①

Lib sch
21/6/2016

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.

Re-Examination

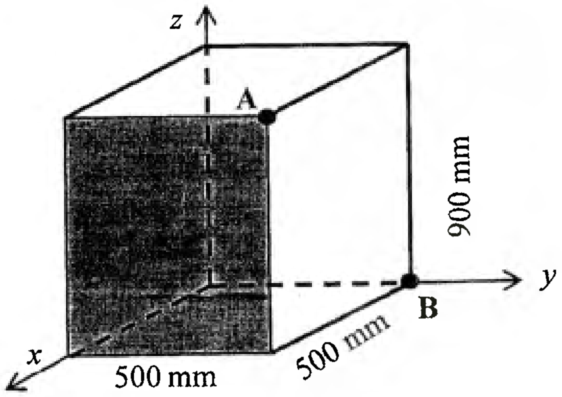
June 2016

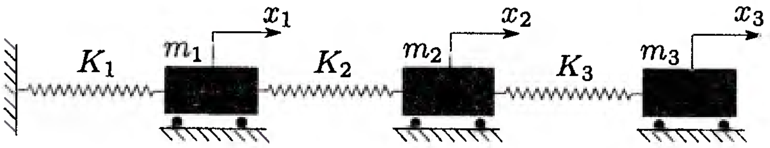
Max. Marks: **100** Duration: **4 Hours**
Class: **M.Tech.** Semester: **I** Program: **M.Tech. in Machine Design**
Name of the Course: **Machine Dynamics and Advanced Vibration** Course Code: **MTMD102**

Instructions:

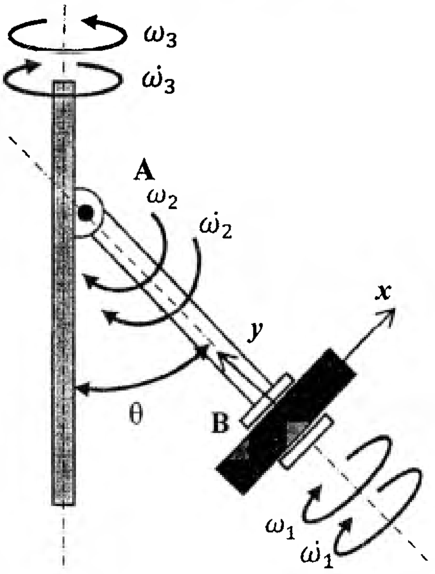
- Question no. **1** is **compulsory**. Attempt any **four** out of remaining six questions.
- Answers to all sub questions should be grouped together.
- Assume suitable data if necessary.

Master file.

			Max. marks	CO No.	Module No.
Q1	a)	State Chasles' theorem for describing the general motion of a rigid body. Illustrate use of the theorem by applying it to a mechanical system.	**(4)**	1	1
	b)	Explain the stiffness and flexibility influence coefficient methods employed in analysis of vibration problems. For which type of systems the flexibility influence coefficient method more suitable?	**(4)**	2	3
	c)	Describe the method based on Fourier series to find response of a single degree of freedom system under general periodic (non-harmonic) forcing function.	**(4)**	2	4
	d)	Discuss working principle of a vibration isolator. Define active and passive vibration isolators. What is transmissibility of an isolator?	**(4)**	3	5
	e)	Give four examples of the nonlinear vibration systems. Explain source of non-linearity and support your answer with neat sketches.	**(4)**	2	6
Q2	a)	A transport box as shown in the figure has mass of 500 kg. The centre of mass has coordinates: x_c = 200 mm, y_c = 200 mm, z_c = 400 mm. If at **A** we know that I_{yy} = 700 kg-m^2 and I_{yz} = 400 kg-m^2, find I_{yy} and I_{yz} at **B**. 	**(8)**	1	1
	b)	Derive equation of motion for the system shown using Lagrange's equation with x_1, x_2 and x_3 as generalised coordinates.	**(12)**	2	3



Q3 a) A 10 kg disc of 500 mm diameter rotates with speed $\omega_1 = 10$ rad/s relative to rod AB. Rod AB rotates with speed $\omega_2 = 5$ rad/s relative to vertical shaft, which rotates with speed $\omega_3 = 2$ rad/s relative to the ground. What is the torque coming onto the bearings at B due to the motion at a time when $\theta = 45°$? Take $\dot{\omega}_1 = 5\ \mathrm{rad}/s^2, \dot{\omega}_2 = 4\ \mathrm{rad}/s^2$, $\dot{\omega}_3 = 3\ \mathrm{rad}/s^2$. **(12)** *1* *2*



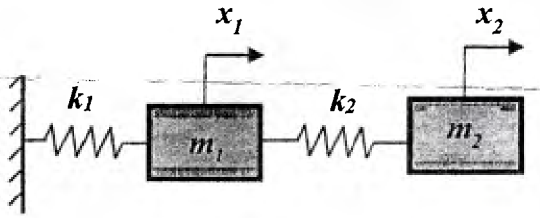
b) An unbalanced flywheel shows an amplitude of 10 μm and a phase angle of 25° clockwise from the phase mark. When a trial weight of magnitude 5 gm is added at an angular position 35° counter clockwise from the phase mark, the amplitude and the phase angle become 12 μm and 55° counter clockwise, respectively. Find the magnitude and angular position of the balancing weight required **(8)** *3* *5*

Q4 a) Formulate governing partial differential equation of motion for free vibration of a stretched cable or string. State the assumptions made clearly. **(8)** *2* *4*

b) Explain the procedure for obtaining solution to the equation of motion of a non-linear vibration system using graphical method. Define following terms used in the method: (a) phase plane, (b) trajectory and (c) isocline. Describe the procedure to obtain time solution from phase plane trajectories. **(12)** *2* *6*

Explain how the graphical method differs from the iterative method for obtaining solution to non-linear vibration system.

Q5 a) Find free vibration response of spring-mass system shown below using modal analysis. Consider $m_1 = 10$, $m_2 = 1$, $k_1 = 30$, $k_2 = 5$. Natural frequencies, modes shapes and initial conditions for the system are as given below. **(12)** *2* *3*



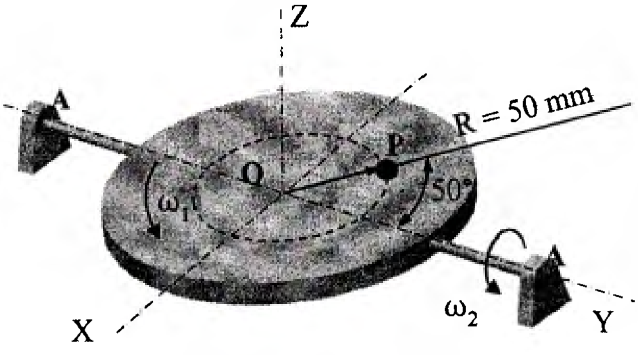
$$\omega_1 = 1.5811, \{X^{(1)}\} = \begin{Bmatrix} 1 \\ 2 \end{Bmatrix} X_1^{(1)};\ \omega_2 = 2.4495, \{X^{(2)}\} = \begin{Bmatrix} 1 \\ -5 \end{Bmatrix} X_1^{(2)}$$

$$\{x(0)\} = \begin{Bmatrix} 0 \\ 1 \end{Bmatrix};\ \{\dot{x}(0)\} = \begin{Bmatrix} 0 \\ 1 \end{Bmatrix}$$

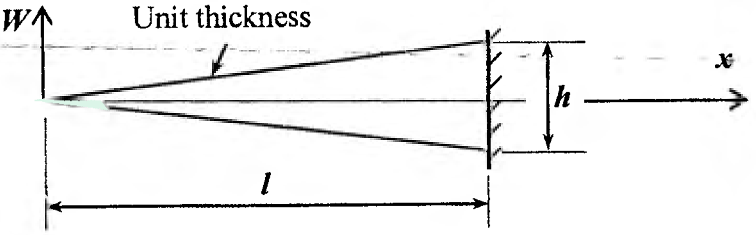
b) Briefly describe two types of frequency measuring mechanical instruments. Draw neat sketches to illustrate. **(4)** *3* *7*

c) Explain signature analysis in the context of experimental study of vibrations. **(4)** *3* *7*

Q6 a) A particle P rotates at a constant angular speed of $\omega_1 = 8$ rad/s on a platform, while the platform rotates with a constant angular speed of $\omega_2 = 15$ rad/s about axis AA. Calculate the absolute velocity and acceleration of particle P at the instant when the platform is in the XY plane and radius vector to the particle forms an angle of 50° with the Y-axis as shown. **(8)** *1* *1*



b) Find the fundamental frequency of transverse vibration of tapered cantilever beam shown in the figure using Rayleigh's method. Assume deflection shape as $W(x) = 1 - \frac{x^3}{l^3}$ **(8)** 2 4



c) Explain the principle of operation of undamped vibration absorber. What is the major limitation of undamped absorber? **(4)** 3 5

Q7 a) Write a short note on Euler's equations of motion. **(5)** *1* 2

b) Explain using suitable example, Holzer's method for obtaining natural frequency and mode shapes of a vibration system. **(5)** 2 3

c) Explain meaning of a singular or equilibrium point of a non-linear vibration system. Give the classification of equilibrium points with their representation on phase plane diagram. Describe in short the concept of limit cycles with a sketch. **(5)** 2 6

d) A spring-mass-damper system, having an undamped natural frequency of 150 Hz and damping constant of 10 N-s/m is used as an accelerometer to measure vibration of a machine operating at a speed of 1700 rpm. If the actual acceleration is 5.0 m/s^2 and recorded acceleration is 4.8 m/s^2, find the mass and spring constant of accelerometer. **(5)** 3 7

---------- oXo ----------

lib section
11/5/2016

Bharatiya Vidya Bhavan's

SardarPatelCollege of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.
End Semester Exam
May 2016

Q. P. Code:
Max. Marks: 100 **Duration: 4 Hour**
Class: M.Tech (Mechanical) with Machine Design **Semester: II** **Program: M. Tech**
Name of the Course: Advanced Finite Element Methods **Course Code : MTMD202**

Instructions:
1. Answer any five questions including Q.No.1 which is compulsory.
2. Assume suitable additional data if necessary and state the same.

