(3 Hours) **Total Marks: 80**

Note:

1. **Question No. 1 is compulsory**.
2. Attempt any **THREE** out of the remaining **FIVE** questions.
3. Assume suitable data if necessary.
4. **Use of Statistical tables are allowed.**

Q. 1. Write short notes on **any FOUR** questions. **(20)**

(a) Explain uniform distribution with example

(b) Explain Karl Pearson's coefficient and Rank correlation coefficient

(c) Describe cluster sampling with example

(d) Explain types of sampling

(e) Explain level of significance and confidence level in statistical hypothesis

Q. 2. (a) The average marks scored by 32 boys is 72 with standard deviation of 8. While that of 36 girls is 70 with standard deviation of 6 test at 1% LOS. whether boys performed better than girls. **(10)**

(b) The following table gives the yields on 15 samples fields under three varieties of seed A, B, C. **(10)**

A	B	C
20	18	25
21	20	28
23	17	22
16	25	28
20	15	32

Q. 3. (a) If discrete random variable has values **(10)**

X	0	1	2	3	4	5	6
P (X = x)	M	3M	5M	7M	9M	11M	13M

Find

i. M
ii. Mean
iii. variance
iv. standard deviation
v. P (X ≤ 5)

(b) Obtained the rank correlation coefficient from the following data by using Karl Pearson's coefficient of correlation. **(10)**

X	10	12	18	15	40
Y	12	18	25	50	25

Q. 4. (a) In a factory turning out blades in mass production, it was found that in a packet of 100 blades on an average 16 blades are defective. Find the standard deviation of the defective blades. Can the distribution of defective blades be approximated to a normal distribution? If so, write it's equation. **(10)**

(b) Explain probability sampling with example **(10)**

Q. 5. (a) Fit a second-degree parabolic curve to the following data. **(10)**

X	1	2	3	4	5	6	7	8	9
Y	2	6	7	8	10	11	11	10	9

(b) The following table gives no of breakdown in a factory in various days of week. Using Chi-square test check whether breakdown are uniformly distributed or not. **(10)**

Days	Mon	Tue	Wed	Thu	Fri	Sat	Sun
No of Breakdown	14	22	16	18	12	19	11

Q. 6. (a) Explain steps in Two-way ANOVA with example **(10)**

(b) Fit a straight line from following data. **(10)**

X	0	1	2	3	4	5
Y	1	2	3	4.5	6	7.5

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[Time: 03 Hours] **[Total marks: 80]**

N.B.

1) Question No.1 is compulsory
2) attempt any three out of remaining questions
3) Draw neat sketches to illustrate your answers
4) Figures to the right indicate full marks.
5) Use of **Standard Data Book** is permitted

Q1 Answer any **four** of the following **20**

a) What is the necessity of theories of failure? List different theories of failure

b) Explain overhauling and self-locking of screw.

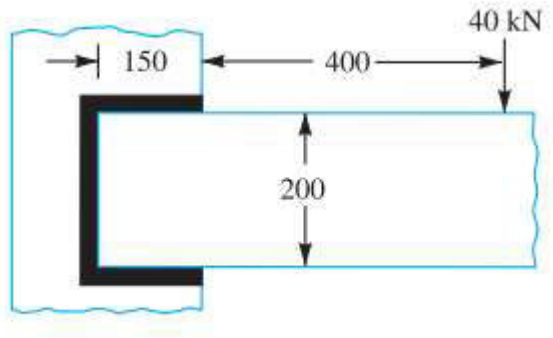
c) Explain the following terms in connection with design of machine members subjected to variable loads: (a) Endurance limit, (b) Size factor, (c) Surface finish factor, and (d) Notch sensitivity. N

d) Explain the nipping of the leaf spring with neat sketch

e) Explain aesthetic consideration in design with suitable examples

Q2 a) Design and draw a cotter joint to support a load, varying from 30 kN in compression to 30 kN in tension. The material used is carbon steel for which the following allowable stresses may be used. The load is applied statically. Tensile stress = compressive stress = 50 MPa ; shear stress = 35 MPa and crushing stress = 90 MPa. **12**

b) A bracket, as shown in Fig, carries a load of 40 kN. Calculate the size of weld, if the allowable shear stress is not to exceed 80 MPa. **08**



All dimensions in mm.

