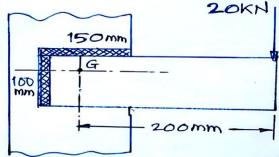Time:03 Hours   **Total marks – 80**

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.

			Marks
Q1.		Attempt any **Four** of the following.	
	(a)	With neat sketch explain various types of threads used as power screws?	**05**
	(b)	Define stress concentration and with neat sketches show various methods to reduce the effect of stress concentration.	**05**
	(c)	Write in brief on Aesthetic and Ergonomics considerations in design.	**05**
	(d)	Explain the nipping of the leaf spring with neat sketch.	**05**
	(e)	State the characteristics of chain drive and discuss the polygon effect.	**05**
Q2.	**(a)**	Selecting suitable material, design a Socket and Spigot Cotter Joint for an axial load of 50 KN. Draw a neat sketch of the joint.	**15**
	(b)	Explain with neat sketches, various types of cyclic stresses.	**05**
Q3.	**(a)**	A radial load on 360^0 hydro dynamically lubricated self-contained bearing supports 10kN. The journal rotates at 1450 rpm. Assuming journal length to it 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 ^{0}C. Find, i. Oil film thickness. ii. Coefficient of friction. iii. Viscosity	**10**
	(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.	**10**
Q4.	**(a)**	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.	**10**

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(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)

10

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 900m 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^2. 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

  a. Driving and Driven pulley diameter.

  b. Considering Rubber Canvas Material for the belt, determine the thickness and width of the belt. **10**

(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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Time: 3 hour   **Max. Marks: 80**
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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   Differentiate Fire tube boiler and Water tube boiler.
b   Explain construction and working of open cycle gas turbine power plant.
c   Explain the construction and working double acting reciprocating pump with neat sketch.
d   Illustrate significance of multistage compression in reciprocating air compressor with the help of P-V Diagram.
e   Define i) Suction head ii) Delivery head iii) Static head iv) Manometric head related to centrifugal pump with neat sketch.

Q.2

a   In a Parson reaction turbine, the angles of receiving tips are 35° and of discharging tips 20°. 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)**

b   Explain the construction and working of Economizer.   **(05)**
c   Derive the forms of Euler's equation applicable to all turbo machines.   **(05)**

Q.3

a   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°C
   Pressure ratio of the cycle = 5
   Isentropic efficiency of the compressor = 80%
   Isentropic efficiency of turbines = 85%
   Maximum temperature in the turbines = 550°C
   Take for air, C_p = 1.0 kJ/kgK, γ = 1.4 and
   for gases, C_p = 1.15 kJ/kgK, γ = 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.

b   Explain construction and working of Pelton wheel turbine.   **(05)**

c   Explain construction and working of Turboprop engine with neat sketch.   **(05)**

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Q.4

a A steam generator evaporates 18000 kg/hrs. of steam at 12.5 bar and a quality of **(10)** 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:
(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 **(10)** 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^2.
Determine (a) the manometric efficiency of the pump, and (b) the vane angle at inlet.

b What is surging and chocking 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 **(10)** kg/min of air from 1.1 bar and 30ºC to 6 bar and delivers it to a receiver. The law of compression is PV$^{1.25}$= Constant. Find the actual power input to compressor if mechanical efficiency is 85%. Neglecting losses due to clearance, leakages and cooling.

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]

   a) Define ton of refrigeration. Differentiate between Heat pump and Refrigerator

   b) Explain construction and working of simple vapor absorption refrigeration system with neat sketch.

   c) Explain the function of reversing valve used in heat pump.

   d) State the various applications of HVACR and explain any one application

   e) Classify refrigerants compressor. Explain working of hermetically sealed compressor

   g) State and Define any four psychrometric properties.

   h) 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. [12] The cockpit is to be maintained at 25^OC.The ambient air pressure and temperature are 0.35 bar and -15°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.

   Determine

   1. Temperature and pressure at all the points.

   2. Mass of air circulated per minute

   3. COP

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Q.3 a) Define Air Conditioning. State the factor which affects air conditioning **[08]** process.Show on psychrometric chart different psychrometric process achieved by Air washer

b) R-22 refrigeration system operates between -15°C and 40°C. The flow rate **[12]** 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

    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 Cp at 40°C = 0.82 kJ/kg K and Cp at -15°C= 0.64 kJ/kg K.

Q.4 a) For HVACR application, Length of duct is 37 m, Q = 4 m³/s and D = 850 **[08]** mm. Calculate friction loss for total length of duct by using relation and friction chart.

b) For a sample of air leaving 28°C DBT, Humidity ratio 0.016kg/kg of dry air **[12]** at barometric pressure of 760 mm of Hg. Determine following properties by using psychrometric relations and Verify your result with psychrometric chart

    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 **[08]** affecting thermal comfort?

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

Application	: Summer Air Conditioning
Inside condition	: 22^Oc, DBT, 60% RH
Outside condition	: 40^Oc DBT, 27^Oc 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^3/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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[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 (10)
following sequence using 5/2 both side solenoid operated valve as DCV.
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 (10)
applications.