Master file.

Question No		Max Marks	CO No	Module No
Q1	a) Obtain an approximate displacement equation for the simply supported beam of length H and sectional property EI shown in Fig.1.Assume that the trial displacement equation is y(x) = A sin п x / H. The governing differential equation is $EI\, d^2y / dx^2 - W\, x(H-x)/2 = 0$	05	3	1
	b)The shape functions for the quadratic element shown in Fig 2 are $N_i = 2(x-X_j)(x-X_k)/L^2$; $N_j = -4(x-X_i)(x-X_k)/L^2$; $N_k = 2(x-X_i)(x-X_j)/L^2$ Show that these shape functions equal one at their own node and are zero at the other two nodes. Also show that the shape functions sum to one.	05	1,3	2
	c) The differential equation $D^{(e)}\, d^2\varphi / dx^2 = 0$ is applicable to each section of the composite wall shown in Fig 3, where $D^{(e)}$ is the thermal conductivity. Calculate the nodal temperature values within the wall. A unit surface area is assumed. Solve the question by using Weighted Residual Integral Method.	05	1	3
	d)The nodal values for a triangular element is as follows:- $X_i = 0.31$, $Y_i = 0.06$, $X_j = 0.38$, $Y_j = 0.09$, $X_k = 0.31$, $Y_k = 0.13$, $\Phi_i = 130$, $\Phi_j = 94$, $\Phi_k = 125$. Calculate the value of Φ at Point A(x= 0.36, y= 0.09).Also find the x y coordinates where the contour line for 110 intersects the element boundaries.	05	1,2 ,3	4
Q2	a) Show that the area coordinates L_1 , L_2 and L_3 for a linear triangular element are identical to the shape functions.	08	2	4
	b) Calculate $[K^{(e)}]$ and $\{f^{(e)}\}$ for a bilinear rectangular element when $D_x = D_y = 1$, G = 12, Q = 5 and the coordinates are $X_i = 0.30$, $Y_i = 0.20$, $X_j = 0.40$, $Y_m = 0.30$, $\Phi_i = 110$, $\Phi_j = 85$, $\Phi_k = 76$, $\Phi_m = 105$. Also determine three sets of x y coordinates for the specific contour line for Φ = 90.	12	1,2	4
Q3	a) Determine the temperature distribution in the circular fin using the three element grid shown in the Fig 4 .Include convection heat loss	10	1,3	4

	from the end of the fin.			
	b) Evaluate $[K^{(e)}]$ and $\{f^{(e)}\}$ for the triangular element shown in the Fig 5. The conductivities are $k_x = k_y = 2W/{}^0C$-cm and $h = 0.2\ W/cm^2-{}^0C$. The heat source Q* is line source.	10	2,4	4
Q4	a) Calculate the axial force in each member of the structural system shown in the Fig 6. Assume $E = 20(10^6)\ N/cm^2$ and $\alpha = 11(10^{-6})/{}^0C$.	10	2	5
	b) For the plane truss shown in Fig 7 , determine the horizontal and vertical displacements of node 1 and the stresses in each element. All elements have E =210 GPa and $A = 4.0\ (10^{-4})\ m^2$.	10	2	5
Q5	a) Explain the concept of work equivalence for distributed load in beam analysis. The cantilever beam of length L with fixed end on the LHS and free end on the RHS is subjected to a uniformly distributed load (w per unit length) over the length L .Solve for the right end vertical displacement and rotation and then for the nodal forces. Assume the beam to have constant EI throughout its length.	10	2,1	5
	b) Calculate the nodal displacements and the internal member forces for the beam shown in Fig 8. Construct the shear force and bending moment diagram for each member. Use $E = 20\ (10^6)\ N/cm^2$ and $I = 8000\ cm^4$.	10	2,4	5
Q6	a) Derive expressions for element stiffness matrix, global stiffness matrix and internal nodal forces for the plane frame element.	10	1,2 ,3	6
	b) Calculate the element stiffness matrix and the thermal force vector for the plane stress element shown in Fig 9. The element experiences a 10 degree C increase in temperature.	10	4	6
Q7	Briefly explain the following:- a) Weighted residual method for obtaining numerical solutions to differential equations.	05 each	1	1
	b)Integral equations for the element matrices for the group problems embedded in the two dimensional field equation $D_x \partial^2 \varphi / \partial x^2 + D_y \partial^2 \varphi / \partial y^2 - G \varphi + Q = 0$.		2	3
	c) Preprocessing, Solution and Post-processing features in ANSYS FEA software.		4	7
	d) Finite Element Modeling and Mesh Generation.		4	7