Q3 a) Design screw, nut, and handle of screw jack to lift a load of **90kN** through a height of 400mm. select suitable material and factor of safety to design screw jack. **12**

b) Design a helical valve spring for an operating load range of **600N to 1200N**. The compression at the maximum load is **30mm**. Take the spring index **6** and permissible endurance shear stress for spring material as **480Mpa** and yield stress in shear is **960Mpa** and G = **80kN/mm^2** **08**

Q4 a) Design a cast iron protective type flange coupling to transmit 15 kW at 900 r.p.m. from an electric motor to a compressor. The service factor may be assumed as 1.35. The following permissible stresses may be used : Shear stress for shaft, bolt and key material = 40 MPa Crushing stress for bolt and key = 80 MPa Shear stress for cast iron = 8 MPa Draw a neat sketch of the coupling. **14**

b) Enumerate the various manufacturing methods of machine parts which a designer should know. N **06**

Q5 a) A horizontal nickel steel shaft rests on two bearings, A at the left and B at the right end and carries two gears C and D located at distances of **250mm** and **400mm** respectively from the centre line of the left and right bearings. The pitch diameter of the gear C is **600mm** and that of gear D is **200mm**. The distance between the centre line of the bearings **14**

is **2400mm**. The shaft transmits **20kW** at **120r.p.m**. The power is delivered to the shaft at gear C and is taken out at gear D in such a manner that the tooth pressure F_{tC} of the gear C and F_{tD} of the gear D act vertically downwards. Find the diameter of the shaft, if the working stress is **100MPa** in tension and **56MPa** in shear. The gears C and D weigh **950**N and **350N** respectively. The combined shock and fatigue factors for bending and torsion may be taken as **1.5** and **1.2** respectively.

b) What is preferred number? Explain use of preferred number in engineering design? **06**

Q6 Design a pair of helical gears for transmitting **22 kW**. The speed of the driver gear is **1800** **15**

a) **r.p.m**. and that of driven gear is **600 r.p.m**. The helix angle is **30°** and profile is corresponding to **20°** full depth system. The driver gear has 24 teeth. Both the gears are made of cast steel with allowable static stress as **50MPa**. Assume the face width parallel to axis as 4 times the circular pitch and the overhang for each gear as **150 mm**. The allowable shear stress for the shaft material may be taken as **50 MPa**. The form factor may be taken as **$0.154–0.912/T_E$**, where **T_E** is the equivalent number of teeth. The velocity factor may be taken as, **350/(350+v)** where **v** is pitch line velocity in **m/min**. The gears are required to be designed only against bending failure of the teeth under dynamic condition.

b) Compare the weight, strength and stiffness of a hollow shaft of the same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have the same material and length **05**

Time: 3 Hours **Total Marks: 80**

N.B: 1) Question No. 1 is *compulsory*.

2) Attempt any *THREE* questions out of remaining *FIVE* questions.

3) Assume suitable data wherever necessary.

4) Use of Graph paper is allowed.

5) Figures to the right indicate full marks.

1. Answer the following questions (*any Four*). **20**

i) What is Metrology? Explain different types of standards.

ii) With respect to surface roughness parameters explain the following terms:
i) Ra; ii) Ry; iii) Rz

iii) Define:
i) Sensitivity
ii) Precision
iii) Threshold

iv) Explain the working of LVDT with a neat sketch.

v) Distinguish between open loop and closed loop control systems.

vi) Using Routh's criterion examine the stability of a control system whose characteristic equation is $\mathbf{4S^5 + 2S^4 + 4S^3 + 8S^2 + 2S + 10 = 0}$

2. (A) Explain with a neat sketch the N.P. L. flatness interferometer. **10**

(B) Design a general type of Go and No Go plug gauge for inspecting a hole 25 D8. Given that: **10**

$\mathbf{i = 0.40\sqrt[3]{D} + 0.001D}$ micron

Tolerance for hole = **25 i**

Fundamental deviation of the hole= $\mathbf{16\ D^{0.44}}$

Wear allowance 10% of gauge design

3. (A) Explain the term clearance fit with respect to limit fit diagram **05**

(B) Derive necessary expression to calculate the best wire diameter. **05**

(C) Draw the Root-Locus of the system having **10**

$$G(s)H(s) = \frac{K}{S(S+1)(S+4)}$$

4. (A) Define gauge factor of strain gauges. Derive an expression for gauge factor. **05**

(B) Briefly, discuss drift. **05**

(C) A system has transfer function given by **10**

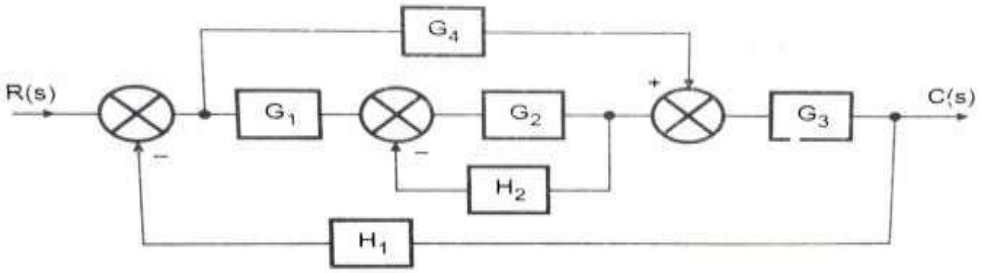
$$G(s)H(s) = \frac{100\,(s+2)}{s(s+1)(s+4)}$$

