

[Time: 3 hours]

[Total Marks: 80]

- NB: 1) Question No. 1 is compulsory  
 2) Attempt any three questions out of the remaining five questions.  
 3) The figures to the right indicate full marks.  
 4) Assume suitable data wherever required but justify the same.
- Q1. Attempt any four** (20)  
 A. Justify the use of Pneumatics and Hydraulics with suitable examples.  
 B. List four levels of automation with suitable examples.  
 C. Explain the components of a Robotic system with a neat sketch.  
 D. Explain the Architecture of PLC with a neat block diagram  
 E. State the meaning of an intelligent system and explain the components of an intelligent system
- Q2** A. Design an electro-pneumatic circuit for two-cylinder operation with the following sequence using 5/2 both side solenoid operated valve as DCV. (10)  
 A+ B+ Delay A-B-  
 With user selection option single cycle Multicycle operation.  
 B. Differentiate between hydraulic meter-in and meter-out circuits with suitable applications. (10)
- Q3** A. State the types of intelligent agents. Explain the goal-based agent along with a neat sketch. (10)  
 B. Illustrate with neat sketches the mechanical and vacuum type of end effectors used in robotic systems, stating their advantages and disadvantages. (10)
- Q4** A. Compare Supervised, Unsupervised, and reinforcement learning with different parameters. (10)  
 B. Design a hydraulic circuit for two-cylinder operation with the following sequence using 4/2 pilot-operated valve as DCV using cascade method, A+ , B+ , Delay B- , A- (10)
- Q5** A. State the use of a decision tree. Explain the terminology of the decision tree with a suitable example. (08)  
 B. Write note on different actuation methods for Direction control valves (08)  
 C. State the steps of the K-mean algorithm for clustering analysis (04)
- Q6** A. What is the activation function? Explain the log-sigmoid activation function with a neat sketch. (08)  
 B. List any five applications of Natural Language Processing (NLP). (06)  
 C. What is the activation function? Explain the log-sigmoid activation function with a neat sketch (06)

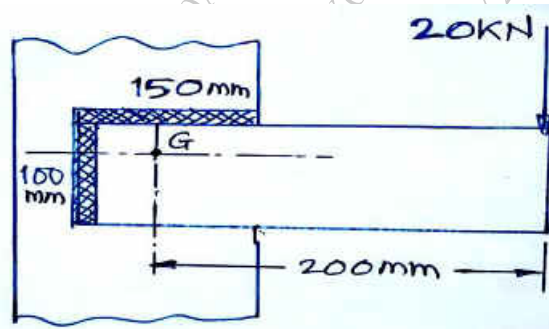
Time:03 Hours

Total marks – 80

- N.B.**
1. Question No 1 is **compulsory**
  2. Solve **Any Three** questions from the remaining **Five** questions.
  3. Assume any **suitable data** if necessary with justification.
  4. Use of **Design Data Book** is permitted.
  5. Figures to the right indicate maximum marks.

- |   | <b>Marks</b> |
|---|--------------|
| <b>Q1.</b> Attempt any <b>Four</b> of the following.  |              |
| <b>(a)</b> With neat sketch explain various types of threads used as power screws?  | <b>05</b>    |
| <b>(b)</b> Define stress concentration and with neat sketches show various methods to reduce the effect of stress concentration.  | <b>05</b>    |
| <b>(c)</b> Write in brief on Aesthetic and Ergonomics considerations in design.   | <b>05</b>    |
| <b>(d)</b> Explain the nipping of the leaf spring with neat sketch.   | <b>05</b>    |
| <b>(e)</b> State the characteristics of chain drive and discuss the polygon effect.   | <b>05</b>    |
| <b>Q2.</b>  |              |
| <b>(a)</b> Selecting suitable material, design a Socket and Spigot Cotter Joint for an axial load of 50 KN. Draw a neat sketch of the joint.  | <b>15</b>    |
| <b>(b)</b> Explain with neat sketches, various types of cyclic stresses.  | <b>05</b>    |
| <b>Q3.</b>  |              |
| <b>(a)</b> A radial load on 360° hydro dynamically lubricated self-contained bearing supports 10kN. The journal rotates at 1450 rpm. Assuming journal length to its diameter as 1 with the bearing length as 50 mm. Take radial clearance as 20 microns, eccentricity as 20 microns, specific gravity of lubricants as 0.86, specific heat of lubricants 2.09 kJ/kg °C. | <b>10</b>    |
| Find, i. Oil film thickness.  |              |
| ii. Coefficient of friction.  |              |
| iii. Viscosity  |              |
| <b>(b)</b> A DGBB is subjected to a radial load of 4.5 KN and axial load of 2.5 KN when operating on 600 rpm. Consider the expected life of 18000 hours with survival probability of 93%. Select suitable standard bearing.   | <b>10</b>    |
| <b>Q4.</b>  |              |
| <b>(a)</b> Design an unprotected type flange coupling to connect the output shaft of an electrical motor to the shaft of centrifugal pump. The motor delivers a power of 20 KW at 900 rpm. Select suitable material for various parts.  | <b>10</b>    |