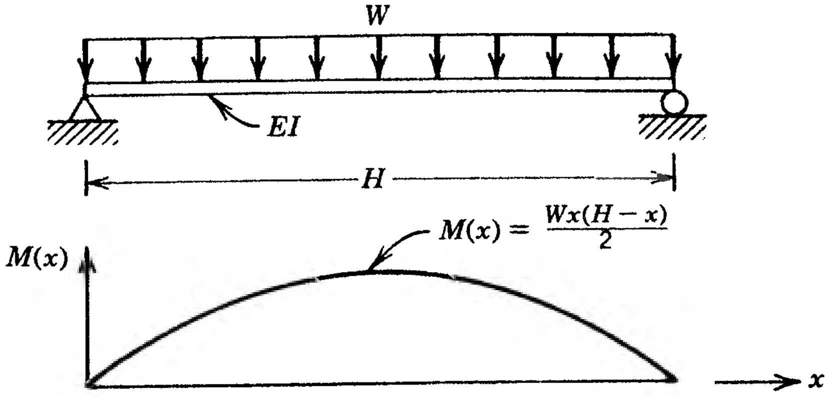


Figure 1

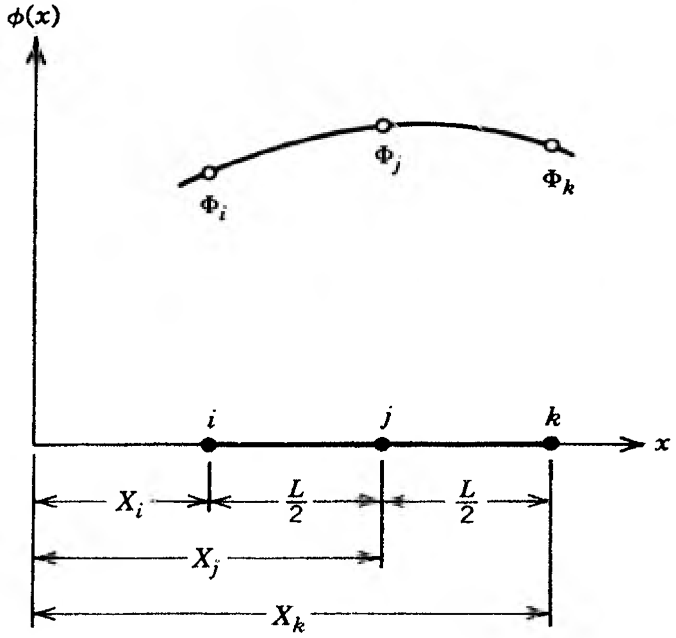


Figure 2

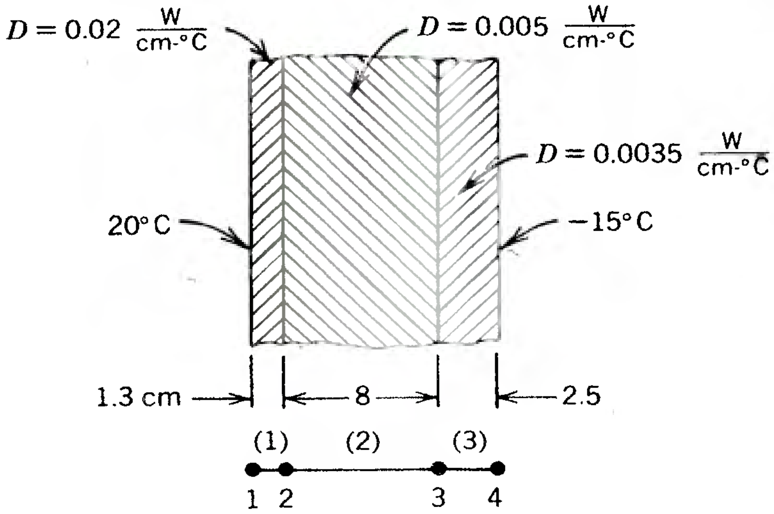


Figure 3

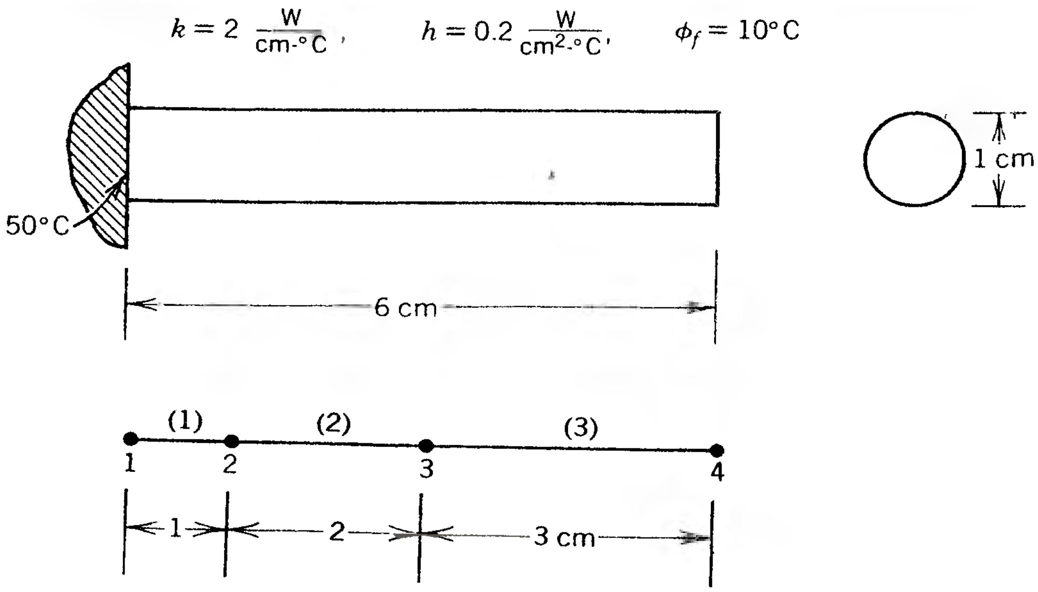


Figure 4

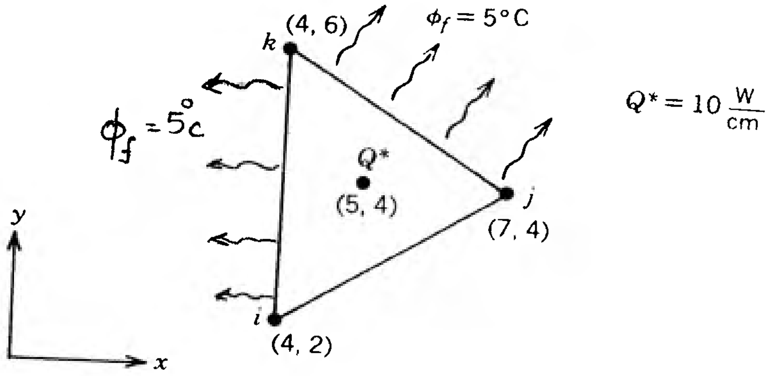


Figure 5

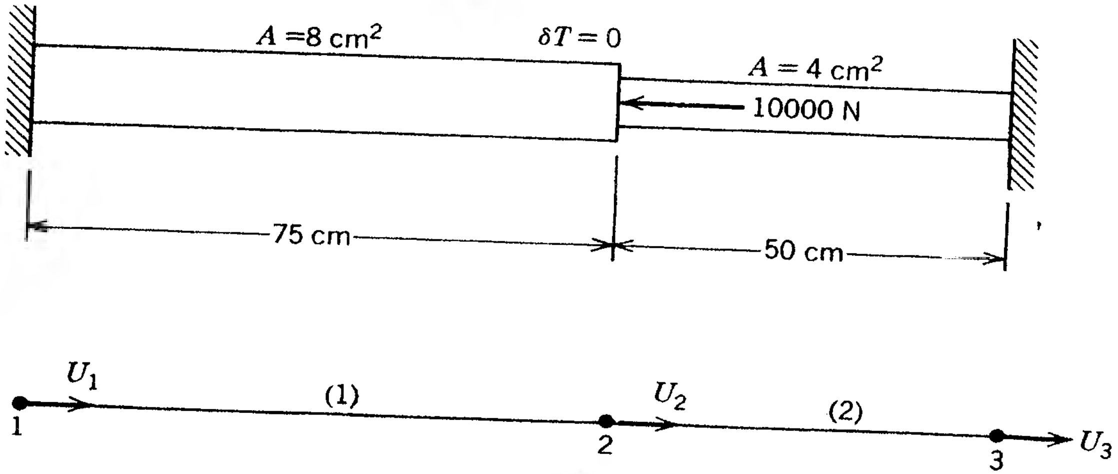
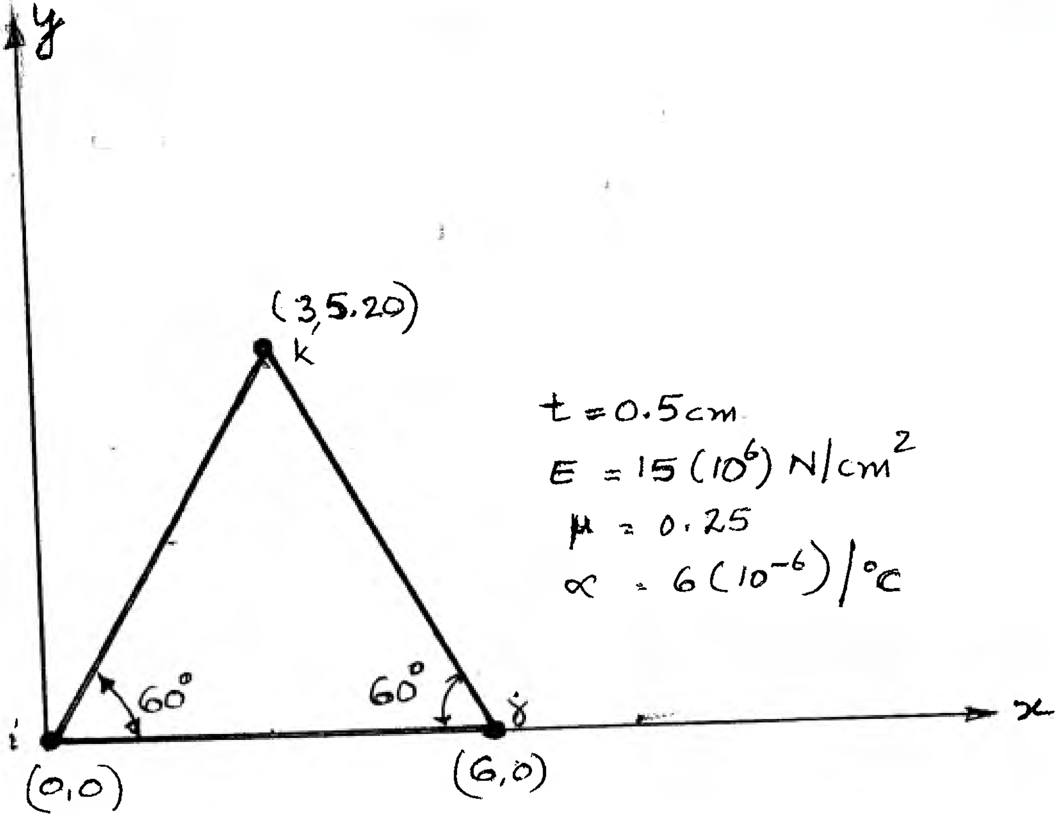


Figure 6



t = 0.5cm

$E = 15(10^6)\ N/cm^2$

$\mu = 0.25$

$\alpha = 6(10^{-6})/°C$

Figure 9.

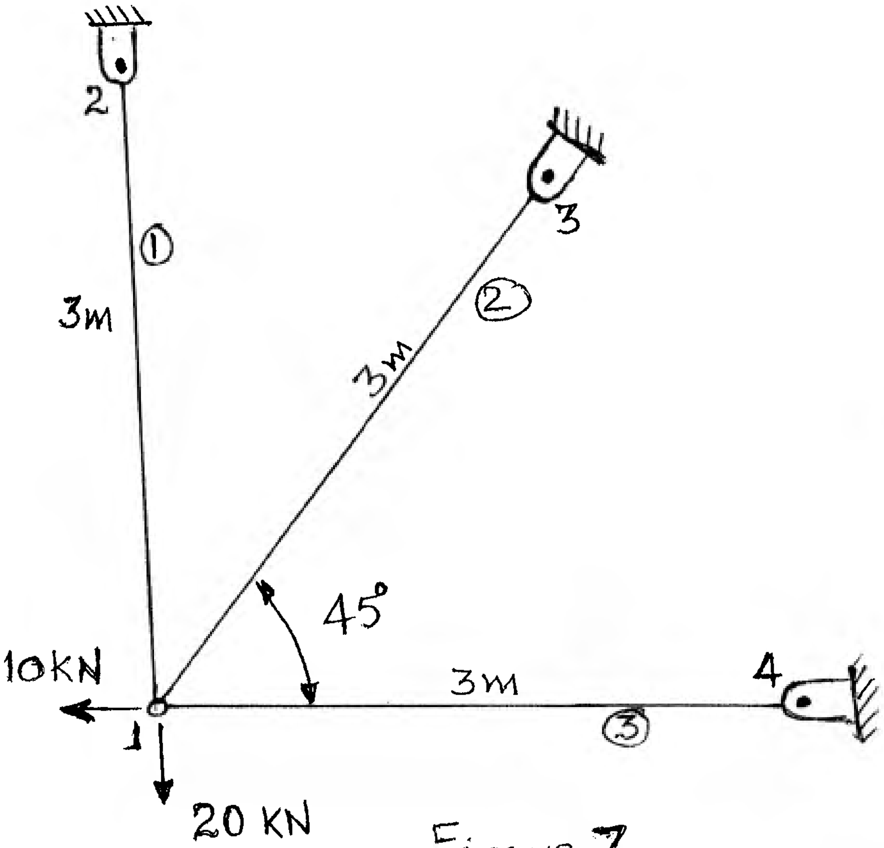


Figure 7

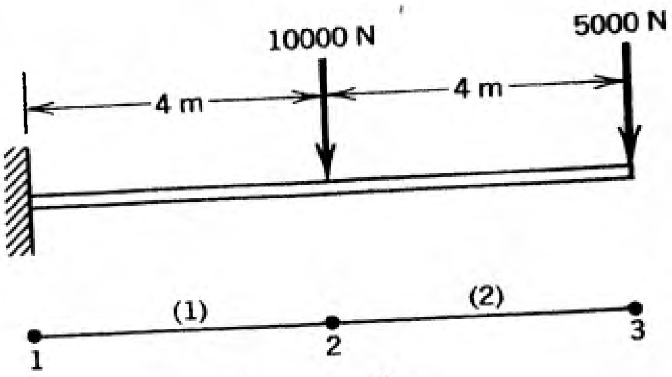


Figure 8

lib Section

9/5/2016

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Exam-- May 2016

Q. P. Code: Max. Marks: **100** Duration: **4 hrs**
Class: **MTech (M/c Dsg.)** Semester: **II** Program: **Mechanical Engineering**
Name of the Course: ***FRACTURE MECHANICS*** Course Code : ***MTMD 201***

Instructions:

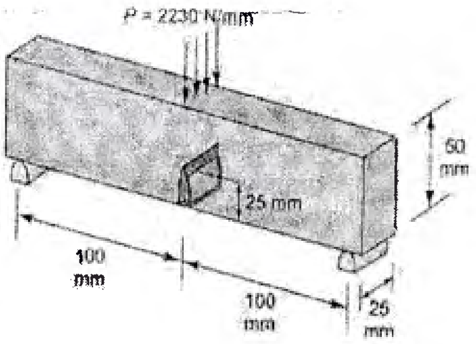
Master file.

