(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 parametric and non-parametric test

(b) Explain Karl Pearson's correlation

(c) Describe any one type of sampling with example

(d) Explain level of significance and confidence level

(e) Explain type -I and type -II error

Q. 2. (a) If 3% of electronic units manufactured by a company are defective. Find the probability that in a sample of 200 units, less than 2 bulbs are defective. **(10)**

(b) To access the significance of possible variation in performance in a certain test between the convent school of a city, a common test was given to a few students taken at random from the senior fifth class of each of the four schools concerned. The results are given below, make an analysis of variance of data **(10)**

A	B	C	D
8	12	18	13
10	11	12	9
12	9	16	12
8	14	6	16
7	4	8	15

Q. 3. (a) Find from the following values of the demand and the corresponding price of a commodity, the degree of correlation between the demand and price by computing Karl Pearson's coefficient of correlation **(10)**

Demand in quintals	65	66	67	67	68	69	70	72
Price in paise per kg	67	68	65	68	72	72	69	71

(b) Fit a second-degree parabolic curve to the following data & estimate the production in 1982. **(10)**

X (Year):	1974	1975	1976	1977	1978	1979	1980	1981
Y (Production):	12	14	26	42	40	50	52	53

Q. 4. (a) 60% of people who purchase sports cars are men. Find the probability that exactly 7 are men if 10 sports car owners are randomly selected. **(10)**

(b) Explain different types of sampling with example **(10)**

Q. 5. (a) Fit a straight line to the following data **(10)**

X :	5	4	3	2	1
Y :	1	2	3	4	5

(b) The following table give the number of breakdowns in a factory in various days of a week. Using Chi- Square Test check whether breakdown is uniformly distributed or not **(10)**

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

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

(b) If discrete random variable has values **(10)**

X	1	2	3	4	5	6	7
P (X = x)	Q	2Q	3Q	Q^2	$Q^2 + Q$	$2Q^2$	$4Q^2$

Find

i. Q
ii. Mean
iii. Variance
iv. $P(X \leq 6)$
v. $P(X \geq 3 / X \leq 5)$

Time: 3 Hours **Max. Marks: 80**

Instructions:

- Question No. 1 is compulsory.
- Answer any three from the remaining five questions.
- Assume suitable data whenever required with proper justification.
- Figures to the right indicate full marks

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

(a) Compare the Abnormal Combustion in SI and CI Engine

(b) List the types of combustion chamber for SI Engine and Illustrate any one

(c) What do you mean by actual cycle efficiency and air standard efficiency? Explain is significance in brief.

(d) A rope brake was used to measure the brake power of a single cylinder, four stroke cycle petrol engine. It was found that the torque due to brake load is 175 N-m and the engine makes 500 r. p.m. Determine the brake power developed by the engine.

(e) Explain different cooling systems associated with CI Engine.

Q.2 (a) Describe with neat sketch the working principle of two stroke and four stroke engine. **08**

(b) A trial carried out in a four stroke single cylinder gas engine gave the following results. Cylinder dia=300 mm, Engine stroke=500 mm, Clearance volume=6750cc, Explosions per minute=100 P_{max} KN/m^2 = 765 Net work load on the brake=190kg Brake dia=1.5m Rope dia=2 5mm, Speed of the engine=240rpm, Gas used=30 m^3/kghr , Calorific value of gas=2 0515 KJ/ m^3. Determine compression ratio, mechanical efficiency, indicated thermal efficiency, air standard efficiency, relative efficiency, assume r=1.4 **12**

GIVEN DATA:-

(i) Dia of cylinder (d)=300mm=0.3m

(ii) Engine stroke (l)=500mm=0.5m

(iii) Clearance volume (vc)=6750/1003=6.75m3

(iv) Explosions per minute (n)=100/minute=1.67/sec

(v) P_{min}=765 KN /m2

(vi) Brake drum dia (D1)=1.5m

(vii) Rope dia (d1)= 0.025m

Work load on the brake (w)=190kg=1.86KN

Q.3 (a) Explain injection systems used in CI Engine with its significance **10**

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

Q.4 (a) Justify the requirement of air motion and swirl in a C.I. Engine combustion chamber is much more stringent than in a S.I. Engine **08**

(b) During a trial of a single cylinder oil engine working on dual cycle, the following observations were made: **12**

Compression ratio = 15, Oil consumption 10.2 kg/h, Calorific value of fuel= 43890 kJ/kg, Air consumption = 3.8 kg/min, Speed = 1900 r.p.m. Torque on the brake drum = 186 N-m, Quantity of cooling water used = 15.5 kg/min, Temperature rise of cooling water = 36°C, Exhaust gas temperature = 410°C, Room temperature = 20°C, C_P for exhaust gases 1.17 kJ/kg K

Calculate: (i) Brake power,

(ii) Brake specific fuel consumption, and

(iii) Brake thermal efficiency.

