Total No. of Questions : 12]

SEAT No. :

P902

NOV-2012

[Total No. of Pages : 4

# [4264] - 431

## B.E. (Mechanical)

## CAD / CAM AND AUTOMATION

## (2008 Pattern) (Semester - I)

*Time :3 Hours]* *[Max. Marks :100*

*Instructions to the candidates:-*

1) *Answer 3 questions from Section I and 3 questions from Section II.*
2) *Answers to the two sections should be written in separate books.*
3) *Neat diagrams must be drawn wherever necessary.*
4) *Figures to the right indicate full marks.*
5) *Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*
6) *Assume suitable data, if necessary.*

### SECTION - I

*Q1)* a) A triangle A (2, 2), B(4, 4) and C (3, 5) has undergone the following operations. Find new co-ordinates of the triangle ABC when

i) Mirrored about a line y = x [7]

ii) Scaled with respect to point A. [5]

b) What do you understand by Mapping of Geometric Models? [4]

OR

*Q2)* a) Given a point P (1, 3, –5). Find; [6]

i) Transformed point P*, if P is translated by a vector d = 2i + 3j – 4k and then rotated by 30° anticlockwise about the z-axis.

ii) Transformed point P*, if P is rotated by 30° anticlockwise about the z - axis and translated by a vector d = 2i + 3j – 4k.

b) What do you understand by concatenated transformation? [4]

c) Explain the terms Global & Local co-ordinates systems. [6]

*Q3)* a) Plot the Bezier curve having end points P0 (1, 3) and P3 (7, 2). The other control points are P1 (5, 6) and P2 (6, 0). Plot the values of u = 0, 0.2, 0.4, 0.6, 0.8, 1 if the characteristics polygon is in the sequence P0 - P1 - P2 - P3. [8]

b) Write a short note on B-spline curves. [4]

*P.T.O.*

c) What are advantage of parametric representation of curves in CAD system? [4]

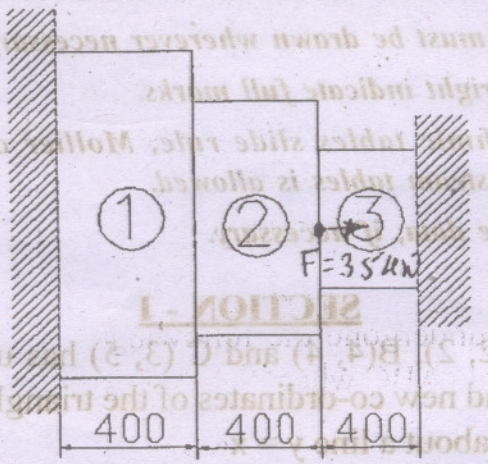
OR

*Q4)* a) What is B-rep and CSG technique in solid Modeling? Compare them. [8]

b) Write a parametric equation of a circle having center at (3, 3, 0) and radius of 3 units. Calculate the points on a circle if it is divided in eight parts. [8]

*Q5)* a) A stepped shaft is shown in following figure. Determine deflection, reaction forces and stresses in each element using Penalty Approach.

Assume F = 35kN and E = 200 GPa [12]



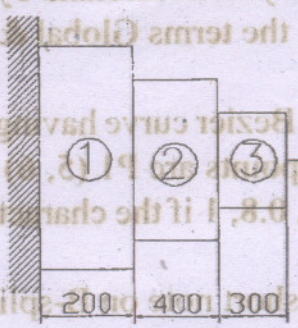

$A1=400mm^2$ $A2=300mm^2$ $A3=200mm^2$

b) Derive the displacement, stress and strain relationship for 1D element. [6]

OR

*Q6)* a) An axial stepped bar is shown in figure. It is subjected to an axial pull of 50 kN. If the material of the bar is uniform and has a modulus of elasticity as 200 GPa. Determine the displacement stress and reaction using 1D element. [10]

$A1=300\ mm^2$ $A2=200mm^2$ $A3=90mm^2$



b) Derive an expression for the element stiffness matrix of the two node one dimensional truss element. **[8]**

## SECTION - II

***Q7)*** a) Explain PTP and continuous path NC machine with sketches and applications. **[4]**

b) Explain 2 axis, 2-½ axis, 3- axis and multi axis NC machine with sketches and applications. **[6]**

c) Explain multiple roughing cycle (G 71) and finishing cycle (G 70) with sketches. **[8]**

OR

***Q8)*** a) Explain open loop and closed loop NC machine with sketches and applications. **[4]**

b) Explain Cutter radius compensation with Suitable G code and figures. **[4]**

c) Write a CNC part program to machine the profile and drill the holes as shown in figure, assume suitable machining data for feed, speed etc. **[10]**

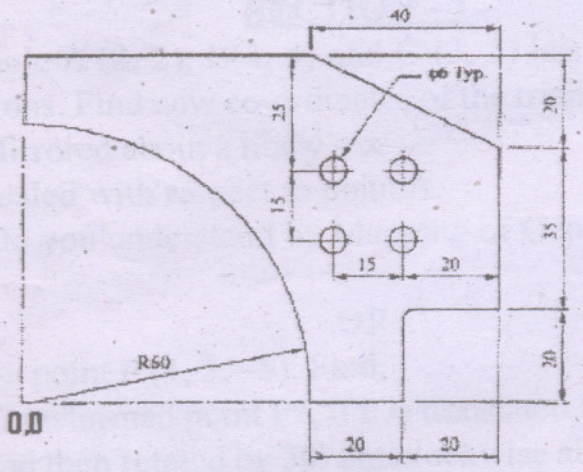



Fig.

***Q9)*** a) List 10 strategies of Automations. Explain any 4 strategies. **[8]**

b) Explain OPITZ method of part classification and coding system in Group technology. **[8]**

OR

*Q10)*a) Classify FMS based on layout with suitable sketches. **[8]**

b) State various work part transfer mechanisms. Explain Geneva Mechanism with neat sketch. **[8]**

*Q11)*a) Explain with figure basic components of robot (Robot anatomy). **[8]**

b) Explain SCARA configuration robot and draw its work envelope. **[8]**

OR

*Q12)*a) Explain the Terms related to robot - pay load, accuracy, repeatability, resolution. **[6]**

b) Classify various types of Grippers. Explain any mechanical gripper with neat sketch. **[10]**

Total No. of Questions : 12]

SEAT No. :

P1115

[Total No. of Pages : 4

[4264]-432

# B.E. (Mechanical) (Common to Mechanical Sandwich)

## DYNAMICS OF MACHINERY

## (2008 Pattern) (Semester - I)

*Time : 3 Hours]* *[Max. Marks : 100*

*Instructions to the candidates:*

1) *Answer any 3 questions from each section.*
2) *Answers to the two sections should be written in separate books.*
3) *Neat diagrams must be drawn wherever necessary.*
4) *Figures to the right indicate full marks.*
5) *Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*
6) *Assume suitable data, if necessary.*

## SECTION - I

*Q1)* a) What do you mean by primary & secondary unbalance in reciprocating engines? **[6]**

b) Four masses A,B,C & D are completely balanced masses C & D makes angles of 90° & 210° respectively with B in the same sense. The planes containing B & C are 300 mm apart. masses A, B, C & D can be assumed to be concentrated at radil of 360, 480, 240 & 300 mm respectively. The masses B,C & D are 15 kg, 25 kg & 20 kg respectively. **[12]**

Determine the

i) Mass A & its angular position.

ii) Positions of planes A & D.

OR

*Q2)* a) The six - cylinder of a single acting two stroke diesel engine are pitched 1 m apart and the cranks are spaced at 60° intervals. The crank length is 300 mm and the ratio of C.R. length to crank radius is 4.5. The reciprocating mass per line is 1350 kg & the rotating mass is 1000 kg. The speed is 200 rpm. Show with regard to primary & secondary balance that the firing order 1 - 5 - 3 - 6 - 2 - 4 gives balance in primary moment only & the order 1 - 4 - 5 - 2 - 3 - 6 gives secondary moment unbalance only. **[14]**

b) Explain partialy primary balancing in reciprocating engine. **[4]**

*Q3)* a) Explain what are free, damped & forced vibrations? **[4]**

b) What is logarithmic decrement? Derive the relations. **[6]**

*P.T.O.*

c) A spring mass system has spring constant of K kg/cm of the weight of mass W kg. It has natural frequency of vibration as 12 cps. An extra 2 kg weight is coupled to W & natural frequency reducer by 2 cps. Find K & W. **[6]**

OR

**Q4)** a) In a spring mass - damped system, m = 10 kg, k = 16 kN/m & c = 1600 N - s/m. The mass is displaced 0.1 m & released with a velocity of 2 m/ sec. in the direction of return motion. Find : **[12]**

i) The circular frequency

ii) Damping factor

iii) Displacement after 1/ 100 sec.

b) Define the following terms **[4]**

i) Critically damping coefficient

ii) Damping coefficient

iii) Damping factor

iv) Coloumb damping

**Q5)** A machine weighing 100 kg is supported on 4 - springs. It has 80 mm stroke & it runs at 1000 rpm. If the springs are symmetrically placed with respect to C.G. of the machine, neglecting damping. Determine the combined stiffness of the spring such that the force transmitted to the foundation is 1/25 times the impressed force. **[16]**

If it is found that the damping, however small, reduces the amplitude of successive vibrations by 25%, determine.

a) The force transmitted to foundation at 1000 rpm.

b) The force transmitted to foundation at resonance.

c) The amplitude of vibration at resonance, if weight of the reciprocating parts is 2 kg.

OR

**Q6)** a) Explain frequency response curve & phase frequency curve. **[6]**

b) Explain the following terms. **[6]**

i) Vibration Isolation

ii) Force transmissibility

c) Explain the term magnification factor & obtain expression for it. **[4]**

## SECTION - II

*Q7)* a) Determine the natural frequencies of the system shown in figure **[10]**

Given : $K_1 = K_2 = 40$ N/m

$K = 60$ N/m

$m_1 = m_2 = 10$ kg

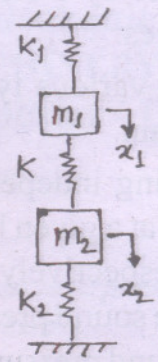



Fig.: Q7(a)

b) Explain the torsional vibrations of a geared system by **[8]**

i) neglecting inertia of gears &

ii) Considering inertia of gears.