- **Question No 1 is compulsory**
- **Attempt any four questions out of remaining six.**
- Assume suitable data if required and state it clearly.
- Answers to all sub-questions should be grouped together.

Q. No.		Max Mark	Module	COs
1.	Answer the following:			
	a) Why plastic zone size in Irvin Model is large compared to LEFM approach. Comment on Plastic zone size corrected by different models with suitable graph.	20	M3	CO1
	b) In general what happens with an advancing crack in component? List typical fractured surface characteristic of ductile fracture.		M1	CO1, CO2
	c) Use of K_{IC} by a designer is on conservative side, comment on the statement. Why is Chevron notch better than V-notch for K_{IC} test.		M5	CO3
	d) What is crack closure? Why does it happen? How does an overload retard the growth of fatigue crack?		M6	CO2
2.	a) Determine the energy release rate, using elementary beam theory for the configuration given in fig.no.2.	14	M2	CO1, CO2
	b) A large plate of 30 mm thickness with an edge crack a=25mm length is pulled very slowly under displacement control loading. At the displacement of 7.2 mm, when the recorded load is 2750 N, the crack starts growing. At a= 41.7 mm, the crack is arrested and the load decreases to 1560 N. Determine the critical energy release rate.	3	M2	CO1
	c) Determine the critical energy release rate of a DCB specimen loaded in a tensile testing machine. The thickness of the DCB specimen is 30mm, depth of each cantilever 12mm and crack length 50mm. The crack is about to propagate at 15405 N pulling load. (E = 207 GPa)	3	M2	CO1
3.	a) Write down the expression of J-integral for a plane problem and explain the term involved in it. State two important features of J-integral.	8	M4	CO1

	b)	Consider three point bend specimen with center load as shown in fig.1. The material properties are given below: Determine: i)K_I ii) Plastic zone size, iii) G_I based on LEFM, iv) J_p $\sigma_{ys} = \sigma_0 = 700$ MPa, $\varepsilon_0 = \sigma_0 / E$ $E = 207$ GPa, $\alpha = 8.2$, $n = 6$	12	M3, M7	CO1, CO2
4.	a)	What is the fatigue fracture? How the cyclic stresses are characterized?	6	M6	CO1
	b)	What are the phases of fatigue life? What are the factors that affect the fatigue life?	6	M6	CO2
	c)	An edge crack detected in large plate, is of length 5mm under a constant amplitude cyclic load having stress range of 138 MPa and minimum stress of 172 MPa. If the plate is made of steel having K_{IC} = 165 MPa $m^{0.5}$, determine—1) propagation life up to failure 2) propagation life without neglecting the change in correction factor if crack length is not to exceed 10mm. Take width as 200mm, $C = 6.8 \times 10^{-12}$, $m = 3.0$	8	M6, M7	CO1, CO2
5	a)	Define CTOD. Write down the expression for CTOD in terms of SIF and also in terms of rate of energy release (G). (*Use the expression of COD of mode I.*)	10	M4	CO1
	b)	Derive the expression for plastic zone shape in plane stress case using Tresca and Misces criterion.	10	M3	CO1, CO2
6	a)	Show that, stress function chosen for mode-I crack problem (Westergaards Approach) satisfies the bi-harmonic equation. Determine the stress and displacement component in terms of Z_I.	8	M3	CO1
	b)	Derive the relation between SIF and energy release rate.	6	M2, M3	CO1
	c)	What is the Griffith theory of fracture? Explain the Irwin-Orowan modifications of Griffith theory.	6	M2	CO1
7	a)	List the different types of specimens used for fracture toughness test. Sketch any one of it showing proper dimensions.	5	M5	CO3
	b)	Show that J-integral is path independent.	5	M4	CO1
	c)	Elaborate Damage tolerant design.	5	M1	CO1
	d)	Discuss historical development of fracture mechanics.	5	M1	CO1

Fig. 1



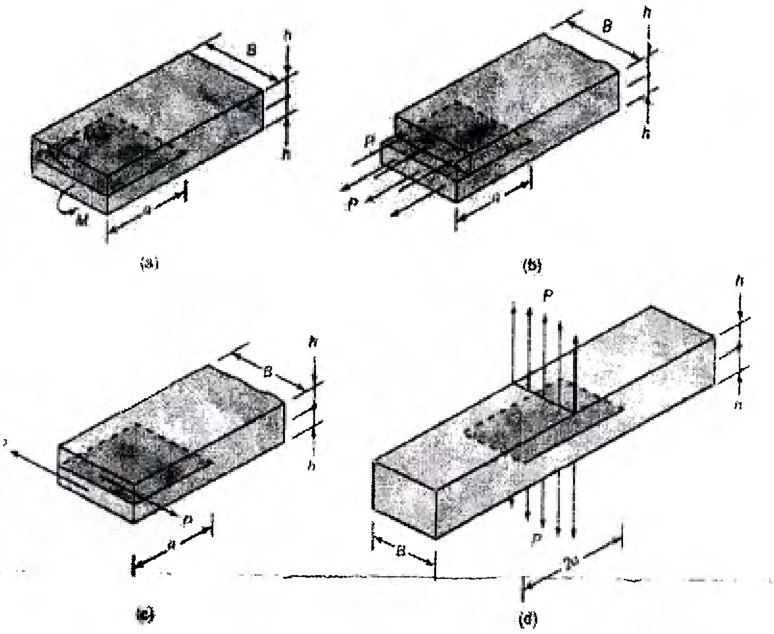


Fig.2

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.
End Semester Exam
May 2016

Max. Marks: 100
Duration: 4 hrs
Class: M.Tech (M/c Design)
Semester: II
Program: M.Tech (M/c Design)
Name of the Course: Optimization Methods
Course Code : MTMD203

Master file.

Instructions:

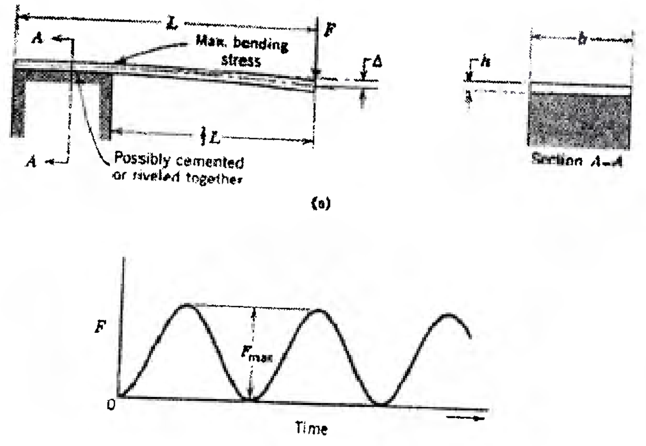
1. Question No. 1 is compulsory
2. Attempt any four questions out remaining six
3. Assume suitable data if necessary

Question No		Maximum Marks	Course Outcome Number	Modul No.
Q1	Attempt any Four of the Following:			
	(a) Formulation of Optimization Problem	05	01	01
	(b) Genetic Algorithm	05	02	02
	(c) Applications of Optimum Design	05	01	03
	(d) Digital Computers in Optimum Design	05	01	06
	(e) Characteristics of Mechanical Systems	05	01	03
Q2 (a)	Explain the classification of optimization.	10	01	01
(b)	A manufacturing firm produces two machine parts using Lathe, Milling machine and Grinding machines. The different machining times required for each part, the machining times available on different machines and the profit on each machine part are given in the following table:	10	03	01

	Machining Time Required (min)		**Maximum Time Available per week (min)**
Type of Machine	**Machine Part 1**	**Machine Part 2**	
Lathe	10	5	2500
Milling	4	10	2000
Grinding	1	1.5	450
Profit	$50	$100	

Determine the no. of parts I & II to be manufactured per week to maximize the profit.

