(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 if required.

Q1 Solve any 4 **[Each 5 Marks]**

i) Explain with neat sketch the Finite Element methods.
ii) What is Boundary Condition? Explain its type in brief ?
iii) Derive the shape function for One Dimensional Linear Element in Natural Coordinates.
iv) What are the sources of Errors in FEA?
v) Explain in brief Jacobian Matrix in FEA.
vi)Write in brief about Consistent and Lumped mass matrix.

Q2 a) Solve the following differential equation using Galerkin Method. [12]

$$\frac{d^2u}{dx^2} + 5 = 0\,; \quad For\ 0 < x < 1$$

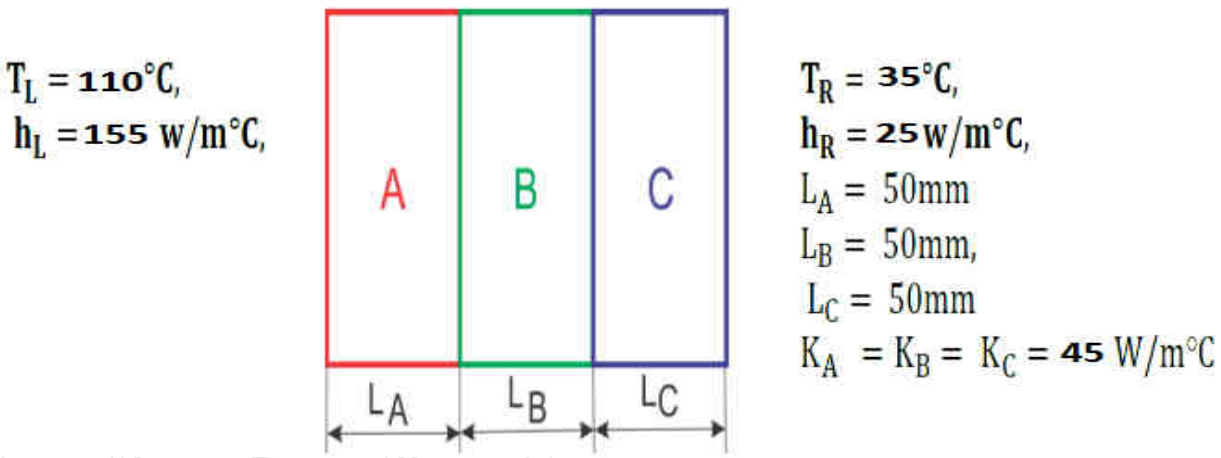
Boundary Conditions are $x = 0\ and\ u = 0$ and at $x = 1\,;\ \frac{du}{dx} + u = 0$

Find u (0.2) =?

b) What is Convergence in FEA? Explain its types in brief. [04]

c) Explain the Principle of minimum total potential with suitable example. [04]

Q3 a) Find the temperature at interfaces and heat transfer per unit area through the wall. [10]

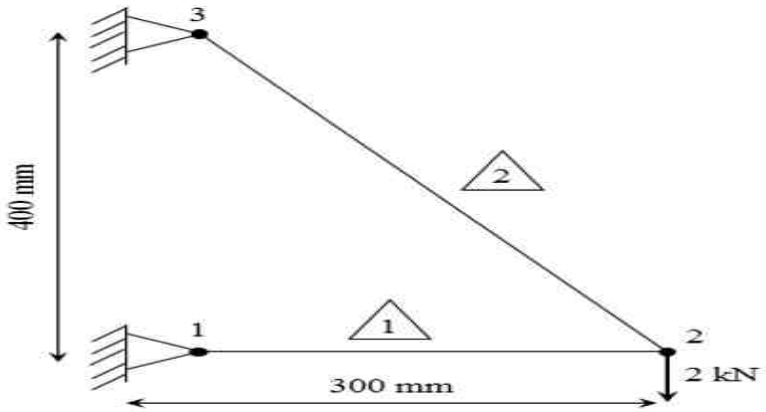


Where K- denotes thermal conductivity, h- denotes heat transfer coefficient and T-temperature.
Where f is the weight of the bar. Consider one end of the bar to be fixed and other end free.

