N.B.:
(1) **Question No.1 is compulsory**
(2) Attempt any **three** questions out of remaining **five** questions
(3) Figures to right indicate full marks
(4) Assume suitable data if **necessary and justify the same.**

Q.1(A)	Figure 1 shows the rheological behavior of four types of viscous fluids. With reference to this figure, match the following two lists.	04

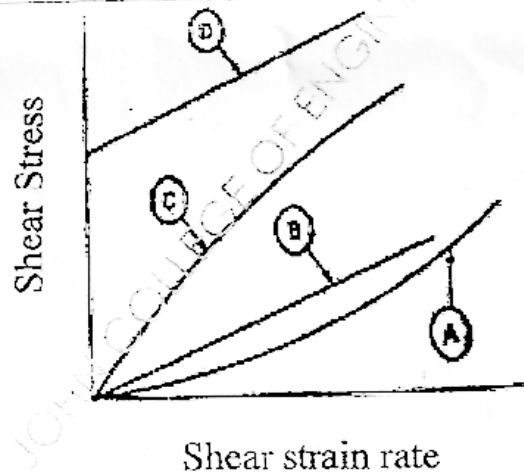| List I (Curves In Figure 1)	List II (Classification)
a. Curve A	1. Dilatant
b. Curve B	2. Ideal Bingham
c. Curve C	3. Pseudo Plastic
d. Curve D	4. Newtonian

Figure 1

(B)	Steady, incompressible flow consist of following velocity components: $u=-cx/y$, $v=c \ln(xy)$ Obtain a relevant stream function for the fluid flow.	06

(C)	If the velocity distribution in a laminar boundary layer on a flat plate is $$\frac{u}{U} = a + b\left(\frac{y}{\delta}\right) + c\left(\frac{y}{\delta}\right)^2 + d\left(\frac{y}{\delta}\right)^3$$ Determine the coefficient a, b, c and d. Here u is the velocity at the distance y from the surface of the flat plate and U be the free stream velocity at the boundary layer thickness δ.	05
(D)	Find the speed of sound in oxygen at a pressure of 100 kPa (abs) and 25^0 C. Take R= 260 J/kg.K and k=1.4.	05
Q. 2(A)	An 80 mm diameter composite solid cylinder consists of an 80 mm diameter 20 mm thick metallic plate having specific gravity 4 attached at the lower end of an 80 mm diameter wooden cylinder of specific gravity 0.8. Find the limits of the length of the wooden portion so that the composite cylinder can float in stable equilibrium in water with its axis vertical.	10
(B)	The diameter of a pipe bend is 30 cm at inlet and 15 cm at outlet and the flow is turned through 120^0 (angle measured in clockwise direction between direction of fluid flow at inlet and outlet) in a vertical plane. The axis at inlet is horizontal and the centre of the outlet section is 1.5 m below the centre of the inlet section. Total volume of water in the bend is 0.9 m³. Neglecting friction, calculate the magnitude and direction of the force exerted on the bend by water flowing through it at 250 litres/s and when inlet pressure is 0.15 N/mm².	10
Q.3 (A)	Determine the maximum discharge of water that can be carried without cavitation by a horizontal 100 mm X 50 mm (inlet diameter 100 mm and throat diameter 50 mm) venturimeter, which has a	10

[TURN OVER

	coefficient of discharge of 0.95. The inlet pressure is 10 kPa (gauge), the vapour pressure of water is 4 kPa (abs) and the local atmospheric pressure is 96 kPa (abs).	
(B)	Given the velocity distribution in a laminar boundary layer on a flat plate as $$\frac{u}{U} = 2\left(\frac{y}{\delta}\right) - 2\left(\frac{y}{\delta}\right)^3 + \left(\frac{y}{\delta}\right)^4$$ where u is the velocity at the distance y from the surface of the flat plate and U be the free stream velocity at the boundary layer thickness δ. Obtain an expression for boundary layer thickness, shear stress, and force on one side of the plate in terms of Reynolds number.	10
Q. 4(A)	A belt conveyor consists of a flat belt 0.5 m wide which slides at a velocity of 4 m/s parallel to a surface separated by a 6 cm thick layer of oil of viscosity 0.25 Ns/m. Determine (i) the pressure gradient required to cause no shear stress at the belt surface (ii) the average velocity and the discharge of oil to be maintained for the above.	10
(B)	Following is the velocity potential function for two dimensional irrotational flow in cylindrical coordinates: $$\phi = \frac{m\cos\theta}{r}$$ Determine the conjugate function (stream function).	10
Q.5(A)	Draw rough nature of Moody Chart showing different regimes of fluid flow and explain its significance	05
(B)	What is critical pressure ratio for compressible flow in nozzle?	05