OR

*Q8)* a) Explain Dunkerley's method to determine the natural frequency of shaft carrying number of point loads. **[4]**

b) Explain the concept of torsionally equivalent shaft. **[4]**

c) A rotor of 10 kg mass is mounted midway on a 2 cm diameter, horizontal shaft supported at the ends by two bearings. The bearing span is 80 cm, because of certain manufacturing defect, the centre of gravity of the rotor is 0.01 mm away from it's geometric centre. If the system rotates at 3000 rpm, determine the amplitude of the steady. state vibration and dynamic force transmitted to the bearing. Take $E = 2 \times 9.81 \times 10^{10}$ N/m$^2$ **[10]**

*Q9)* a) Derive an equation which gives the relation between sound intensity level and sound pressure level. **[6]**

b) Explain in brief the following terms : **[6]**

i) Sound power level

ii) Sound intensity level

iii) Sound pressure level

iv) Sound reflection coefficient

v) Sound absorption coefficient

vi) Sound transmission coefficient

c) Determine the maximum pressure of a sound with a sound pressure level of 112 dB. **[4]**

OR

*Q10)* a) Show that as the distance from a point source doubles, the sound intensity level decreases by 6 dB. Assume that sound propagates in the form of spherical waves. **[6]**

b) What are the various types of sound fields in the vicinity of a sound source? Explain. **[4]**

c) When operating independently in the presence of back ground noise, measurement at a given location of the sound pressure level for machines 1, 2 & 3 are respectively 88 dB, 90 dB, & 87 dB. When the machines are turned off, the sound pressure level at the same point is 86 dB. Determine the overall sound pressure level (SPL) of the three machines independent of the background noise. **[6]**

*Q11)* a) A vibrometer, having the amplitude of vibration of the machine part as 4 mm and damping factor ($\xi$) = 0.2, performs harmonic motion. If the difference between the maximum and minimum recorded values is 10 mm, determine the natural frequency of vibrometer if the frequency of vibration part is 12 rad/sec. **[6]**

b) Explain with neat sketch the working principle of a centrifugal pendulum absorber. **[6]**

c) Describe the various sources of noise. **[4]**

OR

*Q12)* Write a short note on any four, **[16]**

a) Sound level meter.

b) Frequency measuring instruments.

c) Condenser microphone.

d) FFT spectrum analyzer.

e) Noise control at the source.

f) Vibration isolators.

♦♦♦♦

Total No. of Questions : 12]

SEAT No. :

P1116

[Total No. of Pages : 4

# [4264] - 433

## B.E. (Mechanical)

## INDUSTRIAL FLUID POWER

## (2008 Pattern) (Semester - I)

*Time :3 Hours]* *[Max. Marks :100*

***Instructions to the candidates:***

1) *Answer any 3 questions from each section.*
2) *Attempt any one question in each unit.*
3) *Answers to the two sections should be written in separate answer books.*
4) *Neat diagrams must be drawn wherever necessary.*
5) *Figures to the right indicate full marks.*
6) *Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*
7) *Assume suitable data, if necessary.*

### SECTION - I

### Unit - I

*Q1)* a) Explain the advantages of fluid Power Systems over other systems. **[6]**

b) What criteria should be selected for selection of oils for a given hydraulic system. **[5]**

c) What is the difference between static and Dynamic seals. **[5]**

OR

*Q2)* a) What are the functions of Reservoirs? Draw a neat sketch of reservoir & show its internal and external features. **[8]**

b) Write a short note on "Types of filters" for a hydraulic system. **[8]**

### Unit - II

*Q3)* a) Explain with neat sketch working of Bent Axis pump. **[8]**

b) Write a short note on "Pressure and Temperature Switches". **[8]**

OR

*Q4)* a) Explain with neat sketch working of Bladder type Gas charged Accumulator. **[8]**

b) Explain with neat sketches types of pressure Intensifiers. **[8]**

*P.T.O.*

## Unit - III

*Q5)* a) Draw symbols of the following components. **[10]**

i) Pressure Relief valve ii) Unloading valve

iii) Sequence valve iv) Pressure Reducing valve

v) Counter balance valve.

b) What is a Direction Control Valve? Draw the symbols of different DCVs. & Explain their working. **[8]**

OR

*Q6)* a) Explain with neat sketch Meter-In and Meter - Out ckts. **[10]**

b) Write a short note on "Servovalves" and "Proportional control valves" **[8]**

# SECTION - II

## Unit - IV

*Q7)* a) Explain with neat sketch working of "Radial Piston Type Motor". **[8]**

b) A Hydraulic Motor has a displacement of $130cm^3$ and operates with a pressure of 105 bar & speed of 2000 RPM. If the actual flow rate consumed by the motor is $0.005m^3$ / sec and the motor is developing a torque of 200Nm at the output shaft, find: **[8]**

i) Volumetric efficiency

ii) Mechanical efficiency

iii) Overall efficiency

iv) The power output of the motor.

OR

*Q8)* a) Draw "Hydraulic Press Circuit" & explain its working. **[8]**

b) Draw "Sequencing circuit" & explain its working. **[8]**

## Unit - V

*Q9)* a) Write a short note on "Lubricators, Mufflers & Dryers" for a Pneumatic system. **[8]**

b) Draw circuits for **[8]**

i) Controlling speed of pneumatic double acting cylinder.

ii) Speed control of a pneumatic motor.

OR

*Q10)*a) Write a short note on "Types of Vacuum Pumps". **[8]**

b) Explain with neat sketch working of "Twin (Dual) Pressure valve" and "Time Delay valve" used in pneumatics. **[8]**

## Unit - VI

*Q11)*A machine slide is moved by means of a hydraulic cylinder. The motion of the cylinder is as follows. **[18]**

a) Initially, it moves through a distance of 200 mm against a load of 12kN in about 3 seconds.

b) It is followed by a working stroke of 100 mm against an effective load of 35 kN. The feed rate during this part of the stroke is required to be between 0.50 to 01m/min.

c) The return stroke is to be as fast as possible.

A meter-out type is used for speed control.

Draw a hydraulic circuit, which will fulfill these requirements. Select all the different components used in the circuit from the standard data tables given. Mention their Ratings.

OR

*Q12)*In a special purpose machine hydraulic system is used for **[18]**

a) Clamping the job and

b) Moving the machine bed during machining operation.

The clamping force required to be developed by each of the four clamp cylinders is 01 kN. The bed is to be moved against an effective load of 10 kN. The feed rate required is to be between 01m/min to 3.5m/min. The bed movement is 100 cm. Assume a suitable sequence of operations. Draw a hydraulic circuit, which will fulfill these requirements. Select different components used in the circuit from the standard data tables given. Mention their Ratings.

DATA

1. SUCTION STRAINER:

| Model | Flow capacity (lpm) |
|---|---|
| S1 | 38 |
| S2 | 76 |
| S3 | 152 |

2. PRESSURE GAUGE:

| Model | Range (bar) |
|---|---|
| PG1 | 0-25 |
| PG2 | 0-40 |
| PG3 | 0-100 |
| PG4 | 0-160 |

3. VANE PUMP:

| Model | Delivery (lpm) | | |
|---|---|---|---|
| | at 0 bar | at 35 bar | at 70 bar |
| P1 | 8.5 | 7.1 | 5.3 |
| P2 | 12.9 | 11.4 | 9.5 |
| P3 | 17.6 | 16.1 | 14.3 |
| P4 | 25.1 | 23.8 | 22.4 |
| P5 | 39 | 37.5 | 35.6 |

4. RELIEF VALVE:

| Model | Flow range (lpm) | Max. working pressure (bar) |
|---|---|---|
| R1 | 11.4 | 70 |
| R2 | 19 | 210 |
| R3 | 30.4 | 70 |
| R4 | 57 | 105 |

5.FLOW CONTROL VALVE:

| Model | Max. working pressure (bar) | Flow range (lpm) |
|---|---|---|
| F1 | 70 | 0-4.1 |
| F2 | 105 | 0-4.9 |
| F3 | 105 | 0-16.3 |
| F4 | 70 | 0-24.6 |

6. DIRECTION CONTROL VALVE:

| Model | Max. working pressure (bar) | Flow capacity (lpm) |
|---|---|---|
| D1 | 350 | 19 |
| D2 | 210 | 38 |
| D3 | 210 | 76 |

7. CHECK VALVE

| Model | Max. working pressure (bar) | Flow capacity (lpm) |
|---|---|---|
| C1 | 210 | 15.2 |
| C2 | 210 | 30.4 |
| C3 | 210 | 76 |

8. SEQUENCE VALVE

| Model | Max. working pressure (bar) | Flow capacity (lpm) |
|---|---|---|
| PO1 | 210 | 19 |
| PO2 | 210 | 38 |
| PO3 | 210 | 76 |

9. CYLINDER (Max. working pressure -210)

| Model | Bore Dia. (mm) | | Rod Dia. (mm) |
|---|---|---|---|
| A1 | 25 | | 12.5 |
| A2 | 40 | | 16 |
| A3 | 50 | | 35 |
| A4 | 75 | | 45 |
| A5 | 100 | | 50 |

10. OIL RESERVOIR:

| Model | Capacity (lit) |
|---|---|
| T1 | 40 |
| T2 | 100 |
| T3 | 250 |
| T4 | 400 |
| T5 | 600 |

Total No. of Questions : 12]

SEAT No. :

P1118

[Total No. of Pages : 3

# [4264]-437
# B.E. (Mechanical)
# TRIBOLOGY
# (Elective - I) (2008 Pattern) (Sem. - I)

*Time : 3 Hours]* *[Max. Marks : 100*

***Instructions to the candidates:***

1) ***Answers to the two sections should be written in separate answer books.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of electronic pocket calculator is allowed.***
5) ***Assume suitable data, if necessary.***
6) ***Your answers will be valued as a whole.***

## SECTION - I

### Unit - I

*Q1)* a) Explain any three modes of lubrication. **[6]**

b) Explain different types of additives used to improve the properties of lubricating oils. **[6]**

c) State the desirable properties of lubricating oils. **[4]**

OR

*Q2)* a) Write a note on "Effect of Temperature on Viscosity". **[6]**

b) State the importance of recycling of used oils. Explain various method of disposal of used oils. **[6]**

c) Explain the following terms in short. **[4]**

i) Kinematic Viscosity

ii) Absolute viscosity

iii) Viscosity Index

iv) SUS

### Unit - II

*Q3)* a) Explain the method of friction measurement by pin - on - disk apparatus. **[4]**

b) Write short notes on - **[12]**

i) Stick - slip phenomenon

ii) Modified Adhesion theory of friction

iii) Tomlinson theory of molecular attraction

OR

*P.T.O.*

*Q4)* a) What are the factors affecting wear rate [4]

b) Write short notes on - [12]

i) Fretting

ii) Erosive wear

iii) Archard's wear theory

## Unit - III

*Q5)* a) Derive the two dimensional Reynolds equation for hydrodynamic lubrication. Also state the assumptions in derivation. [12]

b) State and explain any three parameters to be considered in hydrodynamic journal bearing design. [6]

OR

*Q6)* a) Derive the equation for pressure distribution and load carrying capacity of infinite width tapered pad bearing. [12]

b) List different types of Hydrodynamic thrust bearing. Explain in short tilting pad thrust bearing. [6]

## SECTION - II

## Unit - IV

*Q7)* a) Derive the equation for flow rate and pressure distribution in hydrostatic step bearing. What are the assumptions made? [8]

b) The following data is given for the hydrostatic step bearing : [10]

- Thrust load = 450 kN
- Shaft Speed = 750 RPM
- Shaft Diameter = 400 mm
- Recess Diameter = 250 mm
- Viscosity of the lubricant = 30 cP
- Specific gravity of lubricant = 0.86
- Specific heat of lubricant = 2 kJ/kg°C

Calculate :

i) The optimum oil film thickness for minimum power loss;

ii) The frictional power loss

iii) The pumping power loss

iv) Total power loss

v) The temperature rise; assuming the total power loss in the bearing is converted into the frictional heat.