Q.3.(a)	Explain the Evolutionary Programming? Give Evolutionary Algorithm	10	02	02

Q.3. (b)	Given is the Himmelblau function: $f(x_1,x_2) = (x_1^2 + x_2 - 11)^2 + (x_1 + x_2^2 - 7)^2$ Minimize $f(x_1,x_2)$ by evolutionary programming. Initial point $x^{(0)} = (1,1)$ & size reduction parameter $\Delta = (2,2)$.	10	03	02
Q.4 (a)	A total length of 100m of tubes must be installed in a shell and tube heat exchanger, in order to provide the necessary heat transfer area. The total cost of the installation in dollars includes: 1. The cost of the tubes which is constant at $900. 2. The cost of the shell = $1100D^{2.5}L$ 3. The cost of the floor space occupied by heat exchanger = 320DL where L is the length of the heat exchanger & D is the diameter of the shell, both in meters. The spacing of the tubes is such that 200 tubes will fit in a cross sectional area of 1 m^2 in the shell. Determine the diameter & length of the heat exchanger for minimum first cost by Lagrange Multiplier method. Also calculate the minimum cost.	10	03	01
(b)	Explain the manufacturing errors and the critical regions where they occur.	10	01	04
Q.5 (a)	Explain the formulation of primary & subsidiary design equation.	10	01	05
(b)	As shown in figure below a cantilever beam is to function as a spring member subjected to varying load. The flat spring has a force gradient of specified value k_1, length L and specified maximum value of load F_{max} as shown in fig. effective length of the cantilever beam is 2/3L. Formulate the problem for minimum material cost of beam. Given are materials, spring steel, phosphor bronze and beryllium copper. Find the optimum material based on the independent material group from the primary design equation formulated.  Figure 10.2 Cantilever flat spring with varying load F. (a) Flat spring showing geometrical parameters, loading, and deflection; (b) variation of load force F for flat spring.	10	03	07
Q.6 (a)	Explain the case of normal and redundant specifications.	10	01	05
(b)	Figure shows two frictionless rigid bodies (carts) A and B connected by three linear elastic springs having spring constants k_1,	10	03	07

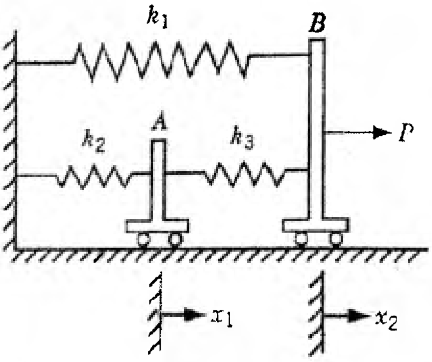
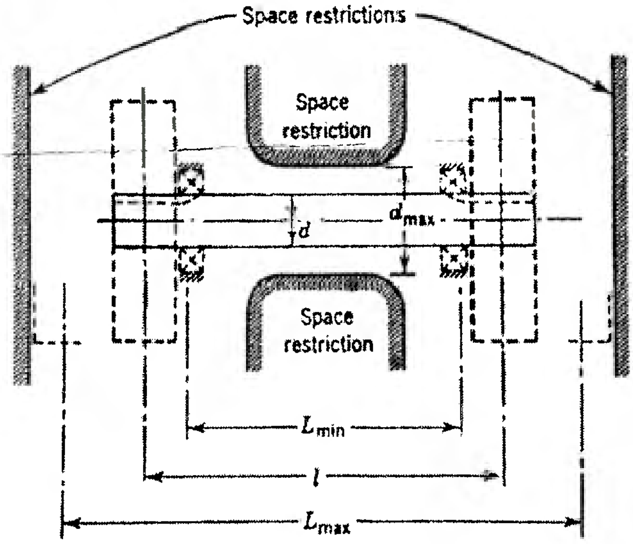
	k_2, k_3. The springs are at their natural positions when the applied force P is zero. Find the displacements x_1 and x_2 under the force P by using the principle of minimum potential energy. Given: P = 10 kN, k_1= 5 kN/m, k_2= 3 kN/m, k_3= 2 kN/m.  			
Q.7(a)	Write the syntax for Matlab programme for the following linear equation: Maximize $f(x_1,x_2,x_3) = -2x_1 - x_2+5x_3$ subject to, $x_1 - 2x_2+x_3 \leq 8$ $3x_1 - 2x_2 \geq -18$ $2x_1 + x_2 - 2x_3 \leq -4$	10	02	06
(b)	Figure shows a transmission shaft supported on two bearings. The shaft is transmitting constant torque of M_t and has constant torsional stiffness k. The geometric constraints are as shown in fig. Formulate the problem for designing the shaft for max. power transmission capability. Data: ω = 1000 rpm, N_y = 1, K_i= 1.2, L_{min}=20 in., k_{min}=$50x10^3$= in-lb/rad, d_{max}=1.25 in. Material AISI steel 4130. From the formulation part and above given data calculate the maximum power.  	10	03	07

TABLE 5.1

Typical Characteristics of Engineering Materials Available at a Particular Time in a Particular Locality

	ω (Weight Density)	c (Unit Material Cost)	α (Temp. Coef.)	Yield Strength (psi × 10^{-3})		Ultimate Strength (psi × 10^{-3})		Modulus of Elasticity (psi × 10^{-6})		Comments
	(lb/in³)	($/lb)	(1/°F × 10^6)	$(S_t)_y$ Ten.	$(S_s)_y$ Shear	$(S_t)_{ult}$ Ten.	$(S_s)_{ult}$ Shear	E Ten.	G Shear	
				METALS						
AISI 1020 HR Stl.	0.283	0.10	6.5	35	21	60	45	29	12	$S_e \sim \frac{1}{2}(S_t)_{ult}$ for machined surface steels, where S_e = endurance limit
AISI 1020 CR Stl.	0.283	0.14	6.5	60	36	80	60	29	12	—
AISI 1095 Stl.	0.283	0.19	6.3	97	55	108	—	29	12	Oil quenched; drawn at 850°F
AISI 2340 Stl.	0.283	0.25	6.4	174	96	282		29	12	Oil quenched, drawn at 400°F
AISI 4130 Stl.	0.283	0.25	6.4	197	—	232	—	29	12	Water quenched; drawn at 400°F
Nitralloy 135 Stl.	0.283	—	6.4	165	—	181	—	29	12	Oil quenched; drawn at 1100°F
304 Stainless Stl.	0.290	0.50	9.6	33	18	75	—	29	12	—
416 Stainless Stl.	0.278	0.36	5.5	40	—	75	—	29	12	—
446 Stainless Stl.	0.273	0.47	5.8	45	—	75	—	29	12	—
Titanium Alloy	0.163	8.00	5.3	130	—	150	—	16	6	S_e = 85,000 psi (500 million cycles)
24 S-T Alum. Plate	0.100	0.45	12.9	46	—	68	41	10.6	4.0	S_e = 18,000 psi (500 million cycles)
75 S-T Alum. Plate	0.101	0.48	13.1	72	—	82	47	10.4	3.9	S_e = 21,000 psi (500 million cycles)
AM-C58S Magnesium Alloy	0.066	0.54	14.5	32	—	46	21.5	6.5	2.4	S_e = 17,500 psi (500 million cycles)
AM-65S Mg Alloy	0.067	0.52	14.5	28	—	40	16	6.5	2.4	S_e = 11,000 psi (500 million cycles)
Phos. Bronze Strip	0.320	0.65	9.6	80	—	91	—	16.5	6.6	27,500 psi fatigue strength
Beryllium Copper	0.300	0.65	9.2	140	—	200	—	18.5	7.4	45,000 psi fatigue strength
Spring Stl. Strip	0.283	0.65	6.5	150	—	180	—	30	11.6	—
Hevimet	0.61	—	3.1	75	—	95	70	50	20.0	Tungsten-nickel-copper alloy
Mallory 1000	0.59	—	3.0	75	52	95	108	40	19.2	Tungsten-nickel-copper alloy
Stl. Oilite	0.254	—	7.0	—	—	35	—	—	—	Relatively new material
				NON-METALLIC MATERIALS						
Cast Phenolic	0.048	0.30	50	7.5	—	10	9.4	0.71	0.28	—
Polystyrene	0.038	0.45	39	6.5	—	9.0	8.2	0.40	0.21	—
Nylon FM 10001	0.041	2.20	55	—	—	11	—	0.40	0.18	—
Nylatron GS	0.041	—	23	—	—	12	—	0.60	0.27	Nylon filled with molybdenum disulfide
Lexan	—	—	—	—	—	8.0	—	0.16	—	Relatively new thermoplastic

lib Secn
18/5/2016

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.

End Semester Exam
May 2016

Max. Marks: **100**
Class: **M.Tech.** Semester: **II**
Name of the Course: **Process Equipment Design**

Duration: **4 Hours**
Program: **M.Tech. in Machine Design**
Course Code : **MTMD212**

Master file.

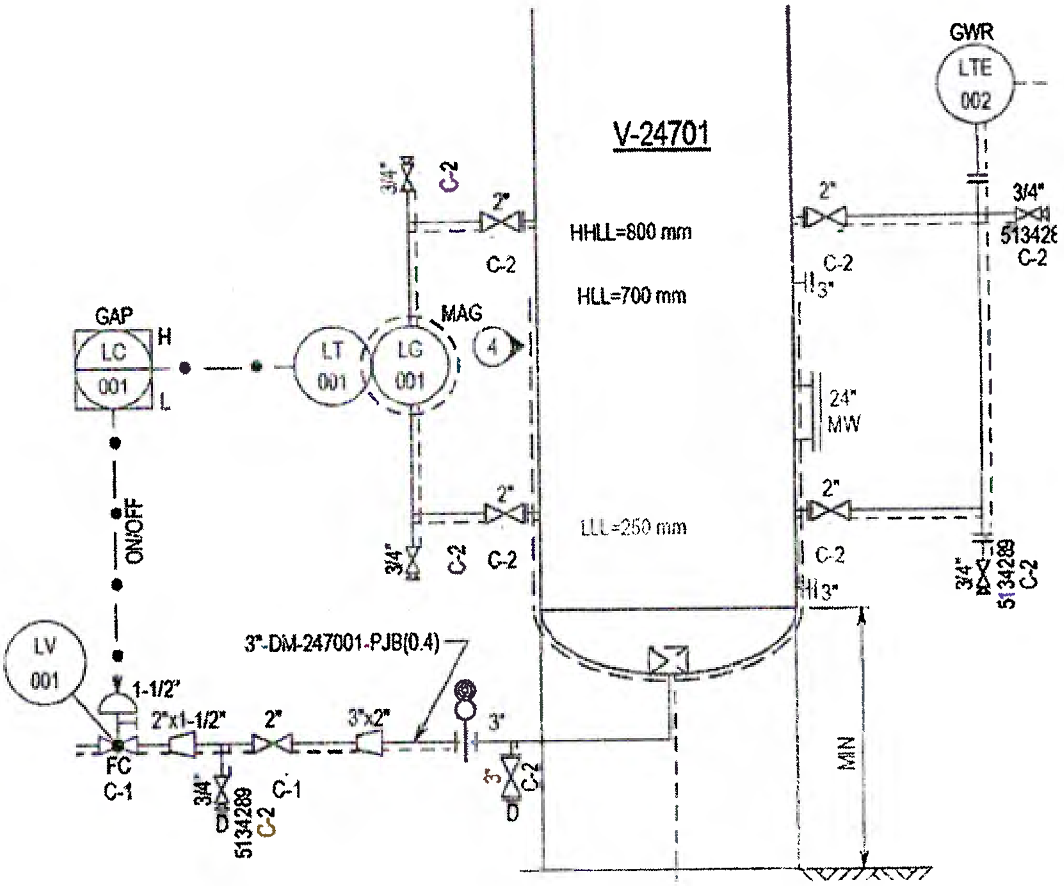
Instructions:

- Question no. **1** is **compulsory**. Attempt any **four** out of remaining six questions.
- Answers to all sub questions should be grouped together.
- Refer Annexure 1 for additional design data. Assume suitable data if necessary.