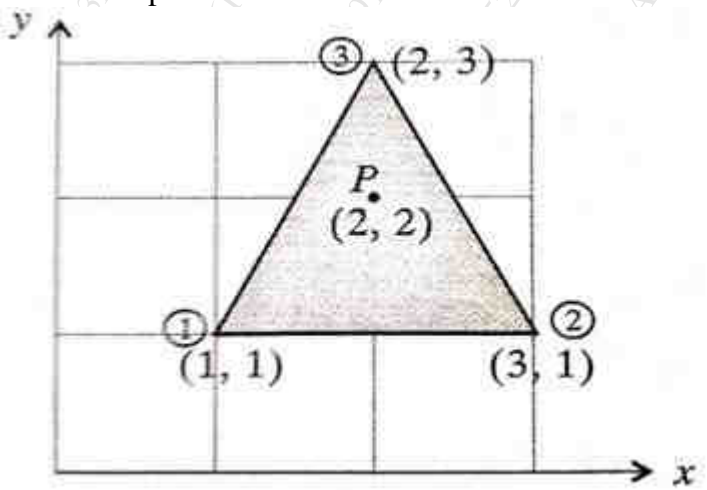
b) Develop the finite element equation for the most general element using Rayleigh Ritz Method for vertical bar with axial loading. The governing differential equation is given below [10]

$$\frac{d}{dx}\left(EA\frac{du}{dx}\right)+f=0 \quad ;0\le x\le L$$

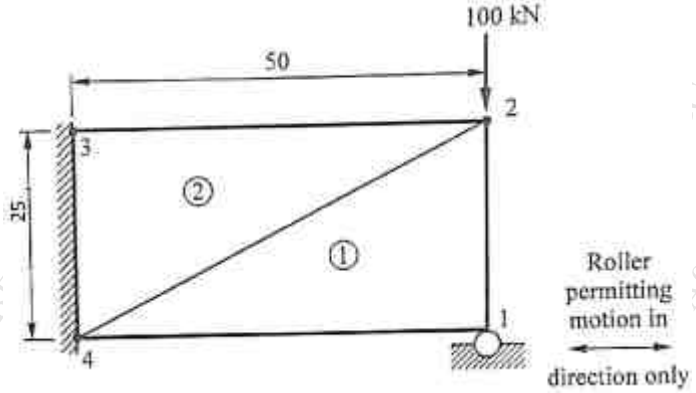
Q4 a) Analyze the truss for displacement Shown in fig [12]
Take E = 200 GPa and Area=100 mm^2



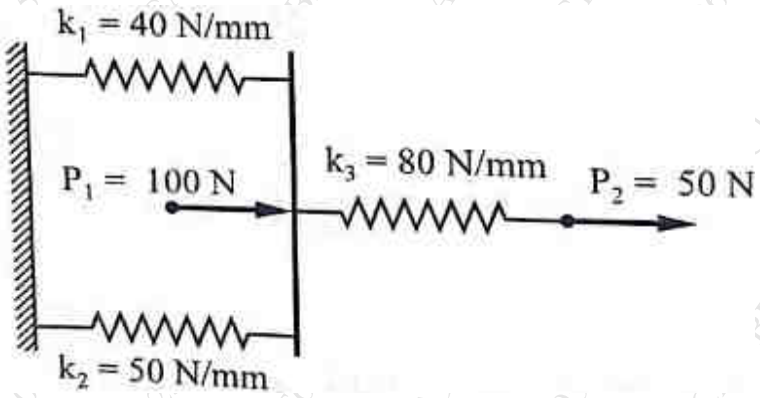
b) For the triangular element shown in figure below fig
$U_1 = 2, U_2 = 3, U_3 = 5,$
$V_1 = 1, V_2 = 2, V_3 = 3$
Where U, V are displacement is x and y at node 1, 2, 3 respectively.
Obtain the displacement of point P. [08]



