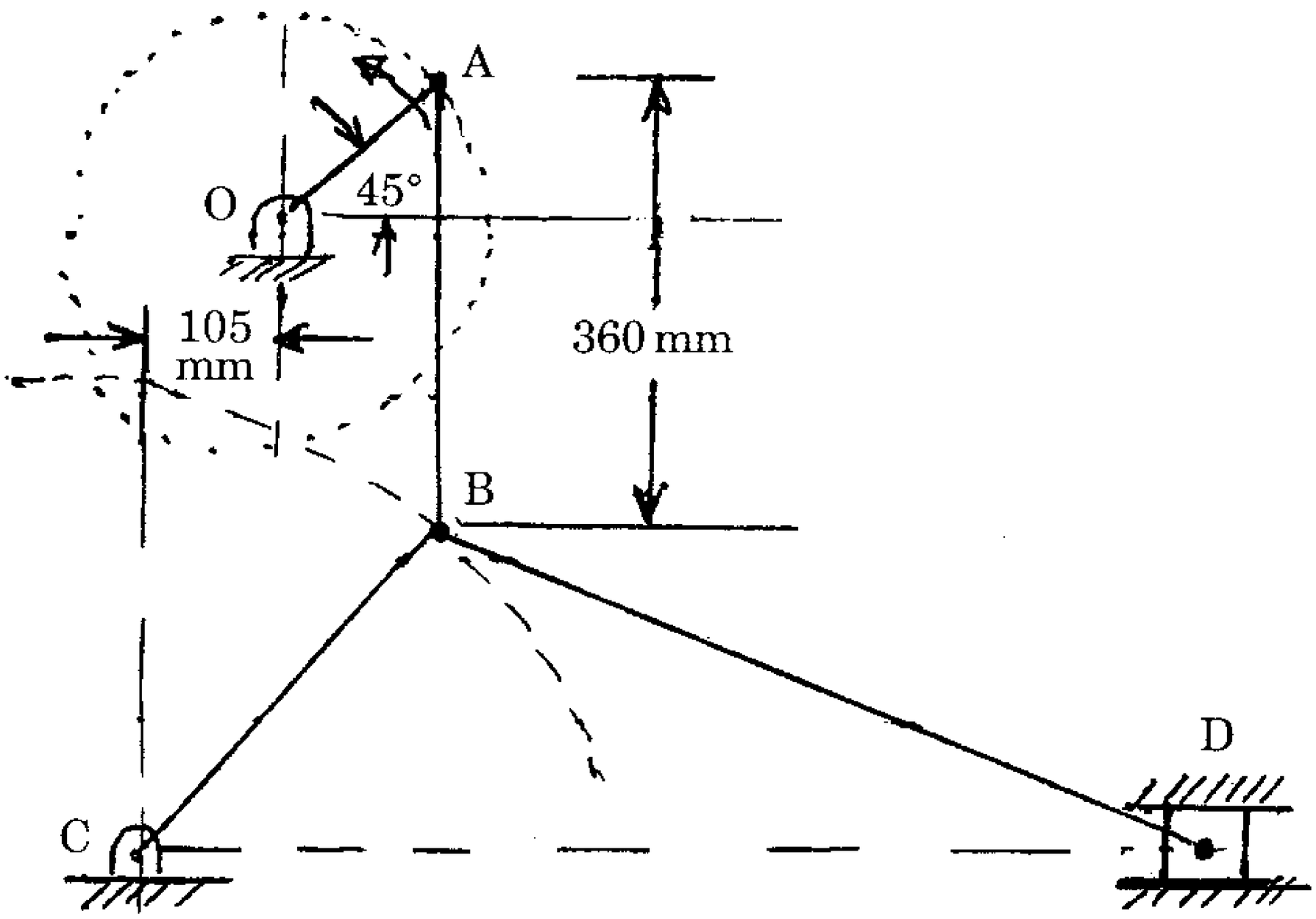


Fig. 2

5. Write short notes on the following (any *four*) : 4×15=60

(*a*) End conditions of a column

(*b*) Natural frequency of compound pendulum

(*c*) Stress strain diagram

(*d*) Jigs and fixtures

(*e*) ABC Analysis and its importance

(*f*) Aggregate production planning.

Roll No.

Candidate should write his/her Roll No. here.

Total No. of Questions : **5** No. of Printed Pages : **8+2**

M1122012

MECHANICAL ENGINEERING

Second Paper

Time : 3 Hours] [Total Marks : 300

Instructions to the candidates :

1. There are *five* questions in this question paper. *All* the five questions have to be answered. Each question has internal choice, except question no. **1**.
2. The total number of marks is **300** and the time allotted is **3** hours. *All* questions carry equal marks, unless specifically stated.
3. The first question will be of short answer type consisting **20** questions, each **one** is to be answered in *two* or *three* lines.
4. Questions should be answered exactly in order in which they appear in the question paper. Answers to the various parts of the same question should be written together compulsorily and no answers of other questions should be inserted between them.
5. Assume suitable data wherever required.
6. All symbols have their usual meanings.
7. Give neat sketches or diagrams wherever necessary.
8. Wherever word limit has been given, it must be adhered to.
9. Use of I.S. codes is permitted.

1. Answer the following short answer type questions in *two* or *three* lines each : 20×3=60

(A) For a thermodynamic process, what is the relationship between the degree of irreversibility and associated availability ?

(B) Mention the thermodynamic processes associated with the Carnot cycle.

(C) Mention the thermodynamic processes associated with the Rankine cycle.

(D) Draw the velocity diagram of an impulse turbine.

(E) Define specific speed of a turbine.