- (b) Fig. No.1 shows a welded joint subjected to an eccentric load of 20KN. Determine the uniform size of weld on entire length of two legs. Take permissible shear stress as 100 MPa.



(Fig. No.1)

- Q5. (a)** A spur gear of 250 mm PCD is mounted at 300 mm to the right of left hand bearing and a 450 mm diameter pulley is mounted at 200 mm to the left of right hand bearing. The shaft is supported in bearing 900mm apart and transmits 20 KW at 400 r.p.m. A gear is driven by a pinion located vertically above and the pulley transmits power through belt to another pulley located vertically below it. The belt tension ratio at pulley is 2. The pulley weighs 500 N. Select suitable material and design shaft. 10
- (b)** A multi-plate clutch transmits a power of 75 kW at 3000 rpm. The plates run in oil and coefficient of friction is 0.07. Axial intensity of pressure is not to exceed 0.15 N/mm<sup>2</sup>. Due to space limitation external radius is restricted to 125 mm. Assuming number of springs as 6, design a) Input and Output Shaft b) Friction and pressure plates. 10
- Q6. (a)** A flat belt drive is used to transmit 6 kW power from an electric motor rotating at 1440 rpm to the blower operating at 400 rpm for 10 hours/ day and the expected life of belt is two and half years approximately. Centre to centre distance is 950 mm. Find
- Driving and Driven pulley diameter. 10
  - Considering Rubber Canvas Material for the belt, determine the thickness and width of the belt.
- (b)** 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

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**(3 Hours)**

**Total Marks: 80**

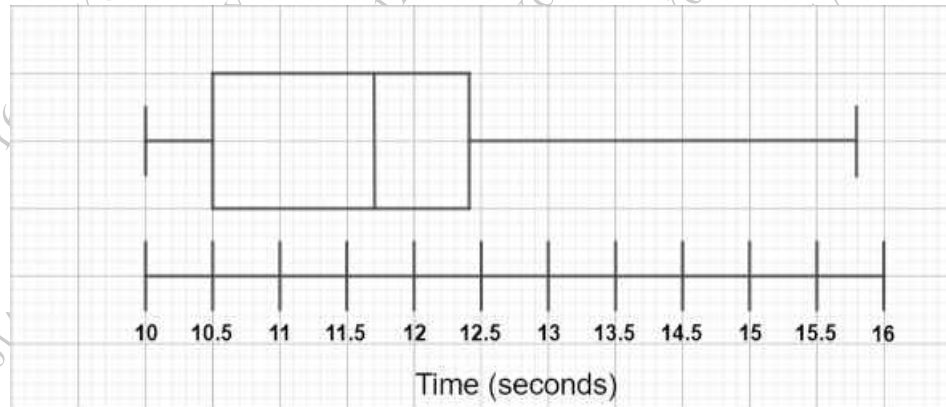
- N.B. 1. Question No. 1 is compulsory.  
 2. Attempt any three questions out of remaining five.  
 3. All questions carry equal marks  
 4. Assume Suitable data, if required and state it clearly.

1 Attempt any four:

**20**

- (a) The box plot below was constructed from a collection of times taken to run a 100 m sprint. Using the box plot, determine the range and interquartile range.

**5**



- (b) Define Type I and Type II Errors

**5**

- (c) In 800 families with 4 children each. Classify according to given criteria, how many families would you expect to have?  
 2 boys and 2 girls

**5**

- (d) A coin is tossed three times. Calculate the probability of obtaining more heads than tails.

**5**

- (e) Explain the various decomposition models used in time series data. Also, state which decomposition model will be appropriate for the following condition:

**5**

- a) When the seasonal variation is relatively constant over time.

- 2 (a) You have just taken ownership of a pizza shop. The previous owner told you that you would save money if you bought the mozzarella cheese in a 4.5 pound slab. Each time you purchase a slab of cheese, you weigh it to ensure that you are receiving 72 ounces of cheese. The results of 7 random measurements are 70, 69, 73, 68, 71, 69 and 71 ounces. Are these differences due to chance or is the distributor giving you less cheese than you deserve?

