

(3 Hours)

[Total marks: 80]

Instructions:

1. **Question 1 compulsory.**
2. Attempt any **three** questions from the remaining **five** questions.
3. Figures to the right indicate full marks.
4. Assume suitable data wherever required but justify the same.

- Q.1.** Solve ANY FOUR questions from following.
- | | | |
|----------|---|-----------|
| a | List four levels of automation with suitable examples | 05 |
| b | Explain backpropagation algorithm used in Artificial Neural Networks. | 05 |
| c | Define Continuous path control system used in robotic system with suitable applications. | 05 |
| d | Summarize with a schematic block diagram, an automated system showing all the basic elements. | 05 |
| e | Explain the concept of Timers and Counters used in PLC architecture. | 05 |
- Q.2.**
- | | | |
|-----------|---|-----------|
| a. | Design an electro- pneumatic circuit for two-cylinder operation with following sequence using 5/2 both side solenoid operated valve as DCV.
A+ , Delay B+ , A-B- | 10 |
| b | Illustrate with neat diagram counter balance valve and Bleed off hydraulic circuits used in hydraulic system. | 10 |
- Q.3.**
- | | | |
|-----------|---|-----------|
| a. | Illustrate with neat sketches any three types of drives used in robotic system with its advantages and disadvantages. | 10 |
| b. | Illustrate Goal based reflex agents and Model based intelligent agents in AI with examples. | 10 |
- Q.4**
- | | | |
|-----------|--|-----------|
| a. | Design a hydraulic circuit for two cylinder operation with following sequence using 4/2 pilot operated valve as DCV using cascade method , A+ , B+ , Delay B- , A- | 08 |
| b | Differentiate between supervised and unsupervised techniques used in machine learning. | 07 |
| c | Define the terms Robot Degrees of freedom for robotic system. | 05 |
- Q.5.**
- | | | |
|-----------|--|-----------|
| a. | Explain the significance of latching in PLC. | 06 |
| b. | Illustrate K nearest neighbours algorithm used in machine learning. | 08 |
| c. | Illustrate with neat sketches, the logic of AND and OR gates, used in operation of pneumatic circuits. | 06 |
- Q.6**
- | | | |
|-----------|---|-----------|
| a. | Differentiate between tree and graph search used in Machine Learning. | 08 |
| b. | Illustrate the concept of Logistic regression in machine learning. | 06 |
| c | Illustrate the concept of Artificial Neural Networks (AAN) in detail. | 06 |

Duration: 3 Hours

[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.

Q.1 Attempt any Five of the following

[20]

- Explain numbering system of refrigerants
- Draw T-s Diagram of vapor compression Refrigeration cycle and show various process.
- Write a note on heat pump.
- State the various applications of HVACR.
- State and explain the types of expansion devices.
- Write a note on food preservation.
- Explain with neat sketches the simple air refrigeration system.

Q.2 a) Explain the difference between vapor compression refrigeration system and vapor absorption refrigeration system with neat schematic diagram.

[08]

- b) An air cooling system for a jet plane cockpit operates on the simple cycle. The cockpit is to be maintained at 15°C . The ambient air pressure and temperature are 0.16 bar and -7°C respectively. The pressure ratio of the jet compressor is 2.5. The plane speed is 1000 kilometres per hour. The pressure drop through the cooler coil is 0.15 bar. The pressure of the air leaving the cooling turbine is 1.07 bar and that in the cockpit is 1.0325 bar. The cockpit cooling load is 65 TR. Determine

[12]

- Temperature and pressure at all the points.
- Mass of air circulated per minute
- COP

- Q.3 a) Define refrigerants and its ideal properties. [08]
b) R-12 refrigeration system operates between -10°C and 35°C . The flow rate refrigerant through the system is 0.2 kg/s . At the entry of the compressor the refrigerant is dry and saturated. Use P-h Chart [12]
1. Actual COP
2. Ideal COP
Take C_p at $40^{\circ}\text{C} = 0.82\text{ kJ/kg K}$ and C_p at $-15^{\circ}\text{C} = 0.64\text{ kJ/kg K}$.
- Q.4 a) Explain various psychrometric process [08]
b) For a sample of air leaving 25°C DBT, Humidity ratio 0.010 kg/kg of dry air at barometric pressure of 750 mm of Hg . Determine following properties by using psychrometric relations and Verify your result with psychrometric chart [12]
1. Partial pressure of water vapour
2. Relative humidity
3. Dew point temperature
4. Vapour density,
5. Enthalpy
- Q.5 a) Define the effective temperature. Discuss various duct design methods [08]
b) In a conference room for seating of 50 persons, [12]
Application : Summer Air Conditioning
Inside condition : 20°C , DBT, 60% RH
Outside condition : 30°C DBT, 27°C WBT
Sensible load per person : 80W
Latent load per person : 50W
Light and fans : 20000 W
Glass and walls : 20000 W
Air infiltration : $20\text{ m}^3/\text{min}$
Assuming 30 % fresh air and 70% of recirculated air are mixed before passing through the Cooling coil.