	Explain its significance.	
(C)	In a normal shock wave occurring in a helium (k=1.66) the density downstream of the shock is three times that on the upstream. Calculate the corresponding pressure ratio and velocity ratio. What are the Mach numbers upstream and downstream of the shock?	10
Q.6 (A)	Three pipes with details as following are connected in parallel between two points **Pipe** **Length** **Diameter** f 1 1000 m 20 cm 0.02 2 1200 m 30 cm 0.015 3 800 m 15 cm 0.02 When the total discharge of 0.30 m³/sec flows through the system, calculate distribution of discharge and head loss between the junctions.	10
(B)	Explain Prandtl mixing length theory for turbulent fluid flow.	05
(C)	Write short note on induced drag on an aerofoil.	05

QP Code : **12577**

(3 Hours) [Total Marks : 80

N. B. : (1) Question No.1 is **compulsory**.
(2) Answer any **three** questions from remaining **five** questions.
(3) **Figures** to the **right** indicate **full** marks.

1. Solve any **four** :– 20
   (a) Explain different types of diodes based on their operating quadrants of V-I characteristics.
   (b) What is the concept of R-L & R-L-E load in case of phase controlled rectifiers?
   (c) Design scaling adder using op-amp to give output as follows
   $V_0 = - (V_1 + V_2 + 3V_3)$ where given inputs V_1, V_2 & V_3.
   (d) State & prove De Morgan's theorem using truth table.
   (e) What is linear actuator motor? Give two applications.

2. (a) Classify & explain triggering methods of SCR with circuit diagrams. 7
   (b) Compare power BJT, IGBT & MOSFFT on the basis of their principle & characteristics. 7
   (c) Explain triac-diac circuit with the help of any one application. 6

3. (a) What is the necessity of inner current loop control circuit? 7
   (b) Write a short note on speed control of a.c. motors. 7
   (c) What is the principle of operation of bridge inverter? Classify them on the basis of applied input. 6

4. (a) What is an instrumentation amplifier? Explain it with block diagram & enlist its applications. 7
   (b) What are the advantages of active filter over passive filter. Draw a circuit diagram and characteristics of active low pass filter using op-amp. 7
   (c) Explain working of monostable mode of operation of IC555 timer. 6

5. (a) Draw and explain functional diagram of MSP430 microcontroller. 7
   (b) What is a servomotor? What are the requirements of a good servomotor? 7
   (c) What are functions of encoder & decoder circuits? 6

6. (a) Select motors for medium power pump & conveyor applications. 7
   (b) Explain with an application significance of multiplexer and demultiplxer circuit. 7
   (c) What are similarities & dissimilarities of microprocessor & microcontroller? 6

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GN-Con: 12084-14.

(3 Hours) [Total Marks: 80]

N.B: (1) Question No. 1 is compulsory.
    (2) Attempt any three questions from remaining five questions.
    (3) Figures to the right indicate full marks
    (4) Illustrate the answer with neat sketches wherever required.
    (5) Answers to questions should be grouped & written together.