Q5 a) For 2D loaded plat shown in below figure below. Determine the displacements of nodes 1 and 2 and the element stresses using the plane stress conditions. Assume thickness as 12 mm, E = 235 GPa and poisons ratio = 0.20, All Dim are in mm [12]



b) A three spring system with stiffness (k) and loads (p) are shown in figure. Calculate the displacement at nodal points. [08]



Q6 a) Find natural frequency of axial vibration of a bar of uniform cross section of 20 mm2 and length 1 m. Take E = 210 GPa and density = 8000 kg/m3. Assuming mass to be uniformly distributed across the element. [8]

b) A beam having cross sectional of radius 10 mm and length of 100 mm, with young's modulus 2.5×10^5 N/mm^2 and poison's ratio 0.3 is fixed at one end, and a transverse load of 100 N is applied at the other end. Calculate the displacement at various node points. [12]

[Time: 3 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) Explain the use of preferred numbers in engineering design.
b) What is cotter? Why taper is provided on the cotter.
c) Discuss various types of threads used for power screw.
d) Explain Notch sensitivity and Endurance limit related to design of machine elements subjected to variable loads.
e) List and explain the important factors that influence the magnitude of factor of safety

Q2 a) Design a knuckle joint to withstand a tensile load of **25kN,** if the permissible stresses are **56MPa** in tension, **40MPa** in shear and **70MPa** in compression. **15**

b) Explain the nipping of the leaf spring with neat sketch **05**

Q3 a) Design a cast iron protective type flange coupling to transmit **15kW** at **900rpm** from an electric motor to compressor. The service factor may be assumed as **1.35**, the permissible stresses are as follows: allowable shear stress for shaft, bolt and key materials **40MPa**; allowable crushing stress for bolt and key **80N/mm^2** and allowable shear stress for cast iron **8N/mm^2**. **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) 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 is **2400mm**. The shaft transmits **20kW** at **120 r.p.m**. The power isdelivered 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. **14**

b) Define stress concentration and discuss the various methods to reduce the effect of stress concentration. **06**

Q5 a) Determine the size of the circular bar using soderberg equation with **FoS=2.5**. if it is subjected to tensile force varying **300kN** to **550kN**. It is made of carbon steel 35C8 with σ_{yt}**=320N/mm^2** and σ_{ut}**=600N/mm^2**. **10**

b) A solid circular shaft of **30mm** diameter is welded to a vertical plate by fillet weld all around. It carries a vertical load **10kN** at a distance 100mm from the plane. Determine the size of the weld is permissible shear stress for the weld is **90N/mm^2**. **10**

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

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**

(3 Hours) **[Total Mark: 80]**

N.B. (1) Question No. 1 is compulsory
(2) Attempt any **Three** Question from Q. No. 2 to Q. No.6
(3) Make suitable assumption if required
(4) Illustrate answers with sketches wherever required

Q1 Attempt any **Four** Questions 20

a) Explain modes of heat transfer with suitable example.
b) Explain steady, unsteady and lump system.
c) Explain the concept of overall heat transfer coefficient.
d) State and explain Wien's displacement law.
e) Explain Hydrodynamic and Thermal Boundary Layer in accordance with Prandtl Number.
f) Explain the function of fins and its effectiveness.

Q2 a) Derive the relation for heat transfer through fin with insulated tip. State the assumptions clearly. 10

b) An insulated steam pipe of 160mm inner diameter & 180mm outer diameter is covered with First layer of insulation 40mm thickness & second layer of insulation 20 mm thick carries steam At 200^{o}C, K(pipe)=32 W/mK, K(first insulation) = 0.23 W/m^{o}C, K(second insulation)= 0.3W/mK h_i=11.6 W/m^{2}K, ho=23.2 W/m^2.^{o}C. If the temp.of the air surrounding the pipe is 25oC, Calculate the rate of heat loss from the pipe of 5m length. Also find the interface temperature. . 10

