This paper contains 3 sheets

College of Engineering, Pune

Department of Mechanical Engineering

End-Semester Examination

F. Y. M.Tech (Mech – Design Engg)

ME5102 Advanced Vibrations and Acoustics

Wednesday, 23rd November, 2011 **Time: 4.00 – 7.00 p.m.**

Maximum Marks: 50 **Duration: 3 Hrs**

Instructions: 1. Write answers to both the sections in same answerbook 2. Attempt any three questions from section-A; Both questions from section-B are compulsory. 3. Figures to the right indicate full marks 4. Elaborate your answers with drawings and sketches wherever necessary 5. Assume suitable data, if necessary

SECTION – A (Q. 1 to Q. 4)

Q. 1 (a) A spring loaded valve is opened by a cam periodically which applies an impulsive force of 1000 N for a period of 0.005 seconds. The valve can be modelled as a spring-mass-damper system with M = 10 kg, K = 9000 N/m and C = 18 N.m/s. The cam strikes the valve every 1 s. Calculate the response of the valve *x(t)* once it has been impacted by the cam. The valve is considered closed if the distance between its rest position and its actual position is less than 0.0001 m. Is the valve closed the very next time it is hit by the cam? **05**

Q.1 (b) Refer to fig. 1. A water wave hits a seawall. The force exerted by the wave can be modelled as **05**

$$F(t) = F_0\left(1 - \frac{t}{t_0}\right) \quad for\ 0 \le t \le t_0$$

and $F(t) = 0\ for\ t > t_0$

Calculate response of the seawall-dike system to such a load in terms of mass of the dike, M, and effective stiffness of the wall, K. Neglect damping and mass of the seawall.

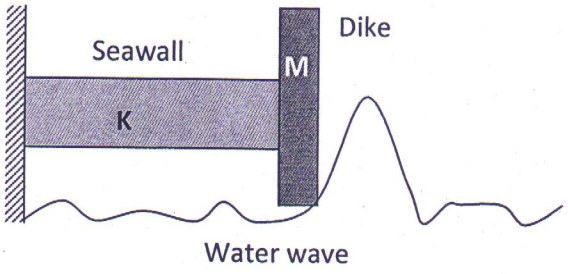


Fig. 1

Q.2 An electric overhead travelling crane, consisting of a girder, trolley, and wire rope, is shown in figure 2. The girder has a flexural rigidity (*EI*) of 1760×10^8 $N.m^2$ and a span of 9 *m*. The weights of crane and trolley and weight lifted are m_1 = 4000 *kg* and m_2 = 1000 *kg*, respectively. **10**

Find area of cross section of the rope such that the fundamental natural frequency of the system is greater than 20 *Hz*.

Take E for material of the wire-rope 210 *GPa* and length of wire rope 3 *m*. (Consider elasticity of girder and wire rope as lumped and neglect their masses; Treat both of them as simple springs with stiffness determined from deflection for a given load. For a beam $\delta = \frac{Wl^3}{48EI}$, and for a bar $\delta = \frac{PL}{AE}$).

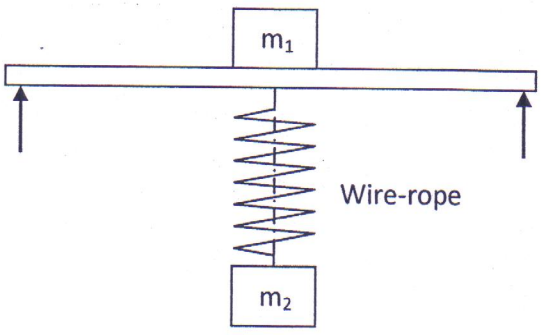


Fig. 2

Q.3 (a) A simplified model of a bicycle with its rider is shown in fig. 3. Find amplitude and frequency of the vertical motion of the rider in response to the forward motion of the bicycle over the road with profile as shown in the figure. The mass normalized modal matrix for the system is given by **05**