Q3 **A.** State the types of intelligent agents. Explain the goal-based agent along with a (10)
neat sketch.
B. Illustrate with neat sketches the mechanical and vacuum type of end effectors (10)
used in robotic systems, stating their advantages and disadvantages.

Q4 **A.** Compare Supervised, Unsupervised, and reinforcement learning with different (10)
parameters.
B. Design a hydraulic circuit for two-cylinder operation with the following sequence (10)
using 4/2 pilot-operated valve as DCV using cascade method, A+ , B+ , Delay B-
, A-

Q5 **A.** State the use of a decision tree. Explain the terminology of the decision tree with (08)
a suitable example.
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 (08)
with a neat sketch.
B. List any five applications of Natural Language Processing (NLP). (06)
C. What is the activation function? Explain the log-sigmoid activation function (06)
with a neat sketch

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Duration: 3 Hours [Max Marks: 80]

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.

Q. 1 Attempt any **four** of the following: **(20)**

A. Explain Tool wear mechanism.

B. Explain orthogonal rake system (ORS) in detail.

C. Explain various heat generation zones in metal cutting.

D. Draw neat sketch of twist drill and name all elements also explain importance of drill land and body clearance.

E. Explain Types of chips.

F. Explain BUE effect on surface finish..

Q. 2 A. For a turning operation, derive relationship for optimum cutting speed and optimum tool life for minimum cost of production. **(10)**

B During machining of C- 25 steel with **0 - 10 - 6 - 6 - 75 - 90 - 1mm** (ORS) shaped tripple carbide cutting tool. The following observation have been made. **(10)**

Spindle Speed 400 rpm, Work diameter 60 mm, Depth of cut 2.5 mm, Tool feed rate 80 mm /min., Cut chip thickness 0.4 mm.

Determine: Chip thickness ratio, Shear plane angle , Dynamic shear strain and theoretical continuous chip length per minute.

Q. 3 A. Explain the concept of minimum quantity lubrication (MQL) and cryogenic cooling **(07)**

B. Derive the following relation for the shear angle ($\emptyset$) **(07)**

$$\emptyset = \tan^{-1}\left(\frac{r\cos\alpha}{1 - r\sin\alpha}\right)$$

Where, r = chip thickness ratio and α = Tool rake angle.

C. How is the tool shank of a single point cutting tool designed ? **(06)**

Q. 4 A. A Carbide tool with mild steel work piece was found to give life of **(10)** 2 hours while cutting at 48 m / min. If Taylor's exponent n = 0.27 Determine: (i) The tool life, if the same tool is used at a speed of 20 % higher than the previous one.
(ii) The value of cutting speed , if the tool is required to have tool life of 3 hours.

   B. Discuss different cutting tool materials with their relative **(10)** advantages and limitations.

Q. 5 A. Explain the various steps involved in the design of circular broach **(10)** and draw the neat diagram.

   B. Give an example of alphanumeric specification (ISO coding **(10)** system) for tipped tools and tool holders and explain it in brief?

Q. 6 A. Explain design considerations for design of reamer. **(10)**

   B. i) Explain Strain gauge type dynamometer. **(10)**

   ii) Explain classification of Cutting fluids and its functions.

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Time: 3 hour   **Max Marks:80**

Note: 1. Q1 is compulsory
       2. Solve any three from remaining
       3. Assume suitable data wherever required

Q1	**Solve any Four out of Six**	20

A. Explain with diagram twinning mechanics of plastic deformation
B. Classify Rolling processes. Write advantages and applications of rolling products
C. Write short note on Average flow stress or mean flow stress
D. Explain various defects in forging with their causes and remedies.
E. List out Extrusion applications in standard shapes
F. Define sheet metal bending process explain with sketches either V-bending or Edge Bending

Q2   A. A block made of a perfectly plastic material with yield stress of 160 MPa in   10
plain strain has dimensions 200 x 100 x 150 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.   10
      B. Differentiate Hot and Cold working with sketches

Q3   10

A. A strip with a cross section of 150mm x 6mm is being rolled with 20%
reduction of area, 400mm diameter steel rolls before and after rolling, The
shear yield stress of the material is 0.35 kN/mm^2 and 0.4   10
kN/mm^{2}respectively. Calculate (i) the final strip thickness, (ii) the average
shear yield stress during the process, (iii) the angle subtended by the
deformation zone at the roll Centre. Assume Coefficient of friction is 0.1
      B. Explain the effect of temperature and strain rate on metal forming.

Q4   A. Determine drawing stress and velocity for a wire having entry diameter of   10
3.5mm and outer diameter 2.4mm Given characteristics of wire drawing as
K =350MPa, μ = 0.08, n = 0.01, α =18degree and power required for   10
drawing is 68Watt.
      B. Explain tube drawing process. With neat sketches and explanation

Q5   A. Explain following deep drawing operations,   10
i) Ironing
ii) Redrawing   10
      B. Explain Electrohydraulic forming process with advantages, limitations,
and applications

Q6   A. Explain explosive forming process with advantages, limitations, and   10
applications   10
      B. Explain High Energy rate forming in the context of principle, application,
advantageous and limitations