(iv) Also draw heat balance sheet on minute basis.

Q.5 (a) Describe the Engine Pollution, list the methods to control the pollution and state the BHARAT norms. **10**

(b) What are the essential properties of lubricant? Explain with neat sketch Mist lubrication system. **10**

Q.6 **Write shorts note on (Any Four)** **20**

(a) Bio diesel as an alternative fuels

(b) Exhaust gas recirculation

(c) Port Timing diagram for two stroke engine

(d) Diesel Knock and its control

(e) Electronic Control Module

(3 Hours) **Total marks 80**

- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining** five questions.
- Figure to the right indicates full marks.
- Assume suitable data wherever required, but justify the same.

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

a) Distinguish between h and p methods of mesh refinement with necessary illustrations. **5**

b) Distinguish between plane stress and plane strain conditions. **5**

c) Describe the significance of principle of minimum potential energy. **5**

d) Explain convergence criteria in FEM. **5**

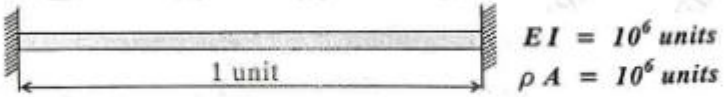
e) Explain lumped mass matrix, consistent mass matrix and HRZ lumping scheme with suitable examples. **5**

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

$$\frac{d^2u}{dx^2} - 9\,u = x^3 \quad ; \qquad 0 \le x \le 1$$

Given boundary conditions are: $u(0) = 0$ and $u(1) = 2$. Determine u (0.5).

b) Determine the two natural frequencies of transverse vibrations of a beam fixed at both ends a shown in fig. Use Consistent Mass Matrix. Take EI = 10^6 units and ρA = 10^6 units. **10**

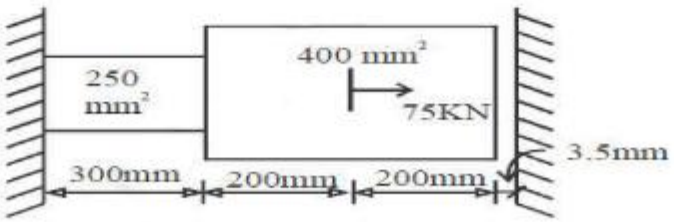


Q. 3 **a)** Solve the following differential equation by Rayleigh Ritz method. **10**

$$\frac{d^2y}{dx^2} - 10\,x^2 = 5 \quad ; \qquad 0 \le x \le 1$$

Given Boundary Conditions are: $y(0) = y(1) = 0$

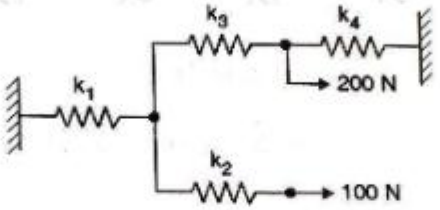
b) Determine the unknown reactions, displacement and element stresses for the stepped bar shown in the figure below (E = 200 GPa). **10**



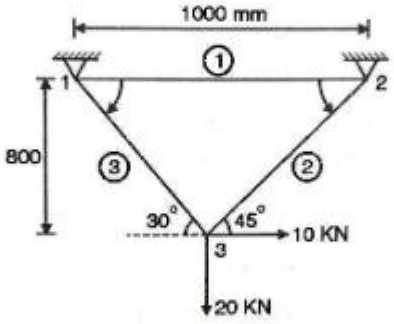
Q. 4 a) Find the natural frequency of axial vibrations of a bar of uniform cross section of 50 mm^2 and length of 1 meter using consistent mass matrix and compare with exact frequencies. Take E = 200 GPa and density = 7860 kg/m^3. Take two linear elements. **10**

b) The triangular element has nodal coordinates (10, 10), (40, 20) and (30, 50) for nodes 1, 2 and 3 respectively. For the point P located inside the triangle, determine x and y coordinates if the shape functions, $N_1 = 0.15$ and $N_2 = 0.25$. **10**

Q. 5 a) Determine the displacement at nodes by using principle of minimum potential energy approach **10**



b) Find nodal displacement, reaction forces and stresses in each element for a truss given below. Take E= 210 GPa and A = 100 mm^2. **10**



