

(3 Hours)

[ Total Marks : 80]

- N.B.** 1) **Question No. 1 is compulsory**  
 2) Solve **Any Three** from remaining **Five** questions.  
 3) Use of standard data book like PSG, Mahadevan is permitted  
 4) Assume suitable data if necessary, giving justification

Q1 Answer any **Four** from the following

- a) Why factor of safety is necessary in design of mechanical elements? Discuss the important factors influencing the selection of factor of safety. **5**
- b) Discuss on various types of threads used for power screw. **5**
- c) What do you mean by endurance limit? How the endurance limit of a component is decided? **5**
- d) Discuss advantages and disadvantages of rolling contact bearings over sliding contact bearings **5**
- e) What is surge in spring? How it can be eliminated. **5**
- Q2a) Design a Knuckle joint subjected to an axial pull of 10 KN. Selecting suitable material for all the parts decide the allowable stresses. Design should include figures for the Joint and failure areas. **15**
- Q2b) Explain overhauling of screw and self-locking of screw. **05**
- Q3a) A solid shaft transmitting 40 KW at 960 rpm, is supported on two bearings 1m apart and has two spur gears keyed on it. The pinion is having 200 mm PCD and is located 150 mm to the left of RH bearing and tangential force acts horizontally on it. The gear is having 500 mm PCD and is located 250 mm to the right of LH bearing, and tangential force acts vertically downward on it. Select suitable material and determine the diameter of shaft using maximum shear stress theory. **15**
- Q3b) Draw and explain different fatigue stress cycles. **05**
- Q4a) A DGBB is subjected to a radial load of 4.5KN and an axial load of 2.5KN. The bearing rotates at 600 rpm. Considering the expected life of 18000 hours with survival probability of 93% and operating temperature of 135 °C, select a suitable standard bearing. **10**
- Q4b) Following data is given for a 360° hydrodynamic bearing. **10**  
 Radial load = 6.5KN, Journal speed = 1200 rpm, journal diameter = 60 mm, bearing length = 60 mm, minimum oil film thickness = 0.009 mm. The class of fit is H7e7 normal running fit. Specify the viscosity of lubricating oil that you will recommend for this application. Choose the lubricant (SAE No.) if mean operating temperature of the bearing is given as 100°

- Q5a) A single cylinder four stroke cycle internal combustion engine produces 15 KW power at 700 rpm. Design a suitable flywheel, assuming coefficient of fluctuation of speed as 0.04. The torque developed during the power stroke may be considered as sine curve and work done during the power stroke is 30% more than the work done per cycle. **10**
- Q5b) Design a chain drive to meet the following specification **10**  
Input power = 5.5 KW, Input speed = 300 rpm, Output speed = 100 rpm.
- Q6a) A helical compression spring is subjected to a maximum force of 5000N with a corresponding deflection of 70 mm. The spring is to operate over a 50 mm diameter rod. Determine the wire diameter and number of active turns. Also decide other details such as free length, pitch, helix angle. Check for solid stress and buckling. State whether the spring is a closed coiled helical spring. For the material of the spring assume following properties. **15**
- $$S_u = \frac{2000}{d^{0.17}} \text{ Mpa} \quad S_{ys} = \frac{1200}{d^{0.17}} \text{ Mpa} \quad G = 80 \text{ Gpa}$$
- Q6b) State different theories of failure and explain any two in details. **05**
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Time: 3 hour

Max. Marks: 80

**Note:**

1. Question No.1 is compulsory.
2. Attempt any three questions from the remaining.
3. Assume suitable data if required.

**Q1. Solve any four out of five. 5 marks each**

- a Write short note on multi staging of reciprocating compressor.
- b Describe working of reheating gas turbine plant with the help of a T-S diagram.
- c Write the differences between Mountings and Accessories of boiler.
- d Write short note on air vessel with neat sketch.
- e Write short note on reciprocating pump with indicator diagram.