Q3 a) A longitudinal copper fin (k=380W/m°C) 600mm long and 5mm diameter is exposed to air stream at 20°C. The convective heat transfer coefficient, is 20W/m^2°C. If the fin base temperature is 150°C. Determine: (i) the heat transferred and, (ii) the efficiency of the fin. Assume that fin is insulated at the tip. 10

b) An egg with mean diameter of 45mm and at 18°C is placed in a boiling water pan for 4.5 min and found to be boiled to consumer's taste. For how long a similar egg for the same consumer should be boiled taken from a refrigerator at 4°C. Take the following properties for egg. Verify whether the lumped heat capacity analysis can be used or not. 10
k=10W/m°C, ρ=1200kg/m^3,C_p=2kJ/kg°C, and h=100W/m^2°C.

Q4 a) Air at atmospheric pressure and 40°C flows with a velocity of U=5m/s over a 2m long flat plate whose surface is kept at a uniform temperature of 120°C. Determine the average heat transfer coefficient over the 2m length of the plate. Also find out the rate of heat transfer between the plate and the air per 1m width of the plate. (Take air at 1atm. and 80°C, ν = 2.107×10^{-5}m^2/s, k = 0.03025W/m.K, Pr = 0.6965.) 10

b) Derive the relationship between effectiveness and the number of transfer units for a parallel flow heat exchanger. 10

Q5 a) Determine the radiant heat exchanger in W/m^2between two large parallel steel plates of emissivity's 0.8 and 0.5 held at temperatures of 1000K and 500K respectively, if a thin copper plate of emissivity 0.1 is introduced as a radiation shield between the two plates. Use $\sigma=5.67\times10^{-8}W/m^2.K^4$. 10

b) i)Differentiate between the mechanism of filmwise and dropwise condensation. 05

ii) Define : Radiosity and Irradiation 05

Q6 a) In a certain double pipe heat exchanger hot water flows at a rate of 5000 kg/h and gets cooled from 95°C to 65°C. At the same time 50000 kg/h of cooling water at 30°C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at $2270W/m^2.K$. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for the both the streams, C_p=4.2 kJ/kg.K. 10

b) Write short note on any **two** of the following 10

i) Heat Pipe.

ii) NTU-effectiveness and LMTD methods

iii) Heisler Charts

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) Define carburetor and factor affecting carburetion

(b) Give a brief account of Exhaust Oxygen sensor

(c) Write note on: Turbo charging v/s supercharging

(d) Explain the main functions of fuel supply system in CI Engines.

(e) Explain assumptions in Air standard cycles and explain the deviations of fuel air cycle with reference to it.

(f) Describe briefly engine pollution and the Norms

Q.2 **(a)** In a test of an oil engine under full load condition the following results were obtained. **15**
ip = 33 kW
brake power = 27 kW
Fuel used = 8 kg/h
Rate of flow of water through gas calorimeter = 12 kg/min
Cooling water flow rate = 7 kg/min
Calorific value of fuel = 43 MJ/kg
Inlet temperature of cooling water = 15 ˚C
Outlet temperature of cooling water = 75 ˚C
Inlet temperature of water to exhaust gas calorimeter = 15 ˚C
Outlet temperature of water to exhaust gas calorimeter = 55 ˚C
Final temperature of the exhaust gases = 80 ˚C
Room temperature = 17 ˚C
Air-fuel ratio on mass basis = 20
Mean specific heat of exhaust gas = 1 kJ/kg K
Specific heat of water = 4.18 J/kg K
Draw up a heat balance sheet and estimate the thermal and mechanical efficiencies.