Determine:

i) Type of system
ii) Error constants K_p, K_v and K_a
iii) Steady state error for input magnitude 2

5. (A) Explain generalized measurement system elements with block diagram. Describe its function with suitable examples. **10**

(B) Reduce the given block diagram to a its canonical form and hence obtain equivalent transfer function, $\frac{C(s)}{R(s)}$. **10**



6. Write short note on ***(any Four)*** **20**

i) Mc-Leod Gauge
ii) RTD
iii) Magnetic Flow Meter
iv) Frequency Domain Specifications
v) Parkinson's Gear Tester
vi) Range and Span

Duration: 3 Hours **Total Marks: 80**

Instructions :

[1] Question No.**1 is compulsory**.
[2] Answer **any three** from the remaining five questions.
[3] Assume suitable data whenever required with proper justification.
[4] Answers to questions should be grouped and written together.
[5] Figures to the right indicate full marks.

Q.1 **Attempt any four of the following. All sub-questions carry equal marks** **20**

(a) Why is the actual cycle efficiency much lower than the air standard cycle efficiency?

(b) Justify the statement: SI engine is called quantity governed engine and CI engine is called quality governed engine.

(c) Give a brief account of Exhaust Oxygen sensor

(d) Give reasons of black, blue and white colored smoke from exhaust of diesel engines..

(e) Explain why turbocharged engines may have inferior values of power output and fuel consumption than naturally aspirated engines especially at low speed.

(f) Write short note on : Control of NOx emissions

Q.2 **(a)** Differentiate between Two stroke & four stroke Engine **05**

(b) In a test of a single cylinder 4 stroke diesel engine with bore 400 mm and stroke 450 mm, the following observations were made: **15**

Duration of test = 1 hr
Fuel Consumption = 7.5 kg
Indicated mean effective press = 3.75 bar
Calorific value of fuel = 44500 KJ/Kg
Total Air consumption = 361 kg
Total Revolutions = 12000
Net brake load = 1500 N
Brake drum diameter = 180 cm
Rope diameter = 3 cm
Quantity of cooling water used = 600 kg
Temperature rise = 42^0 C
Exhaust gas temperature = 300^0 C
Room Temperature = 20^0 C
Cp for exhaust gases = 1.01 KJ/KgK

Calculate:
1) Mechanical Efficiency 2) Indicated and Brake thermal Efficiency 3) Draw heat balance sheet on minute basis.

Q.3 **(a)** Explain the types of combustion chambers used in SI engines and compare them. Why is the maximum diameter of SI engine combustion chambers limited ? **10**

(b) Describe the phenomenon of combustion in CI engines and in detail the various stages in it. **10**

Q.4 **(a)** What are the objectives of supercharging? What are the limitations of supercharging? Explain the term charge coding and how it is achieved in a turbocharged engine? **10**

(b) Explain with neat sketches the working of battery ignition and magneto ignition and compare their advantages? **10**

Q.5 **(a)** Write short note on : **10**
i) Thermosyphon cooling system
ii) Mist lubrication system

(b) The following readings were taken during the test of a single cylinder four stroke oil engine: Cylinder diameter = 250 mm, Stroke length = 400 mm, Gross m.e.p. = 7 bar, Pumping m.e.p. = 0.5 bar, Engine speed = 250 r.p.m., Net load on the brake = 1080 N, Effective diameter of the brake = 1.5 m;Fuel used per hour = 10 kg, Calorific value of fuel = 44300 kJ/kg, **10**
Calculate: (i) Indicated power
(ii) Brake power
(iii) Mechanical efficiency
(iv) Indicated thermal efficiency

Q.6 Write Short notes on **(Any Four)** **20**

(a) Hydrogen as an alternative fuel for I C Engine
(b) Miller Cycle
(c) Exhaust gas recirculation
(d) Types of diesel fuel Injector
(e) ECM

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Time : 3 Hrs **Marks : 80**

- ***Question No.1 is compulsory.***
- *Solve **ANY THREE** questions from the **remaining five questions.***
- *The figure to the right indicates full marks.*
- *Assume suitable data wherever required.*

Q. 1 Solve **ANY FOUR** questions from following. **Marks 20**

i) Explain iso-parametric, sub-parametric and super-parametric element.

ii) Explain shape function and enlist the properties of shape functions.

iii) Explain h-method and p-method of FEM.

iv) Explain Jacobian matrix. And describe the significance of Jacobian Matrix in co-ordinate transformation.

v) Explain plane stress and plane strain conditions applied to elasticity problems.

vi) Explain the sources of error in FEM.