OR

*Q8)* a) Derive an equation for load - carrying capacity for given instantaneous velocity of approach and film thickness in case of rectangular plate approaching a plane. **[8]**

b) A plate of 25 mm length and infinite width is separated from the plane by an oil film of 25 μm thickness and having viscosity of 0.05 N-s/m$^2$. If the normal load per unit width of 20 kN/m is applied on the plate, determine : **[6]**

i) The time required to reduce the film thickness to 2.5 μm

ii) The maximum pressure.

c) Give the examples of squeeze film action. **[4]**

## Unit - V

*Q9)* a) What are applications of Elastohydradynamic lubrication? **[6]**

b) What is the purpose of providing oil grooves in bearings? Explain different types of grooves in bearings. **[6]**

c) Give advantages and limitations of gas lubricated bearings. **[4]**

OR

*Q10)* a) Write short notes on any two of the following : **[8]**

i) Lubricants used in cold metal working

ii) Lubricants used in hot metal working

iii) Gaskets

b) What are the desirable properties of bearing materials? **[4]**

c) Explain Hertz theory of elasto - hydrodynamic lubrication. **[4]**

## Unit - VI

*Q11)* a) Explain in detail the techniques used for surface measurement. **[6]**

b) Give the classification of surface engineering processes. **[4]**

c) Explain in detail concept and structure of Superficial layers. **[6]**

OR

*Q12)* a) Explain general characteristics of superficial layers. **[6]**

b) Explain in detail Cladded Coating technique. **[6]**

c) What is plasma arc spraying? How it differs from the flame spraying? **[4]**

♦♦♦♦

Total No. of Questions : 12]

SEAT No. :

P1117

[Total No. of Pages : 3

# [4264]-434

## B.E. (Mechanical)

## ENERGY AUDIT AND MANAGEMENT

## (2008 Pattern) (Elective - I) (Sem. - I)

*Time : 3 Hours]* *[Max. Marks : 100*

***Instructions to the candidates:***

1) ***Figures to the right indicate full marks.***
2) ***Solve questions 1 or 2, 3 or 4, 5 or 6 from Section-I and 7 or 8, 9 or 10, 11 or 12 from Section-II.***
3) ***Answers to the two sections should be written in separate books.***
4) ***Neat diagrams must be drawn wherever necessary.***
5) ***Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables and time value of money factor table is allowed.***
6) ***Assume suitable data, if necessary.***

## SECTION - I

*Q1)* a) What are the principles of energy management and need of managerial skills in energy management? **[8]**

b) Discuss different aspects of Energy Policy and strategy in Energy conservation systems. **[8]**

OR

*Q2)* a) Explain the need of Renewable energy sources and how do an Industry, nation and globe would benefit from energy efficiency? **[8]**

b) List all the requirements of energy action planning? **[8]**

*Q3)* a) Give a typical energy audit reporting format? **[8]**

b) Write in brief the ten steps to be carried out in Detailed Energy Audit? **[8]**

OR

*Q4)* a) With the help of different examples elaborate the importance of Analysis and Recommendations of Energy Audit? **[8]**

b) Write various energy conservation opportunities in Furnace and DG sets. **[8]**

*Q5)* a) Illustrate the need of Financial analysis and explain the method of Simple Payback Period, its advantages and disadvantages? **[8]**

b) Differentiate between Returns on Investment (ROI) and Internal rate of return (IRR)? **[4]**

***P.T.O.***

c) What is the NPV of a project, (life 2 years) which requires an investment of Rs. 50000 and yield Rs. 30000 in the 1st year and Rs. 40000/- in the next year, if the Interest rate is 10%. [6]

OR

*Q6)* a) What is Time value of money and Net present value? [8]

b) Referring to different types of cash flows explain Sensitivity and Risk analysis? [4]

c) Explain Internal Rate of Return (IRR). What are advantages and disadvantages of IRR? [6]

## SECTION - II

*Q7)* a) List different types of Steam traps and explain any one of them with neat sketch? [8]

b) Explain the opportunities for improving an energy efficiency in the boiler. [8]

OR

*Q8)* a) Explain merit and demerits for Direct and Indirect methods used for calculating Boiler Efficiency? [8]

b) Find the furnace efficiency required to melt one ton of steel from ambient temperature of 30°C. Following data is given : Specific heat of steel = 0.682 kJ/kg/°C, Latent heat for melting of steel = 272 kJ/kg, Melting point of steel = 1650°C. The melting furnace consumed 625 kWh to melt one ton of steel. [8]

*Q9)* a) Explain the energy saving opportunities in Electrical systems? [8]

b) Explain the selection and location of transformer for improving power factor. [8]

OR

*Q10)* a) Discuss various factors which constitutes the billing amount for a medium scale industry. [8]

b) Highlight various ways of how the light can be controlled efficiently in a facility? [8]

*Q11)* a) Describe suitable factors influencing selection of cogeneration plant? [8]

b) What are the direct and indirect benefits of waste heat recovery? [6]

c) How does a shell and tube heat exchanger work? Give typical examples. [4]

OR

*Q12)* a) Define Waste Heat Recovery? Describe its benefits and potentials of savings in Industry? **[8]**

b) Write short notes on **[6]**

i) CDM projects and

ii) Carbon credit calculations

c) How does a plate heat exchanger work? Give typical examples. **[4]**

♦♦♦♦

Total No. of Questions : 12]

SEAT No. :

P1376

[Total No. of Pages : 3

# [4264]-438

## B.E. (Mechanical)

## AUTOMOBILE ENGINEERING

## (2008 Pattern) (Elective - II) (Semester - I)

*Time :3 Hours]* *[Max. Marks :100*

***Instructions to the candidates.:***

1) *Answer 3 questions from Section - I and 3 questions from Section - II.*
2) *Answers to the two sections should be written in separate books.*
3) *Neat diagrams must be drawn wherever necessary.*
4) *Figures to the right indicate full marks.*
5) *Assume suitable data, if necessary.*

## SECTION - I

### UNIT - I

*Q1)* a) What are vehicle specifications? Describe specification of any one light motor vehicle of your choice. **[8]**

b) What is chassis? Compare conventional chassis frame with frameless type chassis frame. **[8]**

OR

*Q2)* a) Explain with the help of neat sketch any one typical layout of an automobile. Also describe advantages and drawback over other layouts. **[8]**

b) Explain with neat sketches different types of vehicle bodies. **[8]**

### UNIT - II

*Q3)* a) Describe working of synchromesh gear box with neat diagram. Also state its advantages and disadvantages. **[8]**

b) Explain fluid flywheel with neat sketch. **[8]**

OR

*Q4)* a) Explain continuous variable transmission with neat sketch. **[8]**

b) Draw a neat sketch of a non slip differential unit in the back axle of a vehicle and explain its working. **[8]**

***P.T.O.***

## UNIT - III

*Q5)* a) Define front end geometry for steering including caster, camber, toe, steering axis inclination and turning radius. **[10]**

b) How the tyres are classified and rated? **[8]**

OR

*Q6)* a) Classify different types of steering gear boxes. Discuss salient features for each of them. Explain the construction and working of a recirculating type steering gear box. **[10]**

b) Explain with neat sketch construction and working of collapsible steering. **[8]**

## SECTION - II

## UNIT - IV

*Q7)* a) What is interconnected suspension? Sketch and describe briefly. **[10]**

b) Explain a hydraulic braking system with neat sketch. **[8]**

OR

*Q8)* a) Draw a neat sketch and explain of double-tube telescopic shock absorber. **[8]**

b) Explain ABS brake system in detail. Also state its advantages over other braking system. **[10]**

## UNIT - V

*Q9)* a) Explain charging system used in automobile vehicle. **[5]**

b) Explain lighting system of any car. **[6]**

c) Explain in brief hybrid drives. **[5]**

OR

*Q10)* Write short notes on any four : **[16]**

a) Electronic stability control

b) Battery construction

c) Engine sensors

d) Wipers

e) Electric Horn

## UNIT - VI

*Q11)* Write short notes on any four : **[16]**

a) Traction and tractive effort

b) Stability of vehicle

c) Vehicle road resistances

d) Seat belt

e) Vehicle safety

OR

*Q12)* a) Explain different vehicle body moments. **[6]**

b) A Leyland truck has a gross vehicle weight of 89026 N. Engine displacement is $10m^3$, power 77.3 kW at governed speed of 2400 rpm and maximum torque 345.8 Nm at 1400 rpm. Rear axle ratio is 6.166:1. Fourth speed reduction ratio in transmission is 1.605:1, drive line losses amount to 10.7 kW at 2400 rpm and 6.3 kW at 1400 rpm. Tyre size is 0.4572m × 1.016m (effective wheel diameter is 0.950m), frontal area of truck $6.95m^2$. Calculate the grades which the vehicle can climb in fourth gear in still air conditions. **[10]**

i) at governed engine speed,

ii) at speed of maximum torque in the equation

$R = kW + ka\ AV^2$

$k = 0.044$, $ka = 0.0462$ & V in km/h.

Over all gear ratio $G = 6.166 \times 1.605:1 = 9.9:1$

Total No. of Questions : 12]

SEAT No. :

P1120

[Total No. of Pages : 7

# [4264] - 440

## B.E. (Mechanical)

## QUANTITATIVE AND DECISION MAKING TECHNIQUES

### (Semester - I) (2008 Pattern) (Elective - II) (Theory)

*Time : 3 Hours]* *[Max. Marks :100*

*Instructions to the candidates:*

1) *All the questions are compulsory.*
2) *Two separate answer books are used for Section I and Section II.*
3) *Figures to the right indicate full marks.*
4) *Use of calculator is permitted.*
5) *Assume suitable data, if necessary.*

## SECTION - I

### Unit - I

*Q1)* a) Explain : [6]

i) Pure and Mixed Strategies

ii) Dominance Rules

b) Solve the following 2 x 5 game by graphical method and find the optimum strategies and value of game. [10]

| | | Player B | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Player A | 1 | –5 | 5 | 0 | –1 | 8 |
| | 2 | 8 | –4 | –1 | 6 | –5 |

OR

*Q2)* a) Define Operations Research. Describe briefly its functions. [6]

b) Solve the following 4 x 4 game using dominance property. [10]

| | | Player B | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Player A | 1 | 6 | 4 | 8 | 0 |
| | 2 | 6 | 8 | 4 | 8 |
| | 3 | 8 | 4 | 8 | 0 |
| | 4 | 0 | 8 | 0 | 16 |

P.T.O.