1. Write short note on **any four** of the following: (20)
    a) Burgers vector
    b) Creep Resistant Materials
    c) Importance of Iron as engineering material
    d) Maraging heat treatment process
    e) Classification of alloying elements
    f) Composite materials

2. (a) Draw and explain Isomorphous and Eutectoid Phase diagrams. (8)
    (b) Explain the process of dislocation generation by Frank Read source. (6)
    (c) Explain Andrade's analysis of the classical creep curve. (6)

3. (a) What is Surface hardening? Name its different methods. Discuss any one method in (8)
        detail.
    (b) Draw a neat and labelled microstructure of White Cast Iron, Grey Cast Iron and (6)
        Nodular Cast Iron.
    (c) What is Critical Resolved Shear Stress? Derive the expression for Critical Resolved (6)
        Shear Stress for deformation by slip.

4. (a) Explain the stages of recrystallization annealing and factors affecting it. (8)
    (b) Discuss the Subzero heat treatment of Steel. (6)
    (c) What are the limitations of Plain Carbon Steel? Explain the effect of alloying (6)
        elements on phase transformation.

5. (a) State Griffith's theory of brittle fracture and derive Griffith's equation. (8)
    (b) Discuss the Full Annealing heat treatment of Steel. (6)
    (c) Give classification on stainless steel. (6)

6. (a) Draw neat Iron- Iron Carbide Equilibrium diagram indicating all important (8)
        temperature, phases and composition.
    (b) Explain fatigue limit for ferrous and nonferrous alloys with the help of S-N diagram. (6)
    (c) What are Nano Materials? Write a note on Nano Composites. (6)

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[3 Hours]   [Total Marks: 80

N.B. (1) Question no. **1** is **compulsory**.
      (2) Attempt any **three** of the remaining.
      (3) Use of statistical table is allowed.

1.   (a) Using Green's theorem evaluate.   5

           $\int_c (xy+y^2)dx +x^2dy$ where c is the closed curve of the region bounded

           by y=x and y= x²·

      (b) Use Cayley-Hamilton theorem to find A⁵- 4A⁴ -7A³+11A²-A-10 I in terms   5

           of A where A= $\begin{bmatrix} 1 & 4 \\ 2 & 3 \end{bmatrix}$

      (c) A continuous random variable has probability density function   5
           f(x)= 6(x-x²) 0≤x≤1 Find mean and variance.

      (d) A random sample of 900 items is found to have a mean of 65.3cms. Can   5
           it be regarded as a sample from a large population whose mean is 66.2cms.
           and standard deviation is 5 cms at 5% level of significance.

2.   (a) Calculate the value of rank correlation coefficient from the following data   6
           regarding marks of 6 students in statistics and accountancy in a test

Marks in Statistics:	40	42	45	35	36	39
Marks in Accountancy:	46	43	44	39	40	43

      (b) If 10% of bolts produced by a machine are detective. Find the probability   6
           that out of 5 bolts selected at random atmost one will be defective.

      (c) Show that the matrix A= $\begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$ 8

           is diagonalisable. Find the transforming matrix and the diagonal matrix.

3.   (a) In a laboratory experiment two samples gave the following results.   6

Sample	size	mean	sum of squares of deviations from the mean
1	10	15	90
2	13	14	108

      Test the equality of sample variances at 5% level of significance.

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3. (b) Find the relative maximum or minimum of the function.   6
$z = x_1^2 + x_2^2 + x_3^2 - 6x_1 - 10x_2 - 14x_3 + 103$

    (c) Prove that $\bar{F} = (y^2\cos x + z^3)i + (2y\sin x - 4)j + (3xz^2 + 2)k$ is a conservative field.   8
Find the scalar potential for $\bar{F}$ and the workdone in moving an object in

this field from $(0, 1, -1)$ to $(\frac{\pi}{2}, -1, 2)$

4. (a) The weights of 4000 students are found to be normally distributed with   6
mean 50kgs. and standard deviation 5kgs. Find the probability that a student
selected at random will have weight (i) less than 45 kgs.
         (ii) between 45 and 60 kgs.