			Max. marks	CO No.	Module No.
Q1	a)	You are part of an engineering team of a process equipment manufacturer which will be visiting an important customer to discuss an order for a critical high pressure reactor vessel for a petrochemical plant located in north Europe. Your manager has instructed you to carefully prepare an exhaustive list of all design parameters and loading conditions which should be discussed during the meeting. Compose the list and briefly explain significance of each term from the list.	**(4)**	*1*	*1*
	b)	Describe different types of nozzle construction with neat sketch. Which construction type you would select for: (i) low pressure storage vessel, (ii) high pressure- high temperature reactor, (iii) vessel subjected to fluctuating loads.	**(4)**	*3*	*2*
	c)	Explain different types of flanges used in process equipment with neat sketches. Discuss salient features of each type. How would you estimate bolt-pre-tightening load for a flanged joint in a pressure vessel?	**(4)**	*2,3*	*4*
	d)	You have been assigned to design support for a vertical vessel. Evaluate various options available to you as a designer. Discuss relative merits of each support type. Support your answer with suitable sketches.	**(4)**	*2*	*6*
	e)	Discuss important differences in mechanical design of heat exchangers as compared against the design of a typical pressure vessel. Highlight design features or components which are unique to heat exchangers.	**(4)**	*3*	*7*
Q2	a)	What is the purpose of providing baffles in a heat exchanger? Write short note on arrangement of baffles in heat exchangers. Mention about function of baffles, types of baffles, baffle hole size, thickness of baffles and tie rod design.	**(5)**	*3*	*7*
	b)	A cylindrical vessel of 2500 mm internal diameter is subjected to an internal pressure of 1.9 MPa. Design the reinforcing pad for a nozzle opening with following data. The nozzle axis makes an angle of 60° with the axis of shell.	**(15)**	*2*	*2*

Internal dia. of nozzle = 430 mm	Noz. height above vessel = 260 mm
Thickness of vessel = calculate and round to the nearest even integer value	Permissible stress for shell and nozzle = 165 MPa
Thk. of nozzle wall = calculate and round to the nearest even integer value	Corrosion allowance = 2 mm

Q3 a) Following figure shows part of P&ID for a process plant. Reproduce the diagram and describe function/type of instrument/valve/fittings, type of connection lines, interpretation of pipeline tag and other information. (8) *1* 5



b) A vertical tower vessel of welded construction has following design specification (12) *2,3* *4*

Inside diameter = 2600 mm	Material = Carbon steel
Straight length of shell = 28,000 mm	Liquid level = 18,000 mm from bottom straight line
Type of heads = 2:1 ellipsoidal at top and hemispherical at bottom end	Liquid specific gravity = 1.20
Design internal pressure = 1.6 MPa	Allowable stress = 125 MPa
Design temperature = 260° C	Corrosion allowance = 1 mm
Joint efficiency = 0.85	Hydrotest pressure = nil

Calculate: (i) Thickness of shell and top/bottom heads, (ii) Pressure-temperature rating class of flanges fitted on the vessel and (iii) suitable schedule for 600 mm nominal diameter nozzle pipe for the vessel.

Q4 a) A carbon steel pressure vessel has shell of 2000 mm inside diameter, '*t*' thickness and 4000 mm unsupported length. The shell is subjected to external pressure of 0.12 MPa at 370° C due to fluid in its external jacket. Calculate the required thickness '*t*' of the shell. Calculate the size of the stiffeners. Corrosion allowance is zero. **(15)** *2,3* *3*

b) Write a short note on significance of following process diagrams: BFD, PFD and P&ID from the perspective of process equipment designer. **(5)** *1* *5*

Q5 a) Design flange with flat face as per following data. **(10)** *2* *4*

Design pressure = 4.2 MPa	Flange inside diameter= 750 mm
Allowable flange stress = 150 MPa	Gasket = PTFE (m=2.75, y=25.5 MPa)
Allowable bolt stress (operating and gasket seating condition) = 195 MPa	

b) A single pass fixed-tubesheet heat exchanger has following specification. **(10)** *3* *7*

Number of tubes = 283	Outside dia. of tubes = 34 mm
Tube side design pressure = 0.8 MPa	Shell side design pressure = 0.6 MPa
Pitch = triangular	Corrosion allowance = nil
Allowable stress (shell/tube)= 75 MPa	Tubesheet design factor, F = 1.0

Determine thickness of tubesheet.

Q6 a) Give classification of process equipment based on geometry, function, service and manufacturing method. What considerations will you apply while designing very high pressure vessels? Describe properties of ferrous and non-ferrous materials employed in design of process equipment. (5) *3* *1*

b) Explain with sketches design of cylindrical storage tanks. Describe construction of bottom closure, cylindrical shell, wind girders and roofs. **(8)** *3* *6*

c) List different types of jacketed vessels. Explain with a sketch, design of half-coil jacket including applicable design formulae. **(7)** *2,3* *6*

Q7 a) Define following terms and mention their significance in the context of process equipment design: (i) Creep strength, (ii) MAWP, (iii) MDMT, (iv) Gasket 'm' factor, (v) corrosion allowance. **(5)** *1* *1*

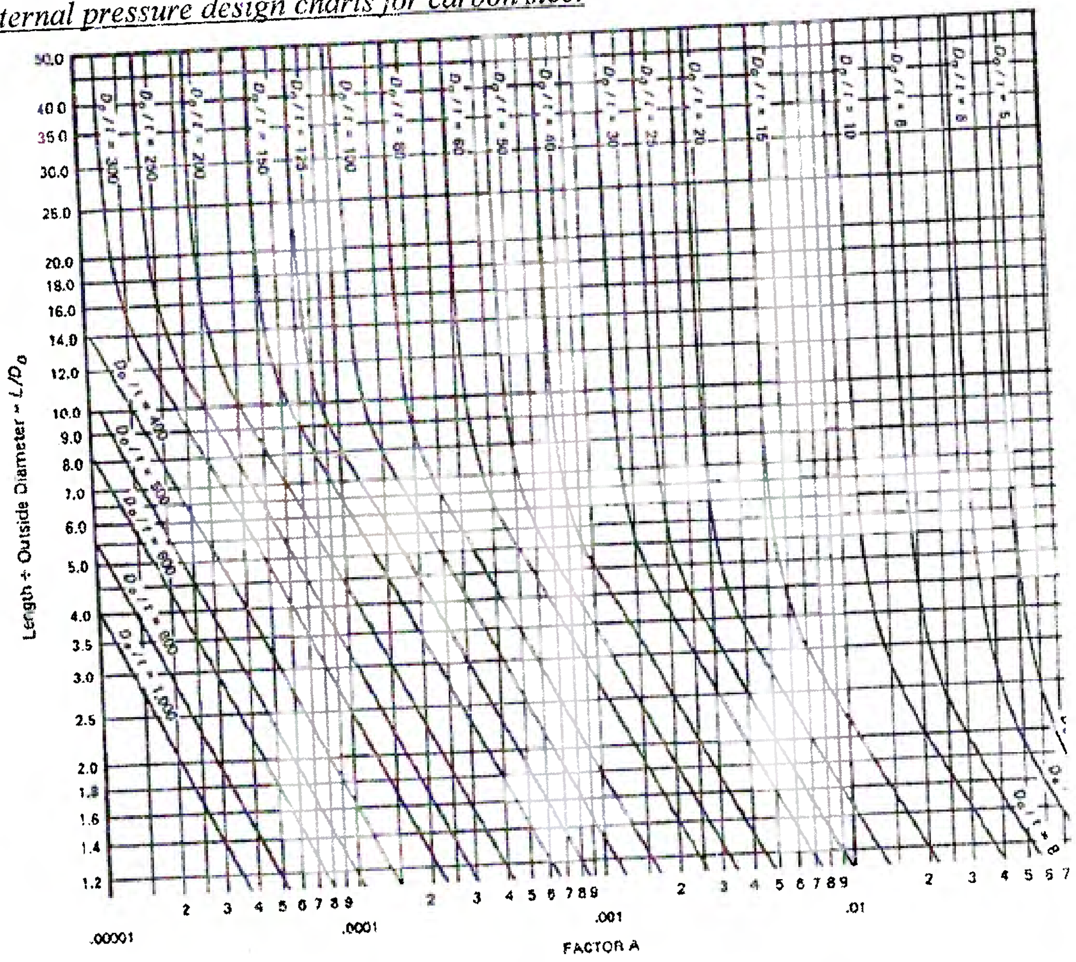
b) Explain procedure for carrying out stress analysis of nozzle to vessel junction using finite element method. Discuss the stress linearization method used to interpret the stress distribution at critical sections. **(5)** *2* *3*