## Unit - II

*Q3)* a) Define following terms of Linear Programming [6]

i) Degenerate solution

ii) Optimum basic feasible solution

b) Solve LPP by Suitable Method [10]

Maximize:

$$Z=2X_1+5X_2$$

Subject to:

$$X_1 + 4X_2 \leq 24$$

$$3X_1 + X_2 \leq 21$$

$$X_1 + X_2 \leq 9$$

$$X_1, X_2 \geq 0$$

OR

*Q4)* a) Define Linear Programming. Give applications of Linear Programming. [4]

b) A factory has decided to diversify its activities. The data collected for the sales and production departments are summarized below: [12]

Potential demand exists for two products A and B. Market can absorb any quantity of A, whereas the share of B for this organization is expected to be not more than 400 units per month. Contribution per unit of products A and B is expected to be Rs. 6 and Rs. 8 respectively. These products require three different processes and the time required per unit of product is given in the table below :

| Process | Product A | Product B | Available Hours |
|---|---|---|---|
| 1 | 2 | 3 | 900 |
| 2 | 1 | 2 | 600 |
| 3 | 2 | 2 | 1200 |

Find the product mix to optimize the contribution.

## Unit - III

*Q5)* a) Discuss the traveling salesman problem as an assignment problem with sub-optimal solution. **[6]**

b) A company has three production shops supplying a product to five warehouses. The cost of production varies from shop to shop and so does the unit transportation cost from shop to warehouse. Each shop has a specific production capacity and each warehouse has certain amount of requirement. The unit transportation costs are given below: **[12]**

| | | Warehouse | | | | | Capacity |
|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | |
| Shop | A | 6 | 4 | 4 | 7 | 5 | 100 |
| | B | 5 | 6 | 7 | 4 | 8 | 125 |
| | C | 3 | 4 | 6 | 3 | 4 | 175 |
| | Demand | 60 | 80 | 85 | 105 | 70 | |

The cost of manufacturing the product at different production shops is

| | | Variable cost (Rs.) | Fixed Cost (Rs.) |
|---|---|---|---|
| Shop | A | 14 | 7000 |
| | B | 16 | 4000 |
| | C | 15 | 5000 |

Find the optimum quantity to be supplied from each shop to different warehouses at minimum total cost.

OR

*Q6)* a) Discuss the similarities and differences between the transportation and assignment problem. **[6]**

b) A Municipal Corporation has decided to out road repairs on four main arteries of the city. Municipal Corporation has granted Rs. 50 Lakh for this work with a condition that the repair must be done at the lowest cost and quickest time. The Municipal Corporation has floated tenders and five contractors have sent in their bids. In order to expedite work, one road will be awarded to only one contractor. **[12]**

i) Find the best way of assigning the repairs to the contractors and associated cost.

ii) If it is necessary to seek supplementary grant, what should be the amount sought.

iii) Which of the five contractors will be unsuccessful in his bid?

| | | Cost of repairs on road (Rs. Lakhs) | | | |
|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 |
| Contractors | C1 | 9 | 14 | 19 | 15 |
| | C2 | 7 | 17 | 20 | 19 |
| | C3 | 9 | 18 | 21 | 18 |
| | C4 | 10 | 12 | 18 | 19 |
| | C5 | 10 | 15 | 21 | 16 |

## SECTION - II
## Unit - IV

*Q7)* a) Classify Inventory Models. & Define Deterministic Model. **[6]**

b) Derive the Economic Order Quantity Relation with instantaneous Stock Replenishment. **[10]**

OR

*Q8)* Attempt Any Two : **[8]**

a) A Manufacturer has to supply his customer 3600 units of his product per year. Shortages are not permitted. Inventory carrying cost amounts Rs. 1.2 per unit per annum. The set-up cost per run is Rs. 80.

Find : -

i) Economic order quantity.

ii) Optimum number of orders per annum.

iii) Average annual inventory cost (minimum).

iv) Optimum period of supply per optimum order.

b) A dealer supplies you the following information with regard to a product dealt in by him : **[8]**

Annual demand : 10,000 units

Ordering cost : Rs 10 per order

Inventory carrying cost : 20% of value of inventory per year.

Price : Rs 20 per unit.

The dealer is considering the possibility of allowing some back-order (stock out) to occur. The dealer has estimated that the annual cost of back-ordering will be 25% of value of inventory.

i) What should be the optimum number of units of products he should buy in one lot?

ii) What quantity of product should be allowed to be back ordered, if any?

iii) What would be the maximum quantity of inventory at any time of the year?

iv) Would you recommend to allow back-ordering? If so, what would be the annual cost of saving by adopting the policy of back ordering?

c) Workers come to tool store room to receive special tools for accomplishing a project. The average time between two arrivals is 60 seconds and the arrivals are in Poisson distribution. The average service time is 40 seconds. Determine. **[8]**

i) average queue length.

ii) average length of non-empty queues.

iii) average number of workers in system including the worker being attended.

iv) mean waiting time of an arrival.

v) average waiting time of an arrival (worker) who waits and.

vi) the type of policy to be established. Determine whether to go in for an additional tool store room attendant which will minimize the combined cost of attendant's idle time and the cost of workers waiting time. Charge of worker is Rs. 4 per hour and that of tool store room attendant is Rs. 0.75 per hour.

## Unit - V

***Q9)*** a) ABC company plans to sell an article at a local market. The articles are purchased at Rs. 5. On the condition that all unsold articles shall be returned. The rent for the space is Rs 2000. The article will be sold at Rs 9. Determine the number of articles which must be sold. **[8]**

i) To break even

ii) To earn Rs. 400 as profit.

iii) If the company sells 750 articles. Calculate margin of safety and profit.

b) Explain the Payback Period Method. [4]

c) Differentiate between Payback Period Method and IRR Method. [4]

OR

*Q10)* A manufacturer is offered 2 machines A & B. A has cost of Rs. 2500, its running cost is Rs. 400 for each of the first 5 years and increases by Rs. 100 every subsequent year. Machine B having the same capacity as A, costs Rs. 1250, has running cost of Rs. 600 for 6 years increasing by Rs. 100 per year there after. If money is worth 10% per year. Which machine should be purchased? Scrap value of both machines is negligibly small. [16]

## Unit - VI

*Q11)* The time estimates (in weeks) for activities of a PERT network are given below. [18]

| Activity | $t_o$ | $t_m$ | $t_p$ | Given that for. |
|---|---|---|---|---|
| 1 - 2 | 1 | 1 | 7 | Z = 1.33; P = 0.9082 |
| 1 - 3 | 1 | 4 | 7 | Z = 0.67, P = 0.7486 |
| 1 - 4 | 2 | 2 | 8 | Z = 1, P = 0.8413. |
| 2 - 5 | 1 | 1 | 1 | |
| 3 - 5 | 2 | 5 | 14 | |
| 4 - 6 | 2 | 5 | 8 | |
| 5 - 6 | 3 | 6 | 15 | |

a) Draw the project network and identify all paths through it.

b) Determine the expected project length.

c) Calculate the standard deviation and variance of project length.

d) What is the probability that the project will be completed

i) at least 4 weeks earlier than expected time.

ii) no more than 4 weeks later than expected time.

e) If the project due date is 19 weeks. What is the probability of not meeting the due date? Completion time is 20 weeks.

f) What should be the scheduled completion time for the probability of completion to be 90%.

OR

*Q12)* Write short note on (Any three) : **[18]**

a) Differentiate PERT and CPM.

b) Types of Floats.

c) Dynamic Programming.

d) Goal Programming.

Total No. of Questions : 12]

P1016

SEAT No. :

[Total No. of Pages : 4

# [4264] - 441

## B.E. (Mechanical Engineering)

## POWER PLANT ENGINEERING

## (2008 Pattern) (Semester - II)

*Time : 3 Hours]* *[Max. Marks :100*

*Instructions to the candidates:*

1) *Answer 3 questions from Section - I and 3 questions from Section - II.*
2) *Answers to the two sections should be written in separate books.*
3) *Neat diagrams must be drawn wherever necessary.*
4) *Figures to the right indicate full marks.*
5) *Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*
6) *Assume suitable data, if necessary.*

### SECTION - I

### Unit - I

*Q1)* a) Write a note on present status of power generation of India. [6]

b) Write a detailed note on carbon credits and its implications on clean technology. [5]

c) Two steam power plants each of 30MW capacity take a load of 45MW. The steam consumption rates in kg/hr for both plants are given by the equations : $S_1 = 2400 + 12L_1 - 0.00012L_1^2$

$S_2 = 1200 + 8.4L_2 - 0.00006L_2^2$

Where L represents the load in kW and s the steam consumption per hour. Find the most economical loading of the plants. [5]

OR

*Q2)* a) Discuss in details the various factors which must be considered in selecting a site for steam power plant. [6]

b) Discuss the role and participation of private sector in development of power sector in India. [6]

*P.T.O.*

c) The monthly electricity consumption of a residence can be approximated as under : [4]

Light load : 6 tube lights 40 watts each working for 4 hours daily.
Fan load : 6 fans 100 watts each working for 6 hours daily.
Refrigerator load : 2kWh daily.
Miscellaneous load : 2kWh for 2 hours daily.
Find the monthly bill at the following tariff:
First 20 units - Rs. 0.50/kWh
Next 30 units - Rs. 0.40/kWh
Remaining units - Rs. 0.30/kWh
Constant charge - Rs. 2.50 per month
Discount for prompt payment = 10 percent.

## Unit - II

*Q3)* a) What do you understand by 'coal benefication'. [5]

b) Discuss the principle of operation of overfeed and underfeed stokers with the help of simple diagrams. [5]

c) The following observations were recorded during a trial on a steam condenser, [6]

Condenser vacuum - 680 mm Hg
Barometer reading - 764mm Hg
mean condenser temperature - 36.2°C
Hot well temperature - 30°C
Determine :

i) Condenser vacuum corrected to standard barometer.
ii) Vacuum efficiency
iii) Condenser efficiency if cooling water inlet and outlet temperature is 20°C and 32°C respectively.

OR

*Q4)* a) Explain the principle of working of electro static dust collector with the help of a neat diagram. [5]

b) Explain construction and working of fluidized bed combustion system for power plant. [5]

c) In a single feed water heater, regenerative cycle, the steam enters the turbine at a pressure of 30 bar and 400°C. The exhaust pressure of steam is 0.1 bar. The feed water heater is direct contact type, which operates at a pressure of 5 bar. Find the thermal efficiency of the cycle and the specific steam consumption. Show the flow diagram, the regenerative cycle on h-s or T-s diagram. [6]

## Unit - III

*Q5)* a) Draw a schematic layout of hydro-electric power plant and explain. **[6]**

b) Show that optimum pressure ratio for maximum work output between fixed temperature limits of the Braytomcycle is given as **[6]**

$$r_p = \left(\frac{Tmax}{Tmin}\right)^{\frac{\gamma}{2(\gamma-1)}}$$

$r_p$ - pressure ratio

$\gamma$ = specific heat ratio

c) Compare the steam, hydro and gas power plant on the basis of site, initial cost, fuel cost, maintenance cost, cooling water requirement. **[6]**

OR

*Q6)* a) What are pumped storage peak load plants. Explain with the help of neat diagram. **[6]**

b) The heat energy absorbed by 20 kg/s of air passing through a gas turbine regenerator is 4200 kJ/s. If the air and products of combustion enters the regenerator at 123°C and 373°C respectively, determine the effectiveness of regenerator and exit temperatures of air and products of combustion. Take $C_p$ for air and gas as 1.05 kJ/kgk. **[6]**

c) Write a note on 'Free piston engine plant'. **[6]**

## SECTION - II

## Unit - IV

*Q7)* a) Describe in brief giving neat sketch, the working of a pressurised water reactor plant. **[8]**

b) List the essential components of a diesel power plant and explain them briefly. **[8]**

OR

*Q8)* a) What is a CANDU - type reactor? Explain with a sketch its main features. What is a calandria? **[8]**

b) What are the advantages and disadvantages of diesel power plant? Which factors should be considered while selecting a site for a diesel power plant? **[8]**

## Unit - V

*Q9)* a) What is a transformer? How are transformers classified? What are the advantages and disadvantages of the following 3 phase transformer :

i) The Y-y connection

ii) The Y-Δ connection [8]

b) Explain with the help of a neat diagram a solar pond electric power plant. [6]

c) State the advantages and disadvantages of fuel cell. [4]

OR

*Q10)* Write short notes on any three : [18]

a) A.C. exiters.

b) earthing of power system.

c) Circuit breakers.

d) geothermal power plant.

e) Magneto hydro dynamic system.