**Q2.**

- a The steam at 4.9 bar and 160°C is supplied to a single-stage impulse turbine at a mass flow rate of 30 kg/min, from where it is exhausted to a condenser at a pressure of 19.6 kPa. The blade speed is 300 m/s. The nozzles are inclined as 25° to the plane of wheel and the outlet blade angle is 35°. Neglecting friction losses, determine Theoretical power developed by the turbine, (b) diagram efficiency, and (c) stage efficiency. **10 marks**

- b Explain the construction and working of once through boiler with neat sketch. **5 marks**

- c Write the Function and location of Blow off cock, Fusible plug, pressure gauge & water level indicator in boiler. **5 marks**

**Q3.**

- a The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature of 20°C. The pressure of the air after compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air-fuel ratio used is 90: 1. If flow rate of air is 3.0 kg/s, find:  
(i) Power developed.  
(ii) Thermal efficiency of the cycle.  
Assume  $C_p = 1.0$  kJ/kg K and  $\gamma = 1.4$  of air and gases  
Calorific value of fuel = 41800 kJ/kg. **10 marks**

- b Write short note on Francis turbine. **5 marks**

- c Write short note on Turbojet engine. **5 marks**

**Q4.**

**a** Calculate the efficiency of (a) boiler, (b) economiser, and (c) whole plant having the following data:

(a) Boiler:

Mass of the feed water = 2060 kg/h

Mass of the coal burnt = 227 kg/h

Calorific value of coal = 30, 000 kJ/kg

Enthalpy of steam produced = 2750 kJ/kg

(b) Economiser:

Inlet temperature of feed water = 15°C

Exit temperature of feed water = 105°C

Atmospheric air temperature = 18°C

Temperature of flue gases entering = 370°C

Mass of flue gases = 4075 kg/h

Specific heat of flue gases = 1.3 kJ/kg.°C.

**8 marks**

**b** Derive the condition for maximum blade efficiency of impulse turbine. **8 marks**

**c** What is the Classification of pumps? **4 marks**

**Q5.**

**a** A pump operates at a maximum efficiency of 82% and delivers 2.25 m<sup>3</sup>/s under a head of 18 m while running at 3600 r.p.m speed. Compute the Power and specific speed of the pump. Also determine the discharge, head and power input to pump at a shaft speed of 2400 r.p.m. Cite the assumption made, if any.

**10 marks**

**b** Write short note on Centrifugal compressor. **6 marks**

**c.** What is specific speed for turbine and centrifugal pump? **4 marks**

**Q6.**

**a** A Pelton wheel has a mean bucket speed of 12 m/s and is supplied with water at a rate of 750 liters per second under a head of 35 m. If the bucket deflects the jet through an angle of 160°, find the power developed by the turbine and its hydraulic efficiency. Take the coefficient of velocity as 0.98. Neglect friction in the bucket. Also determine the overall efficiency of the turbine if its mechanical efficiency is 80%. **10 marks**

**b** What is multistaging of impulse turbine? and What is degree of reaction? **5 marks**

**c** What do you mean by cavitation and its effect in turbine and pump? **5 marks**

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**Duration: 3hrs**

**[Max Marks:80]**

- N.B. :
- (1) Question No 1 is Compulsory.
  - (2) Attempt any three questions out of the remaining five.
  - (3) All questions carry equal marks.
  - (4) Assume suitable data, if required and state it clearly.
  - (5) Use of Refrigerant tables, Friction charts, Psychometrics chart, and Steam table are permitted.

Qu.1 Attempt any Five of the following [20]

- a) Define: i) Ton of Refrigeration ii) iii) Dry bulb temperature iii) Wet bulb temperature iv) Humidity ratio
- b) What are the properties of refrigerants? Compare primary and secondary refrigerant.
- c) Define the term 'by pass factor' Express it for heating and cooling coil.
- d) State the various applications of HVACR and explain any one application.
- f) Explain working of Simple Vapor absorption system
- g) Define the effective temperature. What are the physiological hazards resulting from heat?
- h) State the types of Expansion device and explain working of any one with neat diagram.