**10**

a. State the hypotheses.

b. Calculate the test statistic.

c. Would the null hypothesis be rejected at the 10% level? The 5% level? The 1% level?

- (b) Elaborate moving average and exponential smoothing techniques?

**10**

- 3 (a) Define sampling and central limit theorem ? Elaborate stratified sampling, judgment sampling, systematic sampling and cluster sampling

**10**

- (b) Use multiple regression derive equation for y given x1 and x2. 10

y	x1	x2
-3.7	3	8
3.5	4	5
2.5	5	7
11.5	6	3
5.7	2	1

- 4 a) In a manufacturing unit, four teams of operators were randomly selected and sent to four different facilities for machining techniques training. After the training, the supervisor conducted the exam and recorded the test scores. At 95% confidence level does the scores are same in all four facilities? (Kruskal–Wallis and chi-square table) 10

Facility 1	Facility 2	Facility 3	Facility 4
88	77	71	52
82	76	56	65
86	84	64	68
87	59	51	81

- b) In the context of Multiple linear regression explain what is Over fitting & multicollinearity? 10

- 5 a) Some vehicles pass through a junction on a busy road at an average rate of 300 per hour. 10

- a. Find out the probability that none passes in a given minute.
- b. What is the expected number of passing in two minutes?
- c. Find the probability that this expected number found above actually pass through in a given two-minute period.

- b) Find the simple linear regression equation for the data given below: 10

X	Y
2	21
4	27
6	29
8	64
10	86
12	92

- 6 a) Explain any 3 numerical measures for : 10

- a. Measures of variability
- b. Measures of location
- c. Measures of distribution shape

- b) Difference between 10

- a. Parametric and non-parametric test
- b. Discrete and Continuous probability distribution.

Time: 3 hour

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.

- Q.1** Solve ANY FOUR questions from following. (Each question carries 5 marks). **Marks (20)**
- Differentiate Fire tube boiler and Water tube boiler.
  - Explain construction and working of open cycle gas turbine power plant.
  - Explain the construction and working double acting reciprocating pump with neat sketch.
  - Illustrate significance of multistage compression in reciprocating air compressor with the help of P-V Diagram.
  - Define i) Suction head ii) Delivery head iii) Static head iv) Manometric head related to centrifugal pump with neat sketch.
- Q.2**
- In a Parson reaction turbine, the angles of receiving tips are  $35^\circ$  and of discharging tips  $20^\circ$ . The blade speed is 100 m/s. Calculate the tangential force, power developed, diagram efficiency, and axial thrust of the turbine, if its steam consumption is 1 kg/min. **(10)**
  - Explain the construction and working of Economizer. **(05)**
  - Derive the forms of Euler's equation applicable to all turbo machines. **(05)**
- Q.3**
- The following data refers to a gas turbine plant: **(10)**  
 Power developed = 5 MW  
 Inlet pressure and temperature of air to compressor = 1 bar and  $30^\circ\text{C}$   
 Pressure ratio of the cycle = 5  
 Isentropic efficiency of the compressor = 80%  
 Isentropic efficiency of turbines = 85%  
 Maximum temperature in the turbines =  $550^\circ\text{C}$   
 Take for air,  $C_p = 1.0 \text{ kJ/kgK}$ ,  $\gamma = 1.4$  and  
 for gases,  $C_p = 1.15 \text{ kJ/kgK}$ ,  $\gamma = 1.33$ .  
 If a reheater is used between two turbines at a pressure of 2.24 bar, calculate the following:  
 (a) Mass flow rate of air,  
 (b) The overall efficiency,  
 Neglect the mass of fuel.
  - Explain construction and working of Pelton wheel turbine. **(05)**
  - Explain construction and working of Turboprop engine with neat sketch. **(05)**

**Q.4**

- a** A steam generator evaporates 18000 kg/hrs. of steam at 12.5 bar and a quality of 0.97 dry from feed water at 105°C, when coal is fired at 2040 kg/hrs. If the higher calorific value of coal is 27400 kJ/kg, find the followings: **(10)**  
(a) Heat rate of the boiler in kJ/hrs.  
(b) Equivalent evaporation and  
(c) Thermal efficiency.
- b** Differentiate between boiler mounting and boiler accessories. **(05)**
- c** What is cavitation in hydraulic pump? Explain its effects on performance. **(05)**