(b) Write short note on : **05**
Thermosyphon cooling system

Q.3	**(a)**	Explain in detail various stages of combustion in S I engine.	**10**
	(b)	Explain Battery Ignition system. Why capacitor is required to connect across the breaker point? What is the effect on intensity of spark as speed increases?	**10**
Q.4	**(a)**	**"A good CI engine fuel is bad SI engine fuel and vice versa",** Discuss the validity of the above statements in light of eight factors tendency to reduce knocking in SI and CI engines.	**10**
	(b)	The following details were noted in a test on a four-cylinder, four-stroke engine, diameter = 100 mm; stroke = 120 mm; speed of the engine = 1600 rpm; fuel consumption = 0.2 kg/min; calorific value of fuel is 44000 kJ/kg; difference in tension on either side of the brake pulley = 40 kg; brake circumference is 300 cm. If the mechanical efficiency is 80%, calculate (i) brake thermal efficiency (ii) indicated thermal efficiency (iii) indicated mean effective pressure and (iv) brake specific fuel consumption	**10**
Q.5	**(a)**	Write Short notes on: 1) Hydrogen as an alternative fuel for I C Engine 2) Atkinson Cycle	**10**
	(b)	What are the different functions of lubricating system? State the different lubricating systems used for I C Engines. Explain any one of them.	**10**
Q.6	**(a)**	With neat sketch explain compression induced swirl and divided combustion chamber. Also state its advantages and disadvantages.	**10**
	(b)	With neat sketch explain the various types of fuel nozzle used in CI engine injection systems.	**10**

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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 of the following questions(*any Four)*. **20**

i) Define wavelength standard and state the significance of using it.

ii) Explain different types of fits with suitable examples and sketches

iii) Differentiate between roughness and waviness.

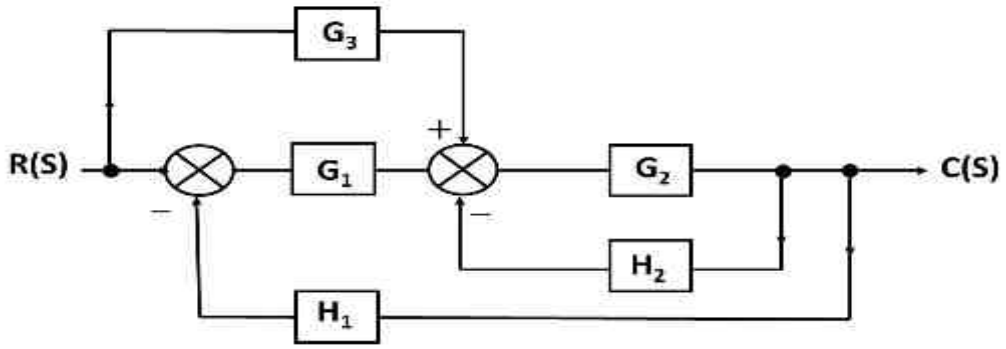
iv) Define and explain i) Resolution; ii) Threshold; iii) Hysteresis

v) Briefly explain the construction and working of a strain gauge load cell.

vi) Using Routh's criterion examine the stability of a control system whose characteristic equation is $S^5 + S^4 + 2S^3 + 2S^2 + 3S + 15 = 0$

2. (A) Define Interferometry. Explain Laser Interferometer with neat sketch. **10**

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



3. (A) Explain generalized measurement system elements with block diagram. Describe functions with suitable examples. **10**

(B) A unity feedback system has $G(s) = \frac{K}{S(2+S)(4+S)}$ **10**

a. If $r_{(t)}$= 2t and K= 4, find steady state error.
b. If it is desired to have steady state error to be 0.4, find corresponding value of "K"
c. Find steady state error if input is changed to 2+6t, and value of K to 10.

4. (A) Explain principle, construction and working of ***Parkinson Gear Tester*** **10**

(B) Draw the root locus and comment on the stability of the control system having open loop transfer function as follows: **10**

$$G(s)H(s) = \frac{K}{s^2(s+1)}$$

5. (A) What are encoders? With a neat sketch, explain the working of an incremental and absolute optical encoder. Give examples of their use. **10**

(B) Design a general type of Go and No Go plug gauge for inspecting a hole 25 d8. Given that: **10**

$i = 0.40\ D^{1/3} + 0.001D$ micron

Tolerance for hole = **25 i**

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

Wear allowance 10% of gauge design

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

i) Floating Carriage Micrometer
ii) Repeatability and Reproducibility
iii) Ultrasonic Flow Meter
iv) Capacitive Pressure Transducer
v) Types of Measurement System Inputs
vi) Frequency Domain specifications

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