Qu.2 a) Draw Schematic, P-H and T-s diagram of standard VCERS and discuss effect of Suction Pressure and Discharge Pressure on the performance of the VCERS. [10]

- b) [10]  
A simple air refrigeration system is used for an aircraft to take a load of 20.TR. The ambient pressure and temperature are 0.9 bar and 22°C resp. The pressure of air is increased to 1 bar due to isentropic ramming action. The air is further compressed in a compressor to 3.5 bar and then cooled in a heat exchanger to 72°C. Finally, air is passed through the cooling turbine and then it is supplied to the cabin at a pressure of 1.03 bar. The air leaves the cabin at a temperature of 25°C. Assuming the isentropic efficiencies of the compressor and turbine are 80% and 75%. Find 1) Power required to take load in the cooling cabin. 2) COP of the system take  $C_p = 1.005 \text{ KJ/kg K}$  and  $\gamma = 1.4$

Qu.3 a) [10]  
A refrigerator uses R-134a as the working fluid and operates on ideal vapor compression refrigeration system. The evaporator and condenser pressure are 0.1 MPa and 0.8 MPa respectively. The mass flow rate of the refrigerant is 0.8 kg/sec. Determine the following:

- 1) Rate of heat removal from the refrigerant space.
- 2) Input power to compressor.
- 3) Heat rejection rate in the condenser.
- 4) The COP
- 5) What would be the COP if compared with that of the Carnot refrigerator operating between 30°C and -10°C.

- b) The humidity ratio of atmospheric air at 28°C DBT and 760 mm of mercury is 0.016 kg/kg of dry air. Determine [10]
- 1) Partial pressure of water vapor
  - 2) Relative humidity
  - 3) Dew point temperature
  - 4) Specific enthalpy
  - 5) Vapor density.
- Qu.4 a) Draw a neat sketch of Air Handling Unit showing each component. Also state functions of each component [06]
- b) List and discuss various components used in Domestic refrigerator. [06]
- c) What are the types of heat pump? Explain any one type with its application. [08]
- Qu.5 a) Explain the working of air cooled, and water-cooled condenser [06]
- b) The design conditions for an air-conditioned hall is: [14]
- Outer conditions = 38°C DBT and 28°C WBT  
Inside condition = 24°C DBT and 60% RH  
Sensible heat load in room = 46.4 kW.  
Latent heat load in room = 11.6 kW.  
Total infiltration air 1200 m<sup>3</sup>/hr.  
Apparatus dew point temperature = 10°C.  
Quantity of recirculated air from the hall = 60%
- If the quantity of recirculated air is mixed with the conditioned air after the cooling coil find the following.
- a) The condition of air leaving the conditioner coil and before mixing with recirculated air.
  - b) The condition of air before entering the hall
  - c) The bypass factor of cooling coil
  - d) The refrigeration load on the cooling coil in tones of refrigeration
- Qu.6 a) Write short note on (any two) [10]
- 1) Types of Cooling towers, performance and selection
  - 2) Dairy and food processing plant
  - 6) Explain working of commercial ice plant.
  - 7) Discuss the method of duct design
- b) Explain various psychrometric process with the help of psychrometric chart [10]

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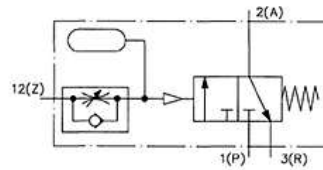
(3 hours)

Total Marks: 80

- NB 1) **Question No. 1 is compulsory**  
 2) **Attempt any three questions out of the remaining five questions.**  
 3) **Figures to the right indicate full marks.**  
 4) **Assume suitable data wherever required but justify the same.**

**Q1. Attempt any four (20)**

- A. Explain the difference between programmable and flexible automation.  
 B. Explain Automation migration strategy.  
 C. List and explain types of joints used in Robots.  
 D. Identify the component and explain the functioning of the component.



- E. What is an end effector? Explain the magnetic gripper with suitable example.

**Q2 A. Design electro Pneumatic circuit for two cylinder operation with following sequence using 5/2 both side solenoid operated valve as DCV. (10)**

A+B+Delay B- A-

With user selection option single cycle Multicycle operation.