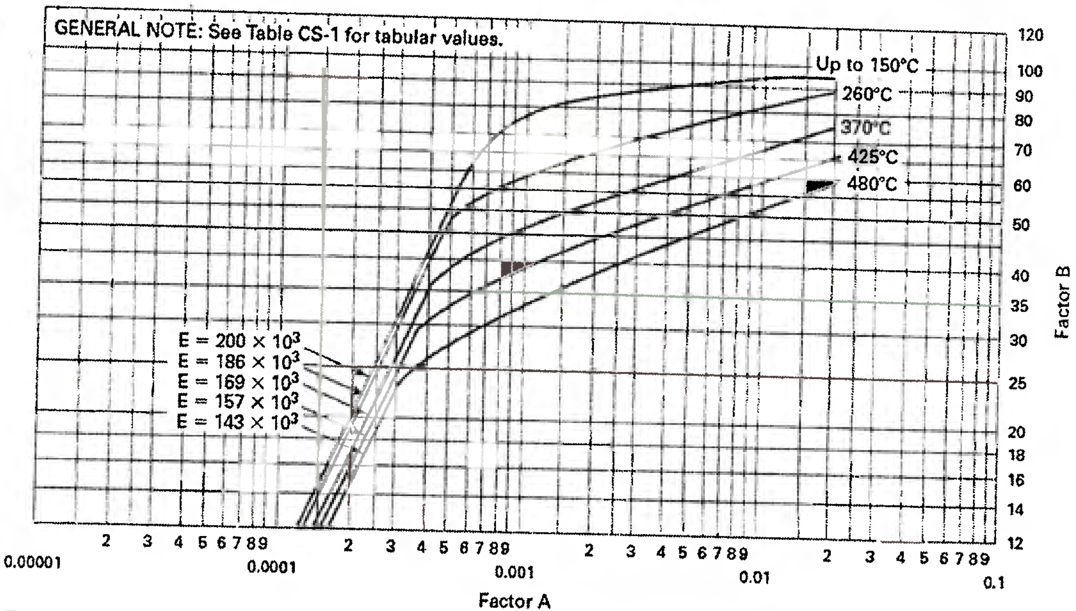
c) Design skirt support for a vertical vessel with the data given below. Determine thickness of skirt and base plate and number/size of anchor bolts. **(10)** 3 6

Vessel ID/thickness = 3200 / 12 mm Skirt ID = 2800 mm	Permissible stress, skirt = 145 MPa (tension), 24 MPa (compression)
Total height of vessel = 60 m	Permissible bending stress, base plate = 140 MPa
Operating weight of vessel = 5500 kN	Permissible stress, bolts = 160 MPa
Empty weight of vessel = 4000 kN	Permissible compressive stress, foundation = 20 MPa
Wind pressure, H>20m = 1600 N/m^2 Wind pressure, H<20m = 800 N/m^2	Seismic factor, C = 0.11

Annexure 1

External pressure design charts for carbon steel





Pressure-temperature rating class for carbon steel flanges

Class Temp., °C	150	300	400	600	900	1500	2500
	Working Pressure by Classes, bar						
-29 to 38	19.8	51.7	68.9	103.4	155.1	258.6	430.9
50	19.5	51.7	68.9	103.4	155.1	258.6	430.9
100	17.7	51.5	68.7	103.0	154.6	257.6	429.4
150	15.8	50.2	66.8	100.3	150.5	250.8	418.1
200	13.8	48.6	64.8	97.2	145.8	243.2	405.4
250	12.1	46.3	61.7	92.7	139.0	231.8	386.2
300	10.2	42.9	57.0	85.7	128.6	214.4	357.1

Pipe schedule

NPS inches	N.D.	O.D. mm	10	20	30	STD	40	60	XS	80	100	120	140	160	XXS
22	550	558.8	6.35	9.53	12.70	9.52	15.87	22.22	12.7	28.57	34.92	41.27	47.62	53.97	-
24	600	609.6	6.35	9.53	12.70	9.52	17.47	24.61	12.7	30.96	38.89	46.02	52.37	59.54	-
26	650	660.4	7.92	12.70	-	9.52	-	-	12.7	-	-	-	-	-	-

Useful expressions for tubesheet design

$$D_{bundle} \approx d_0(\frac{N_t}{0.319})^{1/2.142}$$

Useful expressions for support skirt design against wind and seismic load

$T = 6.35 \times 10^{-5}(H/D)^{1.5}(W/t)^{0.5}$ where W is in kN; wind load $P = k_1 k_2 p H D_0$, wind shape factor k_1=0.7 to 0.85, wind factor related to period, k_2 = 1 if T<0.5 sec, else k_2 = 2

Useful expressions for flange design

Factor $Y = \frac{1}{K-1}\left[0.66845 + 5.71690\frac{K^2 \log_{10} K}{K^2-1}\right]$, K = (flange OD)/(flange ID)

---------- oXo ----------

lib section
2/6/2016

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.
RE Exam
June 2016

Max. Marks: 100
Class: M.Tech (M/c Design) Semester: II
Name of the Course: Optimization Methods

Duration: 4 hrs
Program: M.Tech (M/c Design)
Course Code : MTMD203

Master file.

Instructions:

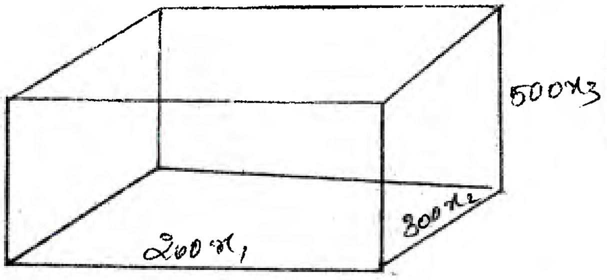
1. Question No. 1 is compulsory
2. Attempt any four questions out remaining six
3. Assume suitable data if necessary

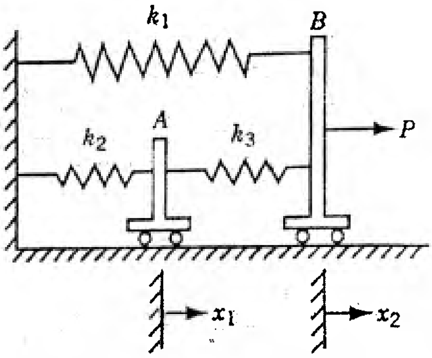
Question No		Maximum Marks	Course Outcome Number	Module No.
Q1	Attempt any Four of the Following:			
	(a) Formulation of Optimization Problem	05	01	01
	(b) Random Search Algorithm	05	02	02
	(c) Characteristics of Mechanical Systems	05	01	03
	(d) Role computer software in solving optimization problem	05	01	06
	(e) Redundant & Incompatible Specification	05	01	03
Q2 (a)	Explain the Quadratic Interpolation Method of Optimization.	10	01	01
(b)	An electrical equipment is engaged in the production of high power and low power transformers using three operations: Making, Coil Assembly, Final Assembly. A high power transformer (HPT) is sold at Rs. 8,000 and low power transformer (LPT) is old at Rs. 3,000. The cost of HPT and LPT are Rs. 3,000 and Rs. 2000 respectively. The time required for hours for each operation and their weekly availability are given below:	10	03	01

Operations	Transformers		Weekly
	HPT (Hrs.)	LPT (Hrs.)	Hours
Mould Making	3	1	50
Coil Assembly	8	3	150
Final Assembly	6	5	100

Formulate the problem and solve for maximizing the profit.

Question No		Maximum Marks	Course Outcome Number	Module No.
Q.3.(a)	Explain the Genetic Programming? Give Genetic Algorithm	10	02	02

Q.3. (b)	Given is the function: $f(x_1,x_2) = (x_1 - 3)^2 + (x_2 - 2)^2$ Minimize $f(x_1,x_2)$ by genetic Algorithm. Solve for atleast three generations	10	03	02
Q.4 (a)	A steel framework as shown in Figure 1 is to be constructed at a minimum cost. The cost in dollars of all the horizontal members in one orientation is $200x_1$ and in other horizontal orientation is $300x_2$. The cost in dollars of all vertical members is $500x_3$. The frame must enclose a total volume of 900 m^3. (a) Set up the objective function for total cost and the constraint(s) in terms of x_1, x_2 and x_3. (b) Using the method of Lagrange multipliers for constrained optimization; determine the optimal values of the dimensions and the minimum cost.  	10	03	01
(b)	Show the effect of minute displacement error on curvature and on rigid body accelerations or theoretical stresses.	10	01	04
Q.5 (a)	Explain the formulation of primary, subsidiary design equation and limit equation	10	01	05
(b)	A cylindrical torsion bar is to be designed for minimum weight to transmit a twisting moment Mt, = 9000 in-lb and to have a torque gradient of k= 900 in-lb/deg. Assuming a factor of safety $N_y = 1.5$. Available materials are AISI 4130, Titanium Alloy, and Aluminum Alloy.	10	03	07
Q.6 (a)	Explain the case of normal and redundant specifications.	10	01	05
(b)	Four identical helical springs are to be used for supporting a milling machine weighing 5000 lb. Formulate the problem for finding wire diameter d, coil diameter D and number of turns N of each spring for minimum weight by limiting deflection to 0.1 in. and the shear stress to 10,000 psi in the spring. In addition, the natural frequency of vibration of the spring. In addition, natural frequency of the vibration of the spring is to be greater than 100 Hz. The stiffness of the spring (k), the shear stress in the spring (τ), and the natural	10	03	07

•	frequency of vibration of the spring (f_n) are given by			
Q.7(a)	Write the syntax for Matlab programme for the following linear equation: Maximize $f(x_1,x_2,x_3) = -3x_1 - x_2 + 10x_3$ subject to, $x_1 - x_2 + x_3 \le 8$ $x_1 - 2x_2 \ge -18$ $2x_1 + x_2 - 2x_3 \le 4$	10	02	06
(b)	Figure shows two frictionless rigid bodies (carts) A and B connected by three linear elastic springs having spring constants k_1, k_2, k_3. The springs are at their natural positions when the applied force P is zero. Find the displacements x_1 and x_2 under the force P by using the principle of minimum potential energy. Given: P = 40kN, k_1= 4 kN/m, k_2= 3 kN/m, k_3= 2 kN/m. 	10	03	07

⑨

Lib Setn

20/6/2016

Bharatiya Vidya Bhavan's

Sardar Patel College of Engineering

(A Government Aided Autonomous Institute)
Munshi Nagar, Andheri (West), Mumbai – 400058.