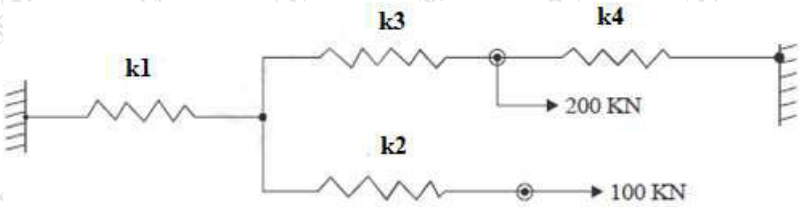
Q. 2 a) Solve following differential equation using galerkin method **10**

$$3\frac{d^2y}{dx^2} - \frac{dy}{dx} + 8 = 0 \; ; \; 0 \le x \le 1$$

Boundary Conditions: y(0) = 1, y(1) = 2, find y(0.3)

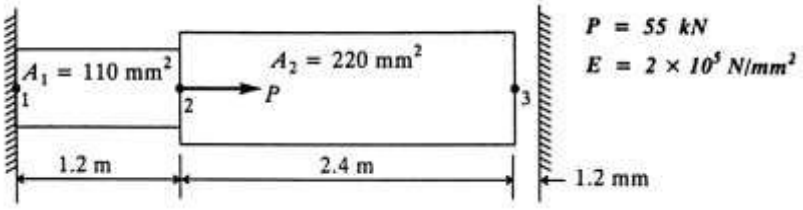
b) Using the concept of serendipity, derive the shape functions for four node rectangular element in natural co-ordinate system (ξ and η). **10**

Q. 3 a) Determine the displacement at nodes by using principle of minimum potential energy approach **10**



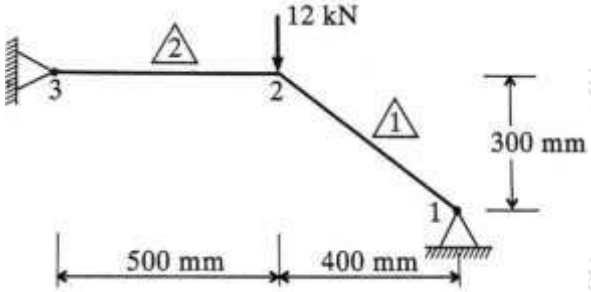
Where, k1=100 N/mm ; k2=300 N/mm ; k3=150N/mm ; k4=200 N/mm

b) Determine the unknown reactions, displacement and element stresses for the stepped bar shown in the figure below. **10**



Q. 4 a) Find the natural frequency of axial vibrations of a bar of uniform cross section of 30 mm^2 and length of 1 meter using consistent mass matrix. Take E = 200 GPa and density = 8000 kg/m^3. Take two linear elements. **10**

b) Find nodal displacement, reaction forces and stresses in each element for a truss given below. Take E= $2x10^5$ N/mm^2 and A = 200 mm^2. **10**



Q. 5 **a)** Calculate linear interpolation functions for linear triangular element whose vertices are A(2, 5), B(1, -1) and C(3, 4). **08**

b) Consider the steady laminar flow of a viscous fluid through a long circular cylindrical tube. The governing equation is **12**

$$-\frac{1}{r}\frac{d}{dr}\left(r\mu\frac{dw}{dr}\right)=\frac{P_0-P_L}{L}\equiv f_0$$

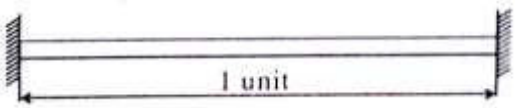
Where, w is axial (z-axis) component of velocity, μ is the viscosity, and f_0 is the gradient of pressure (includes static pressure and gravitational force). The boundary conditions are:

$$\left(r\frac{dw}{dr}\right)\Big|_{r=0}=0, \qquad w(R_0)=0$$

Using symmetry and two linear elements or one quadratic element, determine the velocity field and compare with exact solution at nodes:

$$w_e(r)=\frac{f_0R_0^2}{4\mu}\left[1-\left(\frac{r}{R_0}\right)^2\right]$$

Q. 6 **a)** Determine the two natural frequencies of transverse vibration of a beam fixed at both ends as shown in figure. Use both Lumped and Consistent mass matrices and comment on the results. Divide the whole domain into two elements of equal lengths. [Take EI = 10^6 units, ρA = 10^6 units] **10**



b) Derive the element matrix equation for a simple bar fixed at one end and loaded axially at the other end, as shown in figure. The cross-section area of the bar is A, and the modulus of elasticity is E. The governing differential equation is given by: **10**

$$\frac{d}{dx}\left[EA\frac{du}{dx}\right]=0\,; \qquad \text{for} \quad 0<x<l$$