**B. Explain concept of Artificial Neural Networks (ANN) in detail. List and define Terminologies of ANNs. (10)**

**Q3 A. What is a significance of Cascade method? List rules for cascade method along with example. (10)**

**B. Differentiate between PLC and Relays. (05)**

**C. Write short note on industrial application of Robots. (05)**

**Q4 A. Compare Supervised, Unsupervised and reinforcement learning with different parameters. (10)**

**B. Design simple pneumatic circuit for two cylinder operation with following sequence using 4/2 pilot operated valve as DCV using cascade method (10)**

Delay B+ A+ A- B

With user option of single cycle – multi cycle. Also draw displacement diagram.

**Q5 A. Explain depth first search algorithm with example. (08)**

**B. Write note on different actuation methods for Direction control valves (05)**

**C. Explain linear regression technique with suitable example. (05)**

**Q6 A. Explain hierarchical Clustering with as example. (08)**

**B. Write detail note on Meter in circuit used in Hydraulics operations. (05)**

**C. For a given data set [2,4,10,12,3,20,30,11,25], find the final cluster centres using K=2 clusters. (05)**

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- N.B. : (1) All questions carry equal marks.  
 (2) **Question No. 1 is Compulsory.**  
 (3) Attempt any **three** questions from remaining five questions.  
 (4) Figures to the right indicate full marks.  
 (5) Draw neat sketches wherever necessary.

- Que. 1 Write Short Note on: **Any four** out of six. (20)
- Types of chips.
  - Applications of Cutting fluids.
  - Primary and secondary cutting edge finish.
  - Tool wear mechanisms.
  - Cutting tip and Chip breakers in carbide tools
  - Multi-point Form tools.
- Que. 2 A. An orthogonal cut 2.5 mm wide is made at a speed of 0.5 m/sec and feed of 0.26 mm with a H.S.S. tool having a  $20^\circ$  rake angle. The chip thickness ratio is found to be 0.58, the cutting force is 1400N and the feed thrust force is 360 N. Find: (i) Chip thickness (ii) Shear plane angle (iii) Resultant force (iv) Coefficient of friction on the face of the tool (v) Friction force and normal force on the shear plane (vi) Specific energy. (10)
- B. What are the sources of heat generation in metal cutting and also explain the distribution of temperature during metal cutting process. (10)
- Que. 3 A. Prove that the relationship  $2\phi + \beta - \alpha = \frac{\pi}{2}$  holds good in orthogonal cutting, where  $\phi$  = Shear angle,  $\alpha$  = Rake angle,  $\beta$  = Friction angle. Also state your assumptions. (10)
- B. (i) Explain milling dynamometer with neat sketch. (10)  
 (ii) Write the ISO coding system for tipped tool (Insert)
- Que. 4 A. Derive an expression for optimum cutting speed and tool life for maximum production rate. Also write the assumptions associated to it (10)
- B. (i) Discuss tool angles in ASA system with neat sketch (10)  
 (ii) Write the properties of cutting tool material and explain cubic boron nitride (CBN).



- Que. 5 A. Discuss the following design features of a reamers: (10)
- (i) Reaming allowance (ii) Diameter of Reamer (iii) Length of body (iv) Number of teeth (v) Rake angle and clearance angle.
- B. Explain the various steps involved in the design of circular broach and draw the neat diagram. (10)
- Que. 6 A.  $VT^{0.20} = 640$  is the Taylor tool life equation for Carbide tool-steel workpiece (10)
- obtained experimentally, where V is in m/min and T is in min. A batch of 1000 steel parts, each 100 mm in diameter and 250mm in length is to be rough turned using a feed of 0.2 mm/rev. If the cost per cutting edge of the throw-away carbide insert is Rs.60, time required to reset the cutting edge is 1 min and the total machine rate (including Operator cost) is Rs.300/hr.
- Calculate: (i) Optimum cutting speed for min. cost of production. (ii) Corresponding tool life. (iii) Total production cost if time taken to load & unload the component is 2 min and initial setup time is 2 Hrs. (iv) Total production time for the given batch.
- B. (i) How is the tool shank of a single point cutting tool designed ? (10)
- (ii) Explain synthetic and polycrystalline diamond (PCD).

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