## Unit - VI

*Q11)* a) Name important gaseous pollutants discharged by thermal power plants. How are they classified? [8]

b) What do you mean by 'Thermal pollution'? What is 'Thermal Discharge Index' (TDI). [8]

OR

*Q12)* a) What is 'Particulate emission'? How it is controlled? [8]

b) Write a short note on 'Pollution from nuclear power plant. [8]

❖❖❖❖

Total No. of Questions : 12] SEAT No. :

P950 [Total No. of Pages : 4

# [4264] - 442
## B.E. (Mechanical)
## MECHANICAL SYSTEM DESIGN
## (2008 Pattern) (Semester - II)

*Time : 4 Hours]* *[Max. Marks : 100*

*Instructions to the candidates :*

1) *Answer any three questions from each section.*
2) *Answers to the two sections should be written in separate books.*
3) *Neat diagrams must be drawn wherever necessary.*
4) *Figures to the right indicate full marks.*
5) *Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables are allowed.*
6) *Assume suitable data, if necessary.*

## SECTION - I

*Q1)* a) A compound cylinder consists of an inner steel tube with inner and outer diameters of 40mm and 60mm respectively. It is reinforced by shrinking a steel jacket of outer diameter 80mm. The compound cylinder is subjected to an internal pressure of 60 MPa. The shrinkage allowance is such that the maximum circumferential stresses in inner tube and jacket are same. Calculate :

i) The interference pressure; and
ii) The original dimensions of inner tube and jacket.

Assume : $E = 207 kN/mm^2$. **[12]**

b) Derive Birnie's equation. Also explain under what conditions it is used. **[4]**

OR

*Q2)* a) What are the factors to be considered for design of vertical cylindrical pressure vessel. **[4]**

b) A pressure vessel, subjected to a design pressure of 0.75 MPa, consists of a cylindrical shell with 2 m inside diameter and 10 mm thickness. An opening of inner diameter 300 mm and wall thickness of 10 mm is provided in the shell. The corrosion allowance is 2 mm and the weld efficiency is 0.85. The extension of the opening inside and outside the shell is 15mm. The yield strength of the material used for the shell and the opening is 210 MPa. A reinforcing pad of a 10 mm thick plate is provided for the opening. Determine the dimensions of reinforcing pad. Assume factor of safety as 1.5. **[12]**

*P.T.O.*

*Q3)* a) A two stroke engine is to be designed for a brake power of 7 kW at a speed of 800 rpm. The indicated mean effective pressure may be assumed as 0.5 MPa. Design :

i) The bore and length of the cylinder liner.
ii) The thickness of the liner.
iii) The cylinder head thickness.
iv) The size, number and pitch of the studs.

Also calculate the apparent and net stresses in the liner, if the Poisson's ratio is 0.25. **[12]**

b) Draw a neat sketch of the connecting rod and explain its constructional details. **[4]**

OR

*Q4)* Design a cast iron piston for a single acting four stroke diesel engine with the following data : **[16]**

Cylinder bore = 200 mm
Length of the stroke = 250 mm
Speed = 600 rpm
Brake mean effective pressure = 0.60 MPa
Maximum gas pressure = 4 MPa
Fuel consumption = 0.25 kg per BP per hr
I/d ratio for bush in small end of connecting rod = 1.5
Assume suitable data if required and state the assumptions you make.

*Q5)* a) Explain the Johnson's method of optimum design. **[4]**

b) A thin spherical vessel is to be designed with the objective of maximum gas storage capacity given by $(1/6)\ \pi D^3$, where D is the diameter of the vessel. Mass of the empty vessel should not exceed 150 kg. The vessel is subjected to internal pressure of 5 $N/mm^2$ and the required factor of safety based on yield strength is 2.0. Design the vessel using the following materials. Also find the storage capacity. **[14]**

| Material | Mass Density ($kg/m^3$) | Yield Strength ($N/m^2$) |
|---|---|---|
| Steel alloy | 7800 | $450 \times 10^6$ |
| Aluminium alloy | 2800 | $150 \times 10^6$ |
| Titanium alloy | 4500 | $800 \times 10^6$ |
| Magnesium alloy | 1800 | $100 \times 10^6$ |

OR

**Q6)** A cantilever beam of length 200mm and rectangular cross - section is to function in a device as a spring member. The width of the beam is five times its depth. It is subjected to vertical force which varies from +500N to –500N at its free end. The maximum deflection at the free end is limited to 1mm. The factor of safety is 2. Design the beam for minimum material cost, out of the following materials. **[18]**

| Material | Mass Density ($kg/m^3$) | Material cost (Rs/kg Weight) | Endurance Limit ($N/mm^2$) | Modulus of Elasticity ($N/mm^2$) |
|---|---|---|---|---|
| M1 | 7800 | 20 | 130 | $207 \times 10^3$ |
| M2 | 2800 | 70 | 50 | $72 \times 10^3$ |
| M3 | 4500 | 800 | 260 | $114 \times 10^3$ |

## SECTION - II

**Q7)** a) Explain the basic principles of DFMA. **[6]**

b) A straight tensile bars of diameter $10^{\pm 0.1}$mm are made of plain carbon steel 40C8 having tensile yield strength of $300 \pm 30 N/mm^2$. The load on the bars is $23.5 \pm 5$kN. If the diameters, strength and loads are normally distributed, estimate the reliability of with standing the load by the bars. The areas under the standard normal distribution curve from zero to Z are as follows : **[10]**

| Z | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 | 2.2 | 2.4 |
|---|---|---|---|---|---|---|---|---|
| Area | 0.3413 | 0.3849 | 0.4192 | 0.4452 | 0.4641 | 0.4772 | 0.4861 | 0.4918 |

OR

**Q8)** a) Two populations X and Y are added together. Derive the expressions to find mean and standard deviations of the resultant population. **[6]**

b) Three cylindrical components each with a length of 30mm are to be assembled to give a total length of $90^{\pm 0.6}$mm. All individual cylindrical components have same standard deviation and their natural and design tolerances are equal. Specify the tolerances for individual components. **[10]**

**Q9)** a) Explain the term maximum loss of economic cutting speed. **[4]**

b) Find the speed steps arranged in geometric progression for the following conditions.

Nmin = 100 rpm; Nmax = 1800 rpm.

Number of speed steps z = 8

Also draw the best possible structure diagram for the same. **[12]**

OR

**Q10)** a) The geometric progression ratio ($\phi$) in a multispeed gear box is selected in the range of 1 to 2. Explain its significance. **[5]**

b) Draw a layout of a machine tool gear box having following structural formula 3 (1) 3 (3). Assume that the input speed to the gear box is through a belt drive. [6]

c) Draw a structure diagram for the following structural formulae. [5]

i) 3 (1) 2 (3) 2 (6) ii) $\Leftrightarrow$ 2 (1) 3 (2)

*Q11)* a) Following data refers to a horizontal belt conveyor used for conveying a coal in a thermal power plant. **[12]**

- Capacity of conveyor $M = 300 \times 10^3$kg/hr
- Belt speed $v = 2$m/s
- Density of coal $\rho = 800$kg/m$^3$
- Surcharge factor for belt $c = 0.0725$
- Number of plies for belt $z_p = 3$
- Material factor for plies $K_1 = 2$
- Belt tension and arc of contact factor for belt $K_2 = 80$
- Electric motor speed 1440 rpm
- Centre distance between snub pulleys $L_1 = 255$m
- Centre distance between drive and tail pulley $L_2 = 260$m
- Pitch of carrying run idlers $tc = 1$m
- Pitch of return run idlers $tr = 2.5$m

Determine :

i) Standard belt width.

ii) Reduction ratio of gear reducer.

iii) Number of carrying and return run idlers.

standard belt width (mm) - 500, 600, 750, 800, 900, 1000, 1200, 1400, 1600

b) What are the design considerations in selecting the belt speed of a conveyor. **[6]**

OR

*Q12)* a) Following data refers to a flat belt conveyor for transporting crushed rock.

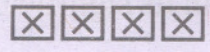
- Mass density $\rho = 2$ Ton/m$^3$
- Belt speed $v = 1.75$ m/s
- Belt width $B = 0.8$ m
- Surcharge angle $\alpha = 25°$ for $k = 2.35 \times 10^{-4}$
- Effective width of the material carried by the belt safety $b = (0.9B - 0.05)$

Determine the capacity of conveyor in Ton/hr. **[8]**

b) Explain concept of containerization and considerations in the design of the same. **[4]**

c) Explain on the basis of applications selection between : **[6]**

i) Chain conveyor. ii) Screw conveyor. iii) Belt conveyor.



Total No. of Questions : 12]

SEAT No. :

P989

[Total No. of Pages : 3

# [4264] - 445

## B.E. (Mechanical)

## ROBOTICS

### (2008 Pattern) (Elective - III) (Semester - II)

*Time : 3 Hours]* *[Max. Marks :100*

***Instructions to the candidates:***

1) ***Answer any 3 questions from each Section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***
6) ***Assume suitable data, if necessary.***

## SECTION - I

***Q1)*** a) Explain the robot anatomy with figure. **[8]**

b) Compare the cylindrical co-ordinate and articulated configuration robot on the basis of

i) Work Volume

ii) Accuracy and Repeatability

iii) Mechanical Flexibility

iv) Dexterity

v) Applications **[10]**

OR

***Q2)*** a) Explain the degree of freedom associated with robot arm and wrist. **[6]**

b) A Cartesian robot has a slide range of 1.5 m and it is desired that it will have a control resolution of 2.8 mm on this axis. Determine the bit storage capacity which control memory must possess to accommodate this level of precision. **[6]**

c) Explain the different joints used in robots. **[6]**

***P.T.O.***

*Q3)* a) What are the different considerations in the design of the gripper? **[8]**

b) A rectangular block weighing 12 kg is gripped at the middle and lifted vertically. If it accelerates at 25 $m/s^2$ and the coefficient of friction between the gripping pad and the block is 0.42. Draw gripper force analysis and calculate gripping force. **[8]**

OR

*Q4)* a) Explain important characteristics of robot sensors. **[8]**

b) State various types of sensors in robot. Explain capacitive and Ultrasonic sensors. **[8]**

*Q5)* a) Classify robot drives. **[6]**

b) Write short notes on Gear motor and Piston Motor. **[10]**

OR

*Q6)* a) Explain the Modeling and control of a single joint in robot. **[8]**

b) One of the joint of articulated robot has to traverse from initial angle of 20° to final angle of 84° in 4 seconds. Using a third degree polynomial calculate the joint angle at 1, 2 and 3 seconds. **[8]**

## SECTION - II

*Q7)* a) Explain steps to implement Denavit Hertenberg convention for robot Manipulator. **[10]**

b) A point 'P' is attached to a frame (XYZ) is subjected to the following transformations, but all transformations relative to the current moving frame are as follows. **[8]**

i) A rotation of '$\alpha$' angle about the OX - axis.

ii) Then a translation of 'a' units along OX axis.

iii) Followed by a rotation of '$\theta$' angle about the OZ-axis.