Q. 6 a) A steel fin of diameter 2 cm, length 10 cm and thermal conductivity 80 W/m-K is exposed to ambient air at 40^0C with a heat transfer coefficient of 100 W/m^2-K. One end of the fin is at a temperature of 540^0C and the other end is insulated. Governing DE is; **10**

$$\frac{d^2\theta}{dx^2} - m^2\theta = 0 \qquad \theta = T - T_\infty$$

Where $m^2 = \frac{hp}{KA}$ *and* $\Omega = 0 \le x \le L$

P = Perimeter, A = Cross section area

h = Heat transfer coefficient

K = Thermal conductivity, and T_∞ = Ambient temperature

Take three liner elements of equal lengths and solve to get temperatures at these intermediate points.

b) Explain the procedure of Rayleigh-Ritz method based on principle of stationary total potential. **10**

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Time: 3 Hours **Total Mark:80**

N.B. **(1)** All questions carry equal marks.
(2) Question **No. 1 is Compulsory**.
(3) Attempt **any three** questions from **remaining five** questions.
(4) Figures to the right indicate full marks.
(5) Draw neat sketches wherever necessary

Q.01. **Attempt any four out of six.** **20**

a) Explain Aesthetics consideration in design.

b) What is preferred number? How to use it, explain with example.

c) Give detailed classification of couplings.

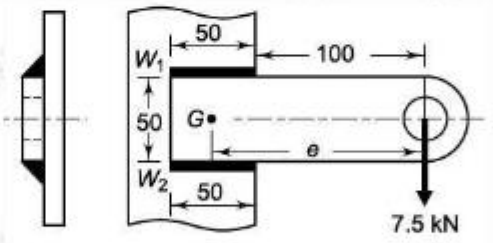
d) Discuss various types of threads used for power screw.

e) Explain fluctuating stress, repeated stress and reversed stress.

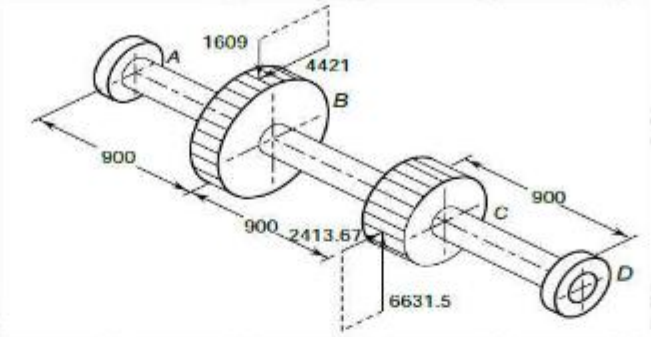
f) Explain nip of leaf spring.

Q.02. A) Design a cotter joint to connect two steel rods of equal diameter. Each rod is subjected to axial tensile load of 50 kN. Select suitable material. **12**

B) A welded connection shown in figure is subjected to an eccentric force of 7.5 kN. Determine the size of weld if permissible shear stress for the weld is 100 N/mm^2. Assume static condition. **08**



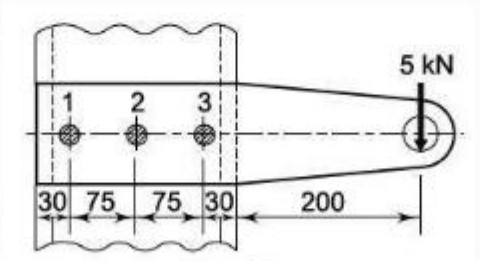
Q.03. A) The layout of an intermediate shaft of a gear box supporting two spur gears B and C is shown in Figure The shaft is mounted on two bearings A and D. The pitch circle diameters of gears B and C are 900 mm and 600 mm respectively. The material of the shaft is steel FeE 580 (Sut = 770 N/mm^2 and Syt = 580 N/mm^2). The factors k_b and k_t of ASME code are 1.5 and 2.0 respectively. Determine the shaft diameter using the ASME code. Assume that the gears are connected to the shaft by means of keys. **12**



B) A forged steel bar, 50 mm in diameter, is subjected to a reversed bending stress of 250 N/mm^2. The bar is made of steel 40C8 (Sut = 600 N/mm^2). Calculate the life of the bar for a reliability of 90%. **08**

Q.04. A) Design a rigid type of flange coupling to connect two shafts. The input shaft transmits 37.5 kW power at 180 rpm to the output shaft through the coupling. The service factor for the application is 1.5, i.e., the design torque is 1.5 times of the rated torque. Select suitable materials for various parts of the coupling. **12**

B) A steel plate subjected to a force of 5 kN and fixed to a channel by means of three identical bolts is shown in Figure. The bolts are made from plain carbon steel 45C8 (Syt = 380 N/mm^2) and the factor of safety is 3. Specify the size of bolts. **08**



Q.05. A) A helical spring is subjected to the load varying from 1000 N to 2000 N, having spring index of 5. The maximum compression under variation of load is 5 mm. Assuming stresses for spring material and G = 81370 N/mm^2 **12**

and Sut =1218 N/mm^2. The permissible shear stress is 50 % of Sut. Design the spring.