Re- Exam--June 2016

Q. P. Code: Max. Marks: **100** Duration: **4 hrs**

Class: **MTech (M/c Dsg.)** Semester: **II** Program: **Mechanical Engineering**

Name of the Course: ***FRACTURE MECHANICS*** Course Code : ***MTMD 201***

Instructions:

- **Question No 1 is compulsory**
- **Attempt any four questions out of remaining six.**
- Assume suitable data if required and state it clearly.
- Answers to all sub-questions should be grouped together.

Master file.

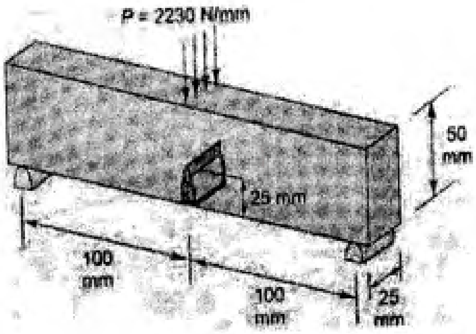
Q. No.		Max Mark	Module	COs
1.	Answer the following:			
	a) List the Fracture Mechanics approaches to design. Explain in detail any one of them.	20	M3	CO1
	b) In general what happens with an advancing crack in component? List typical fractured surface characteristic of ductile fracture.		M1	CO1, CO2 CO3
	c) What are the constraint on specimen geometry for K_{IC} testing? What is the justification for each constraint?		M5	
	d) What is Griffith energy criterion? Explain.		M6	CO2
2.	a) Determine the energy release rate, using elementary beam theory for the configuration given in fig.no.2.	14	M2	CO1, CO2
	b) A large plate of 30 mm thickness with an edge crack a=25mm length is pulled very slowly under displacement control loading. At the displacement of 7.2 mm, when the recorded load is 2750 N, the crack starts growing. At a= 41.7 mm, the crack is arrested and the load decreases to 1560 N. Determine the critical energy release rate.	3	M2	CO1
	c) Determine the critical energy release rate of a DCB specimen loaded in a tensile testing machine. The thickness of the DCB specimen is 30mm, depth of each cantilever 12mm and crack length 50mm. The crack is about to propagate at 15405 N pulling load. (E = 207 GPa)	3	M2	CO1
3.	a) Write down the expression of J-integral for a plane problem and explain the term involved in it. State two important features of J-integral.	8	M4	CO1
	b) Consider three point bend specimen with center load as shown in fig.1. The material properties are given below: Determine: i)K_I ii) Plastic zone size, iii) G_I based on LEFM, iv) J_p	12	M3, M7	CO1, CO2

$\sigma_{ys} = \sigma_0 = 700$ MPa, $\varepsilon_0 = \sigma_0/E$

$E = 207$ GPa, $\alpha = 8.2$, $n = 6$

4.	a)	What is the fatigue fracture? How the cyclic stresses are characterized?	5	M6	CO1
	b)	What are the phases of fatigue life? What are the factors that affect the fatigue life?	5	M6	CO2
	c)	An edge crack detected in large plate, is of length 5mm under a constant amplitude cyclic load having stress range of 150 MPa and maximum stress of 322 MPa. If the plate is made of steel having K_{IC} = 155 MPa $m^{0.5}$, determine—1) propagation life up to failure 2) propagation life considering the change in correction factor(for every 5mm increment of crack) if crack length is not to exceed 15mm. Take width as 200mm, $C = 6.8 \times 10^{-12}$, $m = 3.0$	10	M6, M7	CO1, CO2
5	a)	Define CTOD. Write down the expression for CTOD in terms of SIF and also in terms of rate of energy release (G). (*Use the expression of COD of mode I.*)	10	M4	CO1
	b)	Derive the expression for plastic zone shape in plane strain case using Tresca and Misces criterion.	10	M3	CO1, CO2
6	a)	Show that, stress function chosen for mode-II crack problem (Westergaards Approach) satisfies the bi-harmonic equation. Determine the stress and displacement component in terms of Z_{II}.	12	M3	CO1
	b)	Derive the relation between SIF and energy release rate.	4	M2, M3	CO1
	c)	What is the Griffith theory of fracture? Explain the Irwin-Orowan modifications of Griffith theory.	4	M2	CO1
7	a)	List the different types of specimens used for fracture toughness test. Sketch any one of it showing proper dimensions.	5	M5	CO3
	b)	Show that J-integral is path independent.	5	M4	CO1
	c)	Discuss variable amplitude fatigue loading analysis for life calculation.	4	M1	CO1
	d)	Discuss major factors influencing environment assisted fracture.	6	M1	CO1

Fig.1


P = 2230 N/mm
50 mm
25 mm
100 mm
100 mm
25 mm

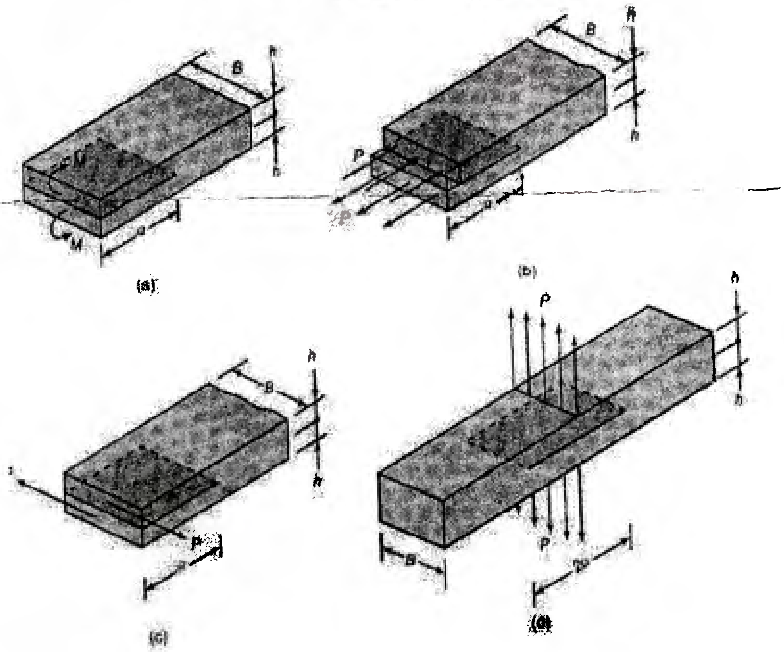

B
h
h
M
M
a
(a)
B
h
h
P
P
a
(b)
B
h
h
P
a
(c)
P
h
h
B
P
2a
(d)

Fig.2

APPENDIX 6B

The J-Integral of Some Common Cases through Engineering Approach

For the engineering approach (Sec. 6.6), J_p is defined as $J_p = \alpha\sigma_0\varepsilon_0 b g_1 h_1 (P/P_0)^{n-1}$. In this appendix, the expressions for the geometric factor g_1 and collapse load P_0 are given, and the geometric factor h_1 is listed for plane stress ($p-\sigma$) and plane strain ($p-\varepsilon$) for some commonly encountered cases. Usually, σ_0 is chosen to be same as yield stress (σ_{ys}).

6B.1 THREE-POINT BEND SPECIMEN

The specimen is loaded with force P per unit thickness, as shown in Fig. 6.12.

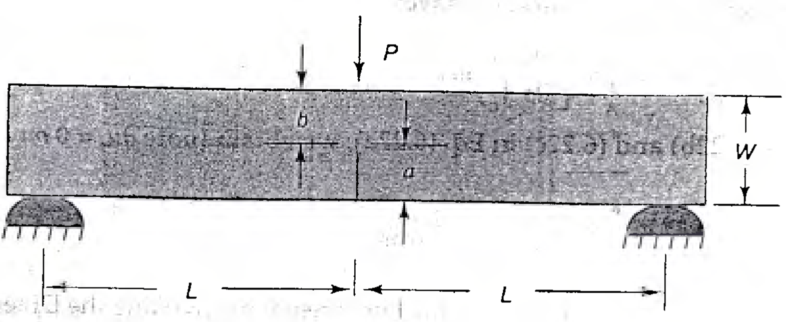


Fig. 6.12 Three-point bend specimen

$P_0 = 0.728\,\sigma_{ys}\,b^2/L$ for plane strain
$P_0 = 0.536\,\sigma_{ys}\,b^2/L$ for plane stress
$g_1 = 1$, and h_1 = listed in Table 6.1 for $L/W = 2$.

TABLE 6.1 h_1 for three-point bend specimen

a/W	Type	n								
		1	2	3	5	7	10	13	16	20
1/8	p-ε	0.937	0.869	0.805	0.687	0.580	0.437	0.329	0.245	0.165
	p-σ	0.676	0.600	0.548	0.459	0.383	0.297	0.238	0.192	0.148
1/4	p-ε	1.20	1.034	0.930	0.762	0.633	0.523	0.396	0.304	0.215
	p-σ	0.869	0.731	0.629	0.479	0.370	0.246	0.174	0.117	0.0593
3/8	p-ε	1.33	1.15	1.02	0.846	0.695	0.556	0.442	0.360	0.265
	p-σ	0.963	0.797	0.680	0.527	0.418	0.307	0.232	0.174	0.105
1/2	p-ε	1.41	1.09	0.922	0.675	0.495	0.331	0.211	0.135	0.0741
	p-σ	1.02	0.767	0.621	0.453	0.324	0.202	0.128	0.0813	0.0298
5/8	p-ε	1.46	1.07	0.896	0.631	0.436	0.255	0.142	0.084	0.411
	p-σ	1.05	0.786	0.649	0.494	0.357	0.235	0.173	0.105	0.471
3/4	p-ε	1.48	1.15	0.974	0.693	0.500	0.348	0.223	0.140	0.0745
	p-σ	1.07	0.786	0.643	0.474	0.343	0.230	0.167	0.110	0.0442