1. Identify and Show psychrometric process required for above application on psychrometric chart
2. Estimate Total load.
3. Calculate RSHF

Q.6 Write a notes on following (any Four)

[20]

1. Air handling Unit
 2. Psychrometry properties
 3. Type of Insulation Material used in HVACR
 4. Cooling tower performance
 5. Ice Manufacturing plant
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(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) Explain overhauling of screw and self-locking of screw. 5
- c) What do you understand by stress concentration? How to minimize the stress concentration 5
- d) Discuss advantages and disadvantages of rolling contact bearings over sliding contact bearings 5
- e) Write a note on Nipping in a leaf spring 5

- Q2**
- a) Design a Socket and Spigot type of cotter joint to transmit an axial load of 60 KN. Select suitable material, factor of safety and draw informative sketch. 15
 - b) Explain the terms applied to rolling element bearing - 1) Rated life 2) Dynamic capacity 3) static capacity. 05

- Q3**
- a) A shaft is supported in bearings A and B, 1000 mm apart. An involute spur gear having PCD 400 mm is located at 300 mm to the right of LH bearing and a 600 mm diameter pulley is mounted 350 mm to the left of RH bearing. The gear is driven by a pinion located vertically above, while the pulley transmits power via belt drive to a pulley located vertically below. The ratio of belt tension is 2.0. The pulley weighs 2500N. Design the shaft, if power transmitted is 30 KW at 400 rpm. The shaft rotates clockwise when viewed from A. 15
 - b) Write note on – Criteria for material selection. 05

- Q4**
- a) A DGBB is to be selected for an intermediate shaft of helical gear box which is subjected to an axial load of 5 KN and radial load of 12 KN when operating at 600 rpm. Select suitable size of bearing if it is required to have a life of 20000 hours with a probability of survival of 92%. 10

- b) Following data is given for a 360° hydrodynamic bearing. 10
Radial load = 10 KN, Journal speed = 1450 rpm, l/d ratio = 1, bearing length = 50 mm, radial clearance = 20 microns, eccentricity = 15 microns. Calculate 1) the minimum oil film thickness 2) Coefficient of friction 3) Power lost in friction 4) Viscosity of lubricant in CP 5) total flow rate of lubricant in liters/minutes.
- Q5 a) 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
- b) Calculate the factor of safety on breaking load for a chain 10A₂ DR50 which is used to transmit 15 KW design power. The input speed is 960rpm and reduction ratio is 2.90. 10
- Q6 a) A close coil helical compression spring is subjected to an axial load varying from 5 KN to 6.5 KN at frequency of 20 cycle per second. The spring rate is 70 N/mm. Design the spring for a factor of safety 1.8. the properties of spring material are 15
 $S_u = \frac{2000}{d^{0.17}} \text{ MPa}$ $S_{ys} = \frac{1200}{d^{0.17}} \text{ MPa}$ $S_{no} = \frac{600}{d^{0.15}} \text{ MPa}$ $G = 80000 \text{ N/mm}^2$
Where d is diameter of wire.
- b) State different theories of failure and explain any two in details. 05
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Time: 3 hour

Max Marks:80

Note: 1. Q1 is compulsory
2. Solve any three from remaining

- Q1 Solve any Four out of Six** **20**
- A. Classify forging processes. Compare hydraulic and Mechanical presses used in forging.
 - B. Classify metal spinning, write applications, and explain any one type of it.
 - C. Differentiate Hot and Cold working.
 - D. Explain various defects in deep drawing with their causes and remedy
 - E. Explain explosive forming process with advantages, limitations, and applications
 - F. Classify extrusion. Write advantages and limitations of hydrostatic extrusion.
- Q2** **20**
- A. A block made of a perfectly plastic material with yield stress of 180 MPa in plain strain has dimensions 250 x 150 x 200 mm (b x hx w). Calculate the peak pressure P at the centre of the die. Also calculate minimum pressure at the edges. Assume sticking friction condition and Tresca's yield criterion.
 - B. Explain the effect of temperature and strain rate on metal forming.
- Q3** **20**
- A. The thickness of plate is reduced from 35 mm to 15 mm by successive cold rolling passes using identical rolls of diameter 700 mm. Assume that there is no change in width and coefficient of friction between the rolls and the workpiece is 0.1. Calculate the minimum number of passes required.
 - B. What is maximum draft in rolling? Derive equation for maximum draft.
- Q4** **20**
- A. In a wire drawing operation, the initial wire diameter is 7 mm and final wire diameter is 6.3 mm. the half die angle $\alpha=10^\circ$. Find the drawing stress considering $\mu=0.1$ and $k=20 \text{ N/mm}^2$. Also calculate the maximum reduction possible.
 - B. Explain deep drawing process with advantages and applications.
- Q5** **20**
- A. Explain stretch forming with advantages, limitations, and applications.
 - B. Write types, causes, and remedies for deep drawing defects.
- Q6** **20**
- A. Explain V and edge bending process.
 - B. Explain various rolling defects with causes and remedies.