    (b) Use Gauss's Devergence theorem to evaluate   6

$\iint \bar{N} \cdot \bar{F} \, ds$ where $\bar{F} = 4x\hat{i} + 3y\hat{j} - 2z\hat{k}$ and s is the surface bounded by

$x = 0, \ y = 0, \ z = 0$ and $2x + 2y + z = 4$

    (c) Based on the following data, can you say that there is no relation between   8
smoking and literacy.

	smokers	nonsmokers
Literates	83	57
Illiterates	45	68

5. (a) A random variable X follows a Poisson distribution with variance 3 calculate   6
$p(X=2)$ and $p(X \geq 4)$

    (b) Use Stoke'stheorem to evaluate $\int_c \bar{F} \cdot d\bar{r}$ where $\bar{F} = x^2 i + xyj$ and c is the   6

boundary of the rectangle $x=0, \ y=0, \ x=a, \ y=b$

    (c) Find the equations of the two lines of regression and hences find correlation   8
coefficient from the following data.

x	65	66	67	67	68	69	70	72
y	67	68	65	68	72	72	69	71

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6.   (a)   Two independent samples of sizes 8 and 7 gave the following results.   6

Sample 1:   19   17 15 21 16 18 16 14
Sample 2:   15   14 15 19 15 18 16

Is the difference between sample means significant.

6.   (b)   If $A = \begin{bmatrix} 2 & 3 \\ -3 & -4 \end{bmatrix}$ find A^{50} 6

     (c)   Use the Kuhn-Tucker Conditions to solve the following N.L.P.P   8
          Maximise $z = 2x_1^2 - 7x_2^2 + 12x_1x_2$
          Subject to $2x_1 + 5x_2 \leq 98$
                 $x_1, x_2 \geq 0$

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QP Code : 12500

(3 Hours)   [Total Marks : 80]

N.B. : (1) Questions No. **1** is **compulsory**.
(2) Attempt any **three** questions out of remaining **five** questions.
(3) Assume **suitable** data if **necessary**.
(4) Illustrate your answer with **neat sketches** wherever **necessary**.

1. Attempt any **four** :–   20
   (a) Show that in metal cutting operation, $V_v = V \cdot \gamma_c$.
   (b) Describe Ratial drilling machine with neat sketch.
   (c) Explain orthogonal rake system.
   (d) Describe internal grinding machine with neat sketch.
   (e) Discuss cutting fluids.

2. (a) Write a part programme using G-code and M code for machining external   10
   contour and drilling hole, at the centre as shown in figgur. All dimensions
   are in mm.
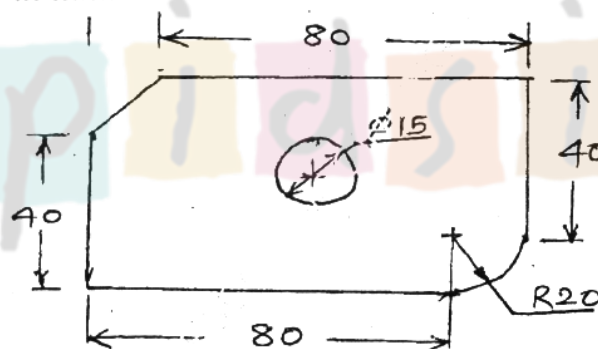
   (b) Derive the relationship $2\phi + \beta \quad \gamma = \dfrac{\pi}{2}$ in merchant's theory, clearly stating   10
   the assumptions.

3. (a) Explain the various steps involved in designing circular pull type broach.   10
   Draw approprate sketches.
   (b) Derive expression for tool life for minimum cost criteria in metal cutting.   10

4. (a) Describe carbides and ceramics as cutting tools.   10
   (b) Draw two dimensional tool dynamometer and explain it features.   5
   (c) List gear manufacturing methods explain any one in detail with neat sketch. 5

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5. (a) Explain with an example, graphical method of designing form tool.   10
    (b) A workpiece of 38 mm diameter is being turned on a lathe with a tool having   10
         rake angle of 33° and a feed of 0·15 mm/rev. The length of chip over one
         revolution of workpiece is 72 mm. The cutting speed is 12·5 m/min the
         tangential force is 410 N and feed force is 170 N
         Calculate :–
                (i)   Coefficient of friction on a rake face
               (ii)   Thickness of chip
              (iii)   Velocity of shear
               (iv)   Velocity of chip along the tool face.