Write homogenous transformation matrix to find new coordinate point of a frame.

OR

*Q8)* a) Sketch and explain the procedure to obtain robot joint Jacobian matrix. **[8]**

b) Derive an equation to calculate static force in two link arm manipulator. **[10]**

*Q9)* a) Explain three major functions of machine vision system. **[8]**

b) Enlist different ways to segment an image and explain any one in detail. **[8]**

OR

*Q10)* a) Enlist the capabilities and Limitations of lead through programming methods. [8]

b) Discuss the general features of robot programming language. [8]

*Q11)* a) Explain various techniques used for representing knowledge in artificial Intelligence. [8]

b) Explain possible schemes to represent the problem in artificial intelligence. [8]

OR

*Q12)* Write short notes on :

a) Economical aspects to design Robot. [6]

b) Robot simulation Tools. [5]

c) Singularities in robot. [5]

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Total No. of Questions : 12]

SEAT No. :

P988

[Total No. of Pages : 4

# [4264] - 444

## B.E. (Mechanical)

## FINITE ELEMENT METHOD

### (2008 Pattern) (Elective - III) (Semester - II) (Theory)

*Time : 3 Hours]* *[Max. Marks :100*

***Instructions to the candidates:***

1) ***Answers to the two sections should be written in separate books.***
2) ***Figures to the right indicate full marks.***
3) ***Assume suitable data, if necessary.***

## SECTION - I

### Unit - I

*Q1)* a) Explain general FEM procedure for one dimensional linear Element. **[8]**

b) Describe the terms discretization & degrees of freedom with the suitable example of each. **[8]**

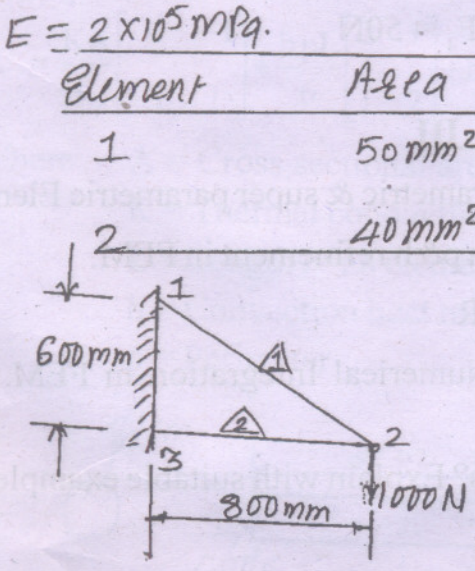
OR

*Q2)* a) What are types of Boundary Conditions & how they are treated in FEM. **[8]**

b) What are advantages & disadvantages of FEM method. **[8]**

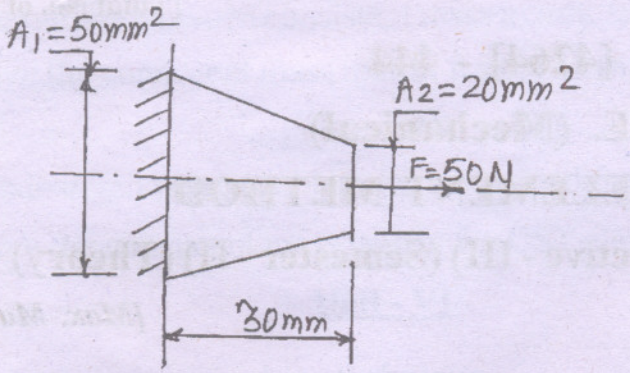
### Unit - II

*Q3)* a) Analyse the truss shown in fig. for axial forces using FE method. Also find out unknown displacements. **[10]**




P.T.O.

b) Analyze the bar for axial displacements. Take three elements. Assume $E = 2 \times 10^5$ MPa **[8]**




OR

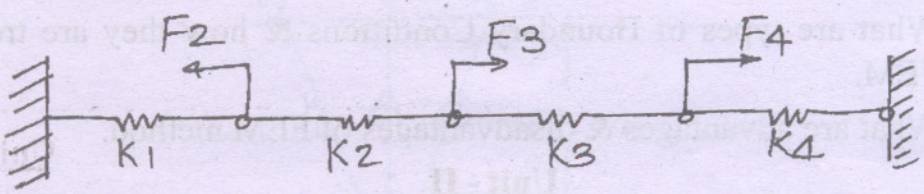
***Q4)*** a) Derive Element stiffness matrix & force vector for two noded bar element using principle of minimum potential Energy (PMPE) method. **[10]**

b) A system of spring is shown in the figure. Find **[8]**

i) Nodal displacement

ii) Reaction forces

iii) Force in each spring




$K_1 = 10N/mm$ $K_2 = 15N/mm$ $K_3 = 25N/mm$ $K_4 = 20N/mm$

$F_2 = 20N$ $F_3 = 30N$ $F_4 = 50N$

## Unit - III

***Q5)*** a) Explain iso-parametric, sub parametric & super parametric Elements. **[8]**

b) Explain the difference between p&h refinement in FEM. **[8]**

OR

***Q6)*** a) What is the significance of Numerical Integration in FEM. Explain Newton cotes method. **[12]**

b) What are higher order elements? Explain with suitable example. **[4]**

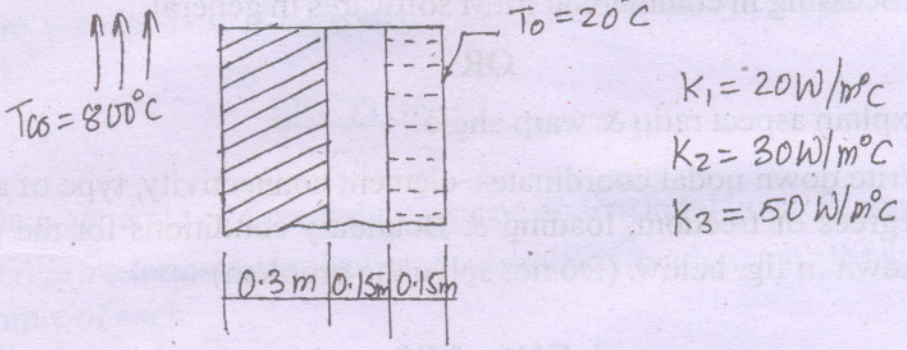
## SECTION - II

### Unit - IV

*Q7)* A composite wall consists of 3 materials as shown in figure below. The outer temperature is To = 20°C. The convection heat transfer takes place on the inner surface of the wall with $T_\infty$ = 800°C and h = 25W/m²°C.

Determine temperature distribution in the wall. The element matrix equation is **[16]**

$$\frac{k^e}{he}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix}\begin{Bmatrix} T_1^e \\ T_2^e \end{Bmatrix} = \begin{Bmatrix} Q_1^e \\ Q_2^e \end{Bmatrix}$$

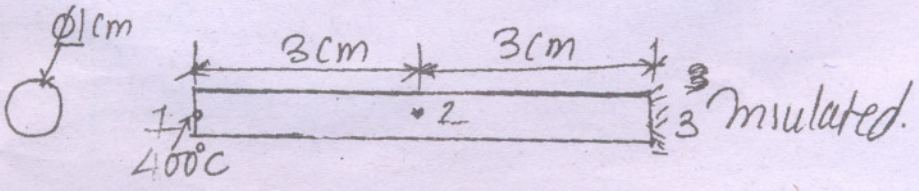



OR

*Q8)* A steel rod of 1cm diameter & length 6cm. With thermal conductivity K = 50 W/m°C has temperature at left end equal to 400°C. The surrounding temperature is 30°C. The convection heat transfer coefficient is h = 20 W/m°C. The right end is insulated. Find temperature at x = 3cm & x = 6cm. Use stiffness matrix as **[16]**

$$K^e = \frac{KA}{L}\begin{bmatrix} 1 & -1 \\ -1 & 1 \end{bmatrix} + \frac{hpL}{6}\begin{bmatrix} 2 & 1 \\ 1 & 2 \end{bmatrix} + hA\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad \& \quad \{K^e\}\{T^e\} = \{Q^e\}$$

Where A = Cross sectional area
K = Thermal conductivity
L = Length of an element
h = Convection heat transfer coefficient
p = Perimeter



## Unit - V

*Q9)* a) Differentiate between consistent mass matrix & lumped mass matrix. **[6]**

b) Derive the consistent mass matrix for bar element & truss element. **[12]**

OR

*Q10)* a) Explain eigen value problem for undamped free vibration system. **[6]**

b) Derive the consistent mass matrix for CST element. **[12]**

## Unit - VI

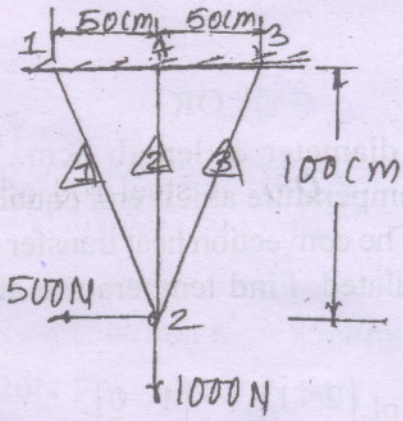
*Q11)* a) What are various meshing techniques. **[8]**

b) What is the difference between preprocessing, processing & post processing in commercial FEM softwares in general. **[8]**

OR

*Q12)* a) Explain aspect ratio & warp angle. **[4]**

b) Write down nodal coordinates, element connectivity, type of analysis, degrees of freedom, loading & Boundary conditions for the problem shown in fig. below. (Do not solve the problem) **[12]**

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[Total No. Of Questions: 12]

Seat No. :
Total No. of Pages : 02

# [ 4264] – 448
# B.E. (MECHANICAL ENGINEERING)
# MANAGEMENT INFORMATION SYSTEM
# ( 2008 Pattern )

*Time : 3 Hours* *Max. Marks : 100*

*Instructions to the Candidates :*

1) *Answer to the two sections should be written in separate answer books*
2) *Neat Diagrams must be drawn wherever necessary*
3) *Figures to the right indicate full marks*
4) *Assume suitable data , if necessary*
5) *Solve Q1 or Q2 , Q3 or Q4, Q5 or Q6 , Q7 or Q8, Q9 or Q10, Q11 or Q12*