(F) Define Entropy with its characteristics.

(G) Define Mach number.

(H) Differentiate between sensible heat and total heat.

(I) What is relative humidity ? Mention the range of relative humidity that is good for human health.

(J) State the fundamental difference between vapour compression and vapour absorption systems.

(K) What is coefficient of performance of a refrigerant ?

(L) Mention the basic thermodynamic cycles for spark ignition and compression ignition engines.

(M) What is Octane number ?

(N) Give the classification of steam turbine on the basis of direction of flow.

(O) What is Draft Tube ? Name its different types.

(P) FMS is best suited for which type of production ?

(Q) Mention the various vehicle guiding systems used for automated guided vehicles.

(R) Enlist the various types of material handling conveyor systems.

(S) Sketch the Cartesian and Polar robotic configurations.

(T) For a 3-joint robot, determine the number of possible configuration if any of the 5 joint-types can be selected for each joint.

2. (*a*) Derive the general equation for steady flow process. Explain the physical significance of several terms of the equation. 20

(*b*) Derive an expression for the efficiency of the ideal cycle for Diesel engine in terms of the compression ratio, r, the cut-off ratio αc and γ. 20

(*c*) 0.56 cubic metre of gas at an atmospheric pressure of 2 kgf/cm^2 and temperature of 30°C is compressed to 21 kgf/cm^2, its temperature

rising to 400°C. Determine its final volume. Suppose the gas considered above is nitrogen for which the characteristic gas constant R is 30.26 kgf-m/kg°K, determine the mass of gas involve. 20

Or

(*a*) Express the various kinds of flexibilities and their applicability for various tests in the context of flexible manufacturing system (FMS). 20

(*b*) What is Vapour Absorption System ? Explain briefly with a neat diagram "Practical Vapour Absorption System". 20

(*c*) A F-12 vapour compression refrigeration system has a condensing temperature of 50°C and evaporating temperature of 0°C. The refrigeration capacity is 7 tons, the liquid leaving the condenser is saturated liquid and compression is isentropic. Determine :

(*i*) The refrigeration flow rate

(*ii*) The power required to run the compressor

(*iii*) The heat rejected in the plant

(*iv*) COP of the system.

The properties of F-12 are :

Temperature (°C)	**Pressure** (bar)	h_f (kJ/kg)	h_g (kJ/kg)	S_f (kJ/kg°K)	S_g (kJ/kg°K)
50	12.199	84.868	206.298	0.3034	0.6792
0	3.086	36.022	187.397	0.1418	0.6960

Take enthalpy at the end of isentropic compression = 210 kJ/kg. 20

3. (*a*) Draft tubes are applied for which types of turbines ? Explain their theory with the help of a suitable diagram. 20

(*b*) Derive the expression for efficiency of a free jet impulse turbine (Pelton wheel). Also state the runner speed that will give maximum efficiency. 20

(c) The impeller of a centrifugal pump is of 30 cm diameter and 5 cm width at the periphery, and has blades whose tip angles incline backward 60° from the radius. The pump delivers 17 m^3/min and the impeller rotates at 1000 rpm. Assuming that the pump is designed to admit radially, calculate :

(*i*) Speed and direction of water as it leaves the impeller

(*ii*) Torque exerted by the impeller on water

(*iii*) Shaft power required

(*iv*) Lift of the pump.

Take mechanical efficiency 95% and hydraulic efficiency 75%. 20

Or

(*a*) What is meant by critical thickness of thermal insulation ? Obtain the condition for critical thickness of an insulating material in the form of a cylinder. 20

(*b*) Hot oil with a capacity rate of 2500 W/K flows through a double pipe heat exchanger. It enters at 360°C and leaves at 300°C. Cold fluid enters at 30°C and leaves at 200°C. If the overall heat transfer coefficient is 800 W/m^{2}K, determine the heat exchanger area required for :

(*i*) Parallel flow, and

(*ii*) Counterflow. 20

(*c*) One end of a long rod, 35 mm in diameter is inserted into a furnace with the other end projecting in the outside air. After the steady state is reached the temperature of the rod is measured at two points 180 mm apart and found to be 180°C and 145°C. The atmospheric air temperature is 25°C. If the heat transfer coefficient is 65 W/m^2 °C, calculate the thermal conductivity of the rod. 20

4. (*a*) Compare the performance characteristics of the Spark Ignition (SI) and Compression Ignition (CI) engines. 20

(*b*) What is the difference between pressure compounding and velocity compounding in the context of steam turbines ? 20

(*c*) A four cylinder two-stroke cycle petrol engine develops 40 hp at 2500 r.p.m. The mean effective pressure of each is 8 kgf/cm^2 and mechanical efficiency of piston is 80%. Calculate the diameter and stroke of each cylinder if stroke to bore ratio is 1.5. Also calculate the brake specific fuel consumption of the engine, if brake thermal efficiency is 28%. The calorific value of the fuel is 10,500 kcal/kg. 20

Or

(*a*) Explain the following types of lead-through robot programming techniques and their suitability for a particular control system :

(*i*) Power lead through

(*ii*) Manual lead through. 20

(*b*) Draw a block diagram of an expert system and briefly describe its scope and components. 20

(*c*) What are the different components used in a nuclear power plant ? Explain each in detail. 20

5. Write short notes in around **200** words on any *four* of the following : 4×15=60

(*a*) Reynolds Number

(*b*) Impulse and reaction turbines

(*c*) How are the refrigerants classified ?

(*d*) Renewable energy sources

(*e*) Deposition of ice inside carburettor (carburettor icing)

(*f*) Advantages of off-line programming of robots.