6. Write short notes on (any **four**) :–   20
        (a) Lapping and honing
        (b) Dressing and truing of grinding wheel
        (c) Co-ordinate measuring machine
        (d) Nomenclature of drilling tool
        (e) Geometry of Milling cutter.

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(3 Hours) [Total Marks : 80

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

1. Attempt any **four** of the following :—   20
 (a) What are the different types of kinematic pair ?
 (b) Classify cams in details.
 (c) State and explain D' Alemberts Principle.
 (d) What do you mean by interference in involute gears ?
 (e) Explain the terms slip and creep in belts.

2. (a) Sketch a polar velocity diagram of a Hooke's Joint and mark it's salient features.   8
 (b) A cam rotating at 150 rpm operates a reciprocating roller follower of radius 2·5 cm.   12
 The least radius of the cam is 5 cm and the stroke of the follower is 5 cm. Ascent
 and descent both takes place by uniform acceleration and retardation. Ascent takes
 place during 75° and descent during 90° of cam rotation. Dwell between ascent and
 descent is 60°. Sketch displacement, velocity and acceleration diagrams and mark
 salient features.

3. (a) What is a Pantograph? Show that it can produce paths exactly similar to the ones   8
 traced out by a point on a link on an enlarged or reduced scale.
 (b) In a mechanism shown in the figure, the crank OA is 100 mm long and rotates   12
 clockwise about O at 120 rpm. The connecting rod AB is 400 mm long. At a point C
 on AB, 150 mm from A, the rod CE 350 mm long is attached. This rod CE slides in
 a slot in a trunnion at D. The end E is connected by a link EF, 300 mm long to the
 horizontally moving slider F. For the mechanism in the position shown, find (i) velocity
 of F, (ii) velocity of sliding of CE in the trunnion and (iii) angular velocity of CE.
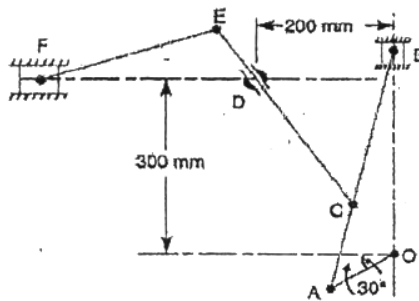
4. (a) With the help of neat sketch derive the equation for the minimum number of teeth on   8
        a pinion for involute rack in order to avoid interference.
    (b) Classify chains in details.   6
    (c) The power is transmitted from a pulley 1 m diameter running at 200 rpm to a pulley   6
        2·25 m diameter by means of a belt. Find the speed lost by the driven pulley as a
        result of creep, if the stress on the tight and slack side of the belt is 1·4 MPa and 0·5
        MPa respectively. The Young's Modulus for the material of the belt is 100 MPa.

5. (a) In a crank and slotted lever quick return motion mechanism, the distance between   8
        the fixed centres is 240 mm and the length of the driving crank is 120 mm. Find the
        inclination of the slotted bar with the vertical in the extreme position and the time
        ratio of cutting stroke to the return stroke. If the length of the slotted bar is 450 mm,
        find the length of the stroke if the line of stroke passes through the extreme positions
        of the free end of the lever.
    (b) What do you mean by Coriolis component of acceleration ? Draw all the direction of   6
        Coriolis component of acceleration.
    (c) State and explain Work Energy principle with the help of an example.   6

6. (a) Two mating gears have 20 and 40 involute teeth of module 10 mm and 20° pressure   8
        angle. If addendum on each wheel is such that path of contact is maximum and
        interference is just avoided, find the path of contact, arc of contact and contact ratio.
        Also find the addendum for each wheel.
    (b) Two pulleys, one 450 mm diameter and the other 200 mm diameter are on parallel   8
        shafts 1·95 m apart and are connected by cross belt. Find the length of the belt
        required and the angle of contact between the belt and each pulley. What power
        can be transmitted by the belt when the larger pulley rotates at 200 rpm, if the
        maximum permissible tension in the belt is 1×10^3 N and the coefficient of friction
        between the belt and the pulley is 0·25 ?
    (c) Differentiate between involute and cycloidal gear tooth profile.   4

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