## SECTION - I

| | | |
|---|---|---|
| Q1. a) | Define MIS. Explain functions of manager. | 06 |
| b) | Write the purpose for which we need to design organisation structure. | 06 |
| c) | Explain the impact of MIS. | 04 |
| | **OR** | |
| Q2. a) | Explain<br>i) Operation support systems. ii) Management support systems. | 08 |
| b) | What is an organisation? Explain the basis model of an organisation structure. | 08 |
| Q3. a) | Differentiate between<br>i) MIS and DSS<br>ii) Programmed Decisions and Non Programmed Decisions | 08 |
| b) | Write a note on Behavioural Decision Making . | 08 |
| | **OR** | |
| Q4. a) | Explain Herbert Simon Model of Decision Making. | 08 |
| b) | Explain Spiral SDLC Model. | 08 |
| Q5. a) | Draw a E – R diagram of library management system. Consider following entities and their attributes.<br>i ) Book ii ) Member iii) Publisher iv) Supplier | 06 |
| b) | Write a note on Data Mining. | 06 |
| c) | Explain knowledge based expert system. | 06 |
| | **OR** | |
| Q6. a) | Define DBMS. Explain Distributed DBMS. | 06 |
| b) | State advantages and disadvantages of decision support system. | 06 |
| c) | Write a note on Data Flow Diagrams ( DFD) | 06 |

## SECTION – II

| | | |
|---|---|---|
| Q7. a) | Write a note on Quality Management in software organisation. | 04 |
| b) | Explain all five levels of Capability Maturity Model. (CMM) | 10 |
| c) | Define Verification. | 02 |
| | **OR** | |
| Q8. a) | State benefits and limitations of CMM. | 04 |
| b) | Write a note on object oriented design of UML. | 10 |
| c) | Define validation. | 02 |

Total No. of Questions : 12]

SEAT No. :

P1019

[Total No. of Pages : 8

# [4264] - 447

## B.E. (Mechanical)

## INDUSTRIAL HEAT TRANSFER EQUIPMENTS

## (2008 Pattern) (Elective - IV) (Semester - II)

*Time : 3 Hours]* *[Max. Marks :100*

*Instructions to the candidates:*

1) *Answer both sections on separate answer books.*
2) *Answer Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8, Q9 or Q10, Q11 or Q12.*
3) *Assume suitable data, if necessary.*

### SECTION - I

*Q1)* a) How heat exchangers are classified according to its arrangement. [5]

b) Explain construction and working of hairpin heat exchanger. [5]

c) State general steps for thermal design of heat exchanger by NTU method. [6]

OR

*Q2)* a) Explain series arrangement of hairpin heat exchangers with figure and state advantages of arrangement. [5]

b) State applications of plate heat exchangers. [5]

c) What will be the hydraulic diameter of an annulus with longitudinal finned tube with following specifications? [6]

Inner diameter of shell 0.0525m

Outer diameter of tube 0.0266m

Number of tubes 1

Thickness of fin 0.9 mm

Axial height of fin from outer periphery of tube is 0.0127m

Number of fins per tube 30

*Q3)* a) Determine the tube side heat transfer coefficient at 30 cm from the inlet of a heat exchanger where engine oil flows through tubes with a diameter of 12.5mm. Oil flows with a velocity of 0.5 m/s and at a local bulk temperature of 30°C, with local tube wall temperature of 60°C. (Use correlations attached) **[8]**

Properties of oil :

$\rho = 882$ kg/m$^3$

$Cp = 1922$ J/kg.K

$\mu = 0.41$ Ns/m$^2$

$k = 0.14$ W/mK

$Pr = 5550$

$\mu_w = 0.074$ Ns/m$^2$ at 60°C

b) What are baffles? State its use and type. **[4]**

c) Define Tube layout angle. Draw tube layout pattern with tube layout angle of 90° and 45°. **[4]**

OR

*Q4)* a) Explain in short : Contents in TEMA standard. **[5]**

b) Write note on : Selection of tube thickness in heat exchanger. **[5]**

c) Explain stepwise process of heat exchanger analysis by Kern's method. **[6]**

*Q5)* a) State factors by which choice of compact heat exchanger is made. **[5]**

b) State limitations of compact fin Heat Exchangers. **[5]**

c) A cross flow heat exchanger with both fluids unmixed is used to heat water flowing at a rate of 20 kg/s from 25°C to 75°C using gases available at 300°C to be cooled to 180°C. The overall heat transfer coefficient has a value of 95 W/m$^2$K. Determine the area required using LMTD method. For gas Cp = 1005 J/kgK, For water Cp = 4180 J/kgK. (Graphs attached can be used) **[8]**

OR

*Q6)* a) Explain any four geometries of PFHE (Plate Fin Heat Exchangers). **[6]**

b) What are Tube-Fin Heat Exchangers? Describe with figure. **[6]**

c) Explain how multi-pass exchangers are to be designed? **[6]**

## SECTION - II

*Q7)* a) Which typical parameters are to be considered during selection and design of condenser compared to S&T HEX? [5]

b) How condensers are classified? [5]

c) Draw sketch and explain in brief spiral condenser. [6]

OR

*Q8)* a) Explain air cooled evaporator with its disadvantages. [5]

b) State main features of cross flow condensers with figure. [5]

c) 'Extra tube support plate is provided near nozzle', justify. [6]

*Q9)* a) Describe Psychometric Analysis of Air Passing Through Cooling Tower. [5]

b) How cooling tower is to be maintained in good working condition? [5]

c) Explain Indirect-Contact or Closed-Circuit Evaporative Cooling Tower. [6]

OR

*Q10)* a) Compare wood and metal as cooling tower material. [5]

b) Explain induced draft cross flow cooling tower. [5]

c) Enlist factors to be considered for locating cooling tower. [6]

*Q11)* a) State use of different materials for better cooling in cabinets. [6]

b) State need of cooling in electrical applications. [6]

c) State advantages of forced electronics cooling. [6]

OR

*Q12)* a) Write note on : Wick structure of heat pipe. [6]

b) Explain liquid cooled PCB. State its advantages and disadvantages. [6]

c) State advantages of natural electronics cooling. [6]

## Equations.

**Eq. 1**

$$Nu = 3.9\,(Re \cdot Pr)^{1/2}\left(\frac{d}{L}\right)^{1/2}\left(\frac{\mu}{\mu_w}\right)^{0.01}$$

for – 1) Laminar flow

2) $\left[\frac{\mu}{\mu_w}\right] > 9.75$

**Eq. 2**

$$Nu = 1.86\,(RePr)^{1/3}\left(\frac{d}{L}\right)^{1/3}\left(\mu/\mu_w\right)^{0.14}$$

for 1) Laminar flow

2) $\left[\left(Re \cdot Pr \cdot \frac{d}{L}\right)^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}\right] > 2$

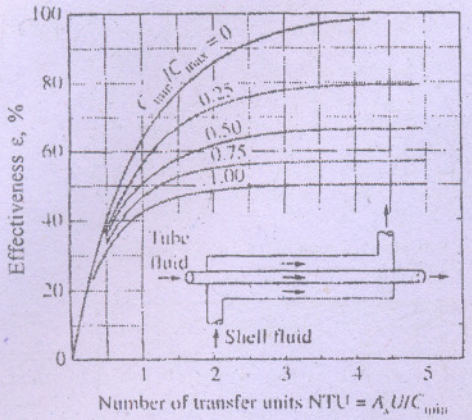
3) $\left[\frac{\mu}{\mu_w}\right] < 9.75$

**Eq. 3**

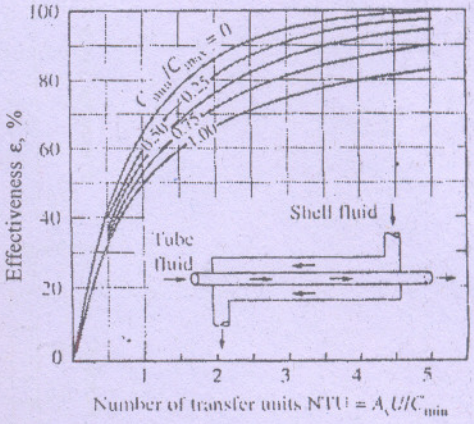
$$Nu = \frac{(f/2)\,Re \cdot Pr}{1.07 + 12.7\,(f/2)^{1/2}\,(Pr^{2/3} - 1)}$$

& $f = (1.58 \ln Re - 3.28)^{-2}$

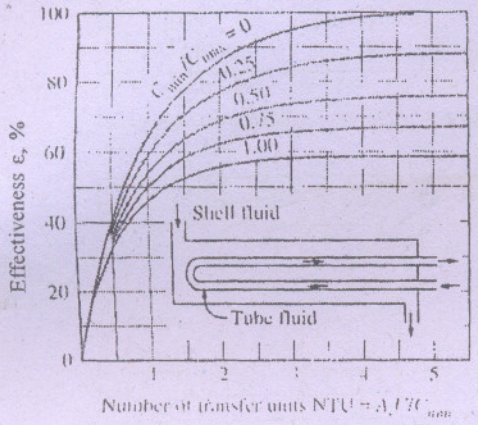
1) for turbulent flow.