**Q.5**

- a** A centrifugal pump has an impeller 0.5 m outer diameter and when running at 600 r.p.m. discharges water at the rate of 8000 liters/minute against a head of 8.5 m. The water enters the impeller without whirl and shock. The inner diameter is 0.25 m, and the vanes are set back at outlet at an angle of 45° and the area of flow which is constant from inlet to outlet of the impeller is 0.06 m<sup>2</sup>. Determine (a) the manometric efficiency of the pump, and (b) the vane angle at inlet. **(10)**
- b** What is surging and choking phenomenon in Centrifugal compressor **(05)**
- c** Explain the construction and working of Once through boiler with neat sketch. **(05)**

**Q.6**

- a** A single-acting, single-cylinder reciprocating air compressor is compressing 20 kg/min of air from 1.1 bar and 30°C to 6 bar and delivers it to a receiver. The law of compression is  $PV^{1.25} = \text{Constant}$ . Find the actual power input to compressor if mechanical efficiency is 85%. Neglecting losses due to clearance, leakages and cooling. **(10)**
- b** Explain velocity compounding in impulse turbine with neat sketch. **(05)**
- c** What is priming? Why is it necessary? **(05)**

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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.

**Q.1** Attempt **any Five** of the following

**[20]**

- Define ton of refrigeration. Differentiate between Heat pump and Refrigerator
- Explain construction and working of simple vapor absorption refrigeration system with neat sketch.
- Explain the function of reversing valve used in heat pump.
- State the various applications of HVACR and explain any one application
- Classify refrigerants compressor. Explain working of hermetically sealed compressor
- State and Define any four psychrometric properties.
- Explain with neat sketches the bootstrap air refrigeration system.

**Q.2**

- a) Draw a neat component diagram of vapor compression Refrigeration system. Apply Steady flow energy Equation to each component and analyze cycle with neat p-h and T-s Diagram.

**[08]**

- b) An air cooling system for a jet plane cockpit operates on the simple cycle. The cockpit is to be maintained at  $25^{\circ}\text{C}$ . The ambient air pressure and temperature are 0.35 bar and  $-15^{\circ}\text{C}$  respectively. The pressure ratio of the jet compressor is 3. The plane speed is 1000 kilometres per hour. The pressure drop through the cooler coil is 0.1 bar. The pressure of the air leaving the cooling turbine is 1.06 bar and that in the cockpit is 1.0325 bar. The cockpit cooling load is 58.05 TR.

**[12]**

Determine

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



- Q.3** a) Define Air Conditioning. State the factor which affects air conditioning process. Show on psychrometric chart different psychrometric process achieved by Air washer [08]
- b) R-22 refrigeration system operates between  $-15^{\circ}\text{C}$  and  $40^{\circ}\text{C}$ . The flow rate refrigerant through the system is  $0.2 \text{ kg/s}$ . At the entry of the compressor the refrigerant is dry and saturated. Use P-h Chart [12]
1. Draw P-h and T-s diagram
  2. Find out Pressure and enthalpy value at all salient points.
  3. Heat extracted by Evaporator
  4. Heat rejected by Condenser
  5. Compressor Work
  6. Actual COP
  7. 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) For HVACR application, Length of duct is  $37 \text{ m}$ ,  $Q = 4 \text{ m}^3/\text{s}$  and  $D = 850 \text{ mm}$ . Calculate friction loss for total length of duct by using relation and friction chart. [08]
- b) For a sample of air leaving  $28^{\circ}\text{C}$  DBT, Humidity ratio  $0.016 \text{ kg/kg}$  of dry air at barometric pressure of  $760 \text{ mm of Hg}$ . 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. Draw Comfort Chart. What are factors affecting thermal comfort? **[08]**

b) In a conference room for seating of 100 persons, **[12]**

Application : Summer Air Conditioning

Inside condition : 22°C, DBT, 60% RH

Outside condition : 40°C DBT, 27°C WBT

Sensible load per person : 80W

Latent load per person : 50W

Light and fans : 15000 W

Glass and walls : 15000 W

Air infiltration : 20 m<sup>3</sup>/min

Assuming 40 % fresh air and 60% 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. Draw neat diagram showing arrangement of cooling coil.
3. Determine Mixing Condition temperature.
4. Estimate Total load.
5. Calculate RSHF.

**Q.6** Write a notes on following (any Four) **[20]**

1. Air handling Unit
  2. Summer air Conditioning and Winter air Conditioning
  3. Type of Insulation Material used in HVACR
  4. Types of Condenser
  5. Ice plant
  6. Duct design methods
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