B) Explain the Estimation of module based on beam strength for spur gear. **08**

Q.06. A) A pair of parallel helical gears consists of a 20 teeth pinion meshing with a 40 teeth gear. The helix angle is 25° and the normal pressure angle is 20°. The normal module is 3 mm. Calculate **12**
(i) the transverse module;
(ii) the transverse pressure angle;
(iii) the axial pitch;
(iv) the pitch circle diameters of the pinion and the gear;
(v) the Centre distance; and
(vi) the addendum and dedendum circle diameters of the pinion.

B) Design a square key for fixing a gear on a shaft of 25 mm diameter. The shaft is transmitting 15 kW power at 720 rpm to the gear. The key is made of steel 50C4 (Syt = 460 N/mm^2) and the factor of safety is 3. For key material, the yield strength in compression can be assumed to be equal to the yield strength in tension. Determine the dimensions of the key. **08**

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) Differentiate between systematic errors and random errors.

ii) How can flatness be checked with the help of an optical interferometer?

iii) Define: Reproducibility, Hysteresis, Threshold, Range and Span of measuring instruments.

iv) Illustrate the working principle of nozzle flapper for displacement measurement.

v) Explain open loop and closed loop control systems.

vi) Using Routh's criterion examine the stability of a control system whose characteristic equation is $S^5 + 2S^4 + 3S^3 + 4S^2 + 5S + 6 = 0$

2. (A) Derive an expression for "Two-wire Method" for effective diameter measurement of a screw thread **10**

(B) Calculate the limits, tolerances and allowances on a 25 mm shaft and hole pair. Designated H7/g6 to get precision fit. The fundamental tolerances is calculated by following equations: **10**

$$i = 0.4533\,D + 0.001D \text{ micron}$$

The following data is given:

a) Upper deviation of shaft = $-2.5\,D^{0.4}$
b) 25 mm falls in the diameter step of 18 - 30 mm
c) IT7 = 16i
d) IT6 = 10i
e) Wear allowance = 10% gauge tolerance

3. (A) With neat sketch, explain the constructional features and working of **10**

i) LVDT
ii) Parkinson's Gear Tester

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

$$G(s)H(s) = \frac{K}{S(S+1)(S+3)(S+4)}$$

4. **(A)** Define desired input, modifying input and interfering input for measuring instruments with suitable examples. Also suggest the methods to minimize the effect of modifying and interfering input. **10**

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

$$\frac{C_{(s)}}{R_{(s)}} = \frac{\mathbf{100}}{\boldsymbol{s^2 + 15s + 100}}$$

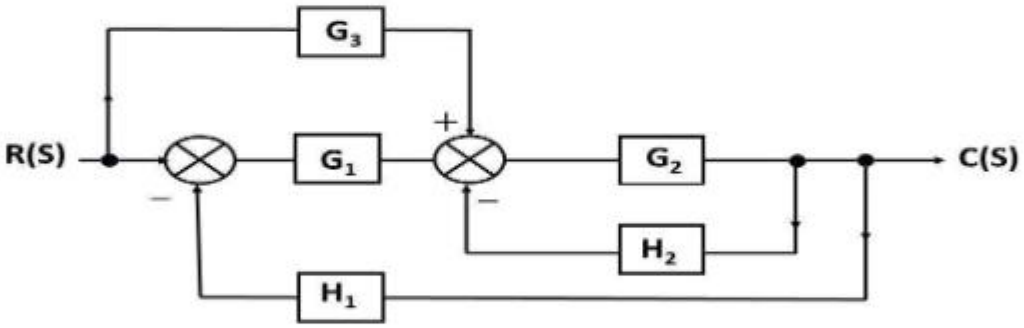
Determine, peak time, percent overshoot, settling time and rise time.

5. **(A)** With neat sketch, explain the constructional features and working of **10**

i) Ultrasonic Flow Meter

ii) Ionization Gauge

(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) Interference Fit

ii) Strain Gauge based load cell

iii) Frequency Domain Specifications

iv) Tomlinson Surface Tester

v) Static Calibration

vi) RTD