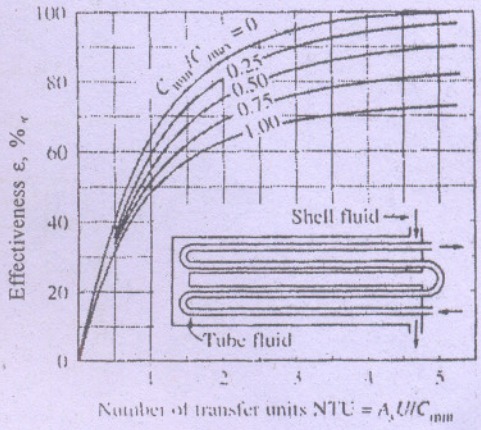

(*a*) Parallel-flow



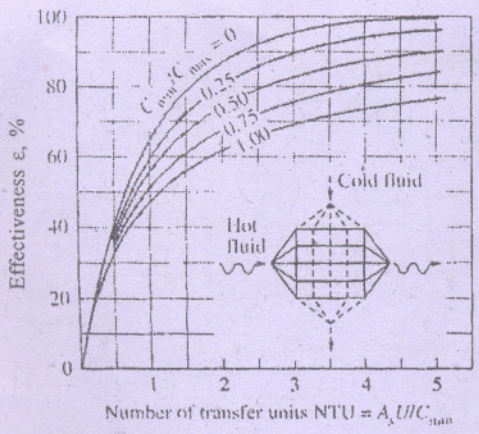

(*b*) Counter-flow



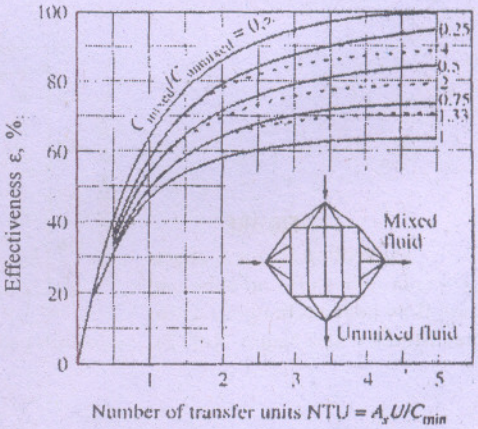

(*c*) One-shell pass and 2, 4, 6, ... tube passes




(*d*) Two-shell passes and 4, 8, 12, ... tube passes



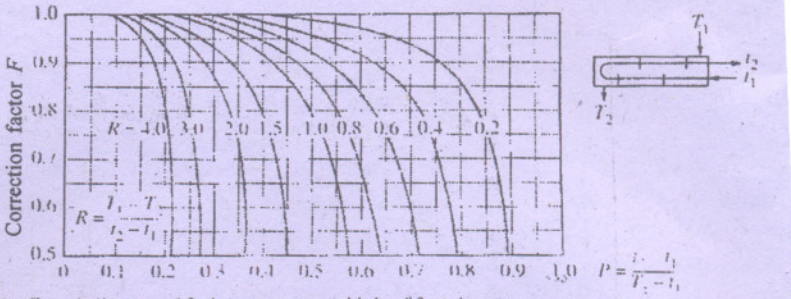

(*e*) Cross-flow with both fluids unmixed



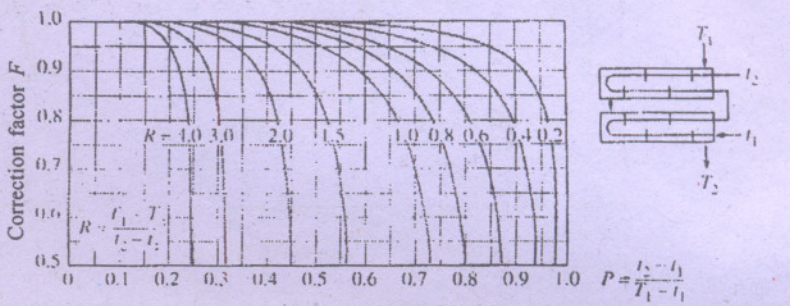

(*f*) Cross-flow with one fluid mixed and the other unmixed

**FIGURE**

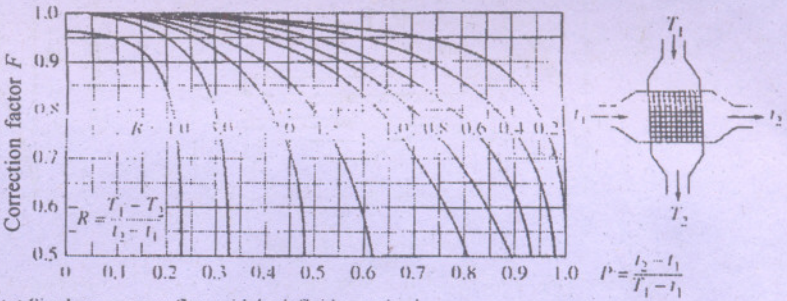
Effectiveness for heat exchangers (from Kays and London, Ref. 5).



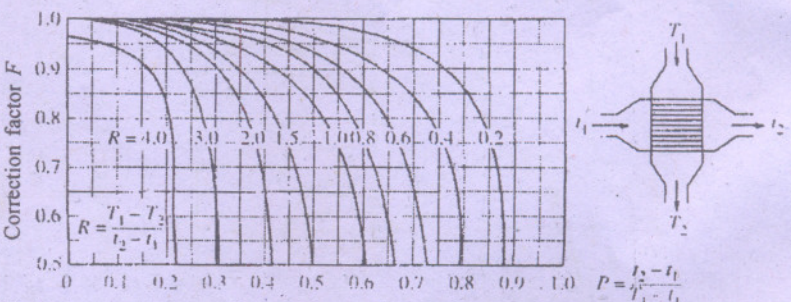

(*a*) One-shell pass and 2, 4, 6, etc. (any multiple of 2), tube passes.




(*b*) Two-shell passes and 4, 8, 12, etc. (any multiple of 4), tube passes




(*c*) Single-pass cross-flow with both fluids *unmixed*




(*d*) Single-pass cross-flow with one fluid *mixed* and the other *unmixed*

**FIGURE**

Correction factor $F$ charts for common shell-and-tube and cross-flow heat exchangers (from Bowman, Mueller, and Nagle, Ref. 2).

## TABLE A2
## Water at Sea-Level Atmospheric Pressure

| Temp. T | | Density $\rho$ | Coef. Exp. $\beta \times 10^3$ | Specific Heat $c_p$ | Thermal Cond. $k$ | Absolute Viscosity $\mu \times 10^6$ | Kinematic Viscosity $\nu \times 10^6$ | Prandtl Number Pr |
|---|---|---|---|---|---|---|---|---|
| °F | °C | kg/m³ | 1/K | J/kg K | W/m K | N s/m² | m²/s | – |
| 32 | 0 | 999.9 | −0.068 | 4217.5 | 0.5580 | 1794 | 1.794 | 13.56 |
| 41 | 5 | 1000 | 0.018 | 4202.7 | 0.5677 | 1530 | 1.530 | 11.33 |
| 50 | 10 | 999.7 | 0.095 | 4192.4 | 0.5774 | 1296 | 1.296 | 9.410 |
| 59 | 15 | 999.1 | 0.16 | 4185.8 | 0.5870 | 1136 | 1.137 | 8.101 |
| 68 | 20 | 998.2 | 0.22 | 4181.7 | 0.5967 | 993 | 0.995 | 6.959 |
| 77 | 25 | 997.1 | 0.26 | 4179.5 | 0.6064 | 880.6 | 0.883 | 6.069 |
| 86 | 30 | 995.7 | 0.31 | 4178.6 | 0.6155 | 792.4 | 0.796 | 5.380 |
| 95 | 35 | 994.1 | 0.35 | 4178.5 | 0.6243 | 719.8 | 0.724 | 4.818 |
| 104 | 40 | 992.2 | 0.39 | 4179.0 | 0.6325 | 658.0 | 0.663 | 4.348 |
| 113 | 45 | 990.2 | 0.42 | 4179.9 | 0.6401 | 605.1 | 0.611 | 3.951 |
| 122 | 50 | 988.1 | 0.45 | 4181.1 | 0.6472 | 555.1 | 0.562 | 3.586 |
| 131 | 55 | 985.8 | 0.48 | 4182.6 | 0.6536 | 512.6 | 0.520 | 3.280 |
| 140 | 60 | 983.5 | 0.51 | 4184.5 | 0.6594 | 470.0 | 0.478 | 2.983 |
| 149 | 65 | 980.8 | 0.54 | 4186.8 | 0.6643 | 436.0 | 0.445 | 2.748 |
| 158 | 70 | 978 | 0.57 | 4189.5 | 0.6686 | 402.0 | 0.411 | 2.519 |
| 167 | 75 | 974.9 | 0.60 | 4192.9 | 0.6724 | 376.6 | 0.386 | 2.348 |
| 176 | 80 | 971.7 | 0.63 | 4196.6 | 0.6753 | 350.0 | 0.361 | 2.175 |
| 185 | 85 | 968.5 | 0.66 | 4201.0 | 0.6778 | 330.5 | 0.341 | 2.048 |
| 194 | 90 | 965 | 0.69 | 4205.7 | 0.6797 | 311.0 | 0.322 | 1.924 |
| 203 | 95 | 961.7 | 0.72 | 4210.6 | 0.6811 | 294.3 | 0.306 | 1.819 |
| 212 | 100 | 958.4 | 0.75 | 4215.5 | 0.6822 | 277.5 | 0.290 | 1.715 |

## TABLE A1
## Air at Sea-Level Atmospheric Pressure

| Temp. T | | Density $\rho$ | Coef. Exp. $\beta \times 10^3$ | Specific Heat $c_p$ | Thermal Cond. $k$ | Absolute Viscosity $\mu \times 10^6$ | Kinematic Viscosity $\nu \times 10^6$ | Prandtl Number Pr |
|---|---|---|---|---|---|---|---|---|
| °F | °C | kg/m³ | 1/K | J/kg K | W/m K | N s/m² | m²/s | – |
| 32 | 0 | 1.293 | 3.664 | 1003.9 | 0.02417 | 17.17 | 13.28 | 0.7131 |
| 41 | 5 | 1.269 | 3.598 | 1004.3 | 0.02445 | 17.35 | 13.67 | 0.7127 |
| 50 | 10 | 1.242 | 3.533 | 1004.6 | 0.02480 | 17.58 | 14.16 | 0.7122 |
| 59 | 15 | 1.222 | 3.470 | 1004.9 | 0.02512 | 17.79 | 14.56 | 0.7118 |
| 68 | 20 | 1.202 | 3.412 | 1005.2 | 0.02544 | 18.00 | 14.98 | 0.7113 |
| 77 | 25 | 1.183 | 3.354 | 1005.4 | 0.02577 | 18.22 | 15.40 | 0.7108 |
| 86 | 30 | 1.164 | 3.298 | 1005.7 | 0.02614 | 18.46 | 15.86 | 0.7103 |
| 95 | 35 | 1.147 | 3.245 | 1006.0 | 0.02650 | 18.70 | 16.30 | 0.7098 |
| 104 | 40 | 1.129 | 3.193 | 1006.3 | 0.02684 | 18.92 | 16.76 | 0.7093 |
| 113 | 45 | 1.111 | 3.142 | 1006.6 | 0.02726 | 19.19 | 17.27 | 0.7087 |
| 122 | 50 | 1.093 | 3.094 | 1006.9 | 0.02761 | 19.42 | 17.77 | 0.7082 |
| 131 | 55 | 1.079 | 3.048 | 1007.3 | 0.02801 | 19.68 | 18.24 | 0.7077 |
| 140 | 60 | 1.061 | 3.003 | 1007.7 | 0.02837 | 19.91 | 18.77 | 0.7072 |
| 149 | 65 | 1.047 | 2.957 | 1008.0 | 0.02876 | 20.16 | 19.26 | 0.7067 |
| 158 | 70 | 1.030 | 2.914 | 1008.4 | 0.02912 | 20.39 | 19.80 | 0.7062 |
| 167 | 75 | 1.013 | 2.875 | 1008.8 | 0.02945 | 20.60 | 20.34 | 0.7057 |
| 176 | 80 | 1.001 | 2.834 | 1009.3 | 0.02979 | 20.82 | 20.80 | 0.7053 |
| 185 | 85 | 0.986 | 2.795 | 1009.8 | 0.03012 | 21.02 | 21.32 | 0.7048 |
| 194 | 90 | 0.972 | 2.755 | 1010.3 | 0.03045 | 21.23 | 21.84 | 0.7044 |
| 203 | 95 | 0.959 | 2.718 | 1010.7 | 0.03073 | 21.41 | 22.33 | 0.7041 |
| 212 | 100 | 0.947 | 2.683 | 1011.2 | 0.03101 | 21.58 | 22.79 | 0.7038 |



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