Time: 3 Hours

Max. Marks: 80

Instructions:

- Question No.1 is compulsory.
- Solve ANY THREE questions from the remaining five questions.
- Figure to the right indicates full marks.
- Assume suitable data wherever required, but justify the same.
- Use of steam table is permitted.

Marks

- Q. 1** Solve ANY FOUR questions from following. (Each question carries 5 marks) **(20)**
- a) What will be the effect on multi stage compressor if the intercooler is not used in it?
 - b) How regeneration improves the efficiency of gas turbine? Does it affect the turbine work?
 - c) Why water tube boiler is preferred over fire tube boiler in power plant or large-scale applications?
 - d) Write short note on centrifugal pump.
 - e) Write short note on air vessel.
- Q. 2**
- a) In a single stage impulse turbine the mean diameter of the blade ring is 1m and the rotational speed is 3000 r.p.m. The steam is issued from the nozzle at 300 m/s and nozzle angle is 20° . The blades are equiangular. If the friction loss in the blade channel is 19% of the kinetic energy corresponding to the relative velocity at the inlet to the blades, what is the power developed in the blading when the axial thrust on the blades is 98 N ? **(10)**
 - b) Explain any five mountings of boiler. **(05)**
 - c) What is Euler's theory? What is the use of it in turbomachinery? **(05)**
- Q. 3**
- a) Air is drawn in a gas turbine unit at 15°C and 1.01 bar and pressure ratio is 7:1. The compressor is driven by the H.P. turbine and L.P. turbine drives a separate power shaft. The isentropic efficiencies of compressor, and the H.P. and L.P. turbines are 0.82, 0.85 and 0.85 respectively. If the maximum cycle temperature is 610°C , calculate : **(10)**
 - (i) The pressure and temperature of the gases entering the power turbine.
 - (ii) The net power developed by the unit per kg/s mass flow.
 - (iii) The work ratio.
 - (iv) The thermal efficiency of the unit.
 Neglect the mass of fuel and assume the following:
 For compression process $C_{pa} = 1.005 \text{ kJ/kg K}$ and $\gamma = 1.4$
 For combustion and expansion processes; $C_{pg} = 1.15 \text{ kJ/kg K}$ and $\gamma = 1.333$.
 - b) Derive the condition for maximum efficiency of reaction turbine. **(05)**
 - c) Illustrate working of Turbojet Engine. **(05)**

- Q. 4 a)** A boiler generates 7.5 kg of steam per kg of coal burnt at a pressure of 11 bar, (08)
 from feed water having a temperature of 70°C. The efficiency of boiler is 75% and
 factor of evaporation 1.15, specific heat of steam at constant pressure is 2.3.
 Calculate:
 (i) Degree of superheat and temperature of steam generated;
 (ii) Calorific value of coal in kJ/kg;
 (iii) Equivalent evaporation in kg of steam per kg of coal
- b)** What is degree of reaction? Prove that the degree of reaction for parson's Reaction (08)
 turbine is 50%.
- c)** What is cavitation in pump? (04)
- Q. 5 a)** A centrifugal pump has the following characteristics: outer diameter of impeller = (10)
 800 mm; width of impeller vanes at outlet = 100 mm; angle of impeller vanes at
 outlet = 40°. The impeller runs at 550 r.p.m and delivers 0.98 m³ of water per
 second under an effective head of 35 m. A 500 kW motor is used to drive the
 pump. Determine the manometric, mechanical and overall efficiencies of the
 pump. Assume water enters the impeller vanes radially at inlet.
- b)** Write short note on surging and choking of compressor. Explain it with the help (6)
 of Pressure ratio versus Mass flow rate graph.
- c)** Define equivalent evaporation of boilers and what the significance of it is. (4)
- Q. 6 a)** Design a Francis turbine runner with the following data: (10)
 Net head $H = 68$ m;
 speed $N = 750$ r.p.m;
 output power $P = 330$ kW;
 $\eta_h = 94\%$;
 $\eta_o = 85\%$;
 flow ratio $\psi = 0.15$;
 breadth ratio $n = 0.1$;
 inner diameter of runner is half of outer diameter.
 Also assume 6% of circumferential area of the runner to be occupied by the
 thickness of the vanes. Velocity of flow remains constant throughout and flow is
 radial at exit.
- b)** Write short note on compounding of Impulse turbine. (5)
- c)** What is priming? and why it is not required in reciprocating pump? (5)