$$phi = \begin{bmatrix} -0.0993 & 0.0514 \\ -0.0727 & -0.140 \end{bmatrix}$$

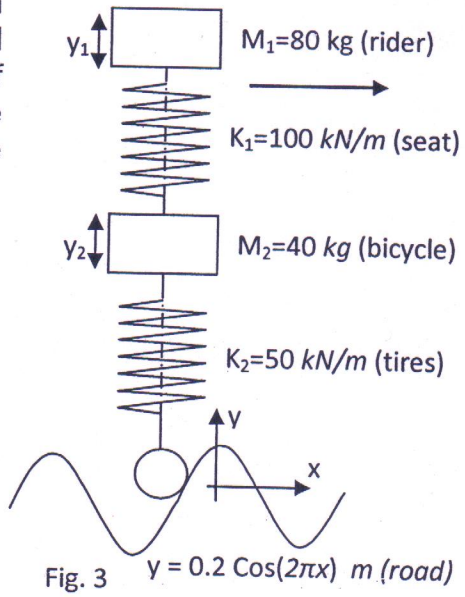


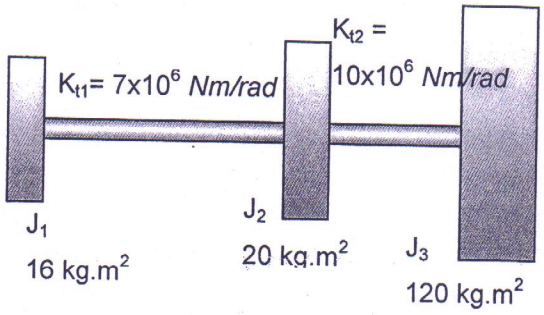
Fig. 3 y = 0.2 Cos(2πx) *m (road)*

Q.3 (b) Compute the fundamental frequency of a cantilever with concentrated mass attached at the free end using Rayleigh-Ritz method. Use single-parameter approximation: **05**

$$Y(x) = C_1\left[Sin\left(1.87\frac{x}{l}\right) + Sinh\left(1.87\frac{x}{l}\right)\right]$$

Q.4 (a) Starting with differential equation of motion of free transverse vibration of beams, show that the eigen-functions (mode shapes) are orthogonal. **05**

Q.4 (b) For a three rotor system shown in fig. 4, calculate lowest natural frequency using Holzer's method. Start with an initial guess of ω^2 = 260000 and conduct three trials. Also draw mode shape for final value of the frequency. **05**



P.T.O. for Section-B

SECTION – B (Q.5 and Q. 6)

Q.5 (a) Given a beam of acoustic wave in water to contain 100 watts of energy distributed over a circular cross section of 40 *cm* diameter. The frequency of the waves is 24 *kHz*. Determine: **08**

a. Intensity of the beam in W/cm^2
b. Sound pressure amplitude
c. Acoustic particle velocity amplitude
d. Acoustic particle displacement amplitude

Sound pressure level re 0.1 *Pa*

Q. 5 (b) Given plane waves in water of 1000 *Hz* frequency to be normally incident on a concrete wall. **06**

(a) What is resulting standing wave ratio?
(b) Where are the first two nodes located near the wall?

Q.6 A simple source (breathing sphere) of sound in air radiates spherical waves at a frequency of 400 Hz and at an acoustic power of 10 milliWatt. Calculate: **06**

a. Sound intensity at 0.5 m from the source
b. The pressure amplitude at this distance
c. Particle velocity amplitude at this distance
d. Sound pressure level at this distance

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Department of Mechanical Engineering

College of Engineering Pune

Weleslley Road, Shivaji nagar,
Pune 411005

Subject: Advance Machine Design (ME 5102)

END SEMESTER (Autumn 2011-12)

Year: FYMTech (Design) Marks: 50

Day & Date Monday 21/11/11 Time: 4 to 7pm

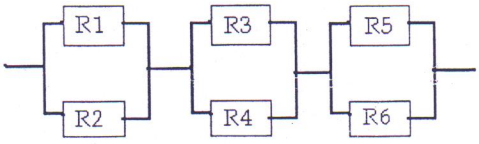
Instructions: Que. No. 2 and 5 are compulsory. Solve any two questions from rest of the questions.

Que No.1

1. Many roads in Pune are being widened so much that trees which were on the side of the original roads are now located within the road. The city will not like to cut the trees. Thus the cars and other vehicles will go on both sides of the trees. To survive in healthy manner, the roots of the trees need both air and water, usually rain water. You have got an assignment to design a system which will allow the plying of the vehicles on both sides of the trees in such a way that the obstruction is minimal. Also the roots of the tree should be able to get air and water.
   a). Construct a need statement (not too broad and not too narrow and it should have all main requirements)
   b) Develop quantitative and qualitative Specifications and Constraints
   c). Generate an idea-rack. Let the imagination fly and generate many ideas including whacky, funny, stupid, and unworkable. Note that this problem does not strictly belong to Mechanical Engineering and, therefore, you can also generate ideas which may belong more to other engineering. Communicate your ideas properly in such a way that the examiner is able to follow them. You may use sketches and words. The ideas should not be detailed but should not be too broad (general).
   d) Choose one idea for further developments. No justification required. (10)

Que. No.2

1. Analyze the following statement: Reliability of a series system is smaller than that of an individual component while that of a parallel system is larger than that of an individual component. (3)
2. Derive the expression for reliability of the following system with component reliability as shown in the figure. (2)



3. Torque transmitting capacity of a single plate clutch under uniform wear condition is given by $T = [\mu F (D+d)]/4$; where, $\mu \sim N(\text{mean } 0.4, \text{std. deviation } 0.018)$ is co efficient of friction between friction plate and clutch plate, F axial force= 2000N, D outer diameter of friction plate =250mm and d inner diameter of friction plate = 180mm.

Estimate the reliability of the clutch, if the torque required to be transmitted is given by T~N(mean 90,000Nmm, std.deviation 4000Nmm). (4)

4. The spring rate of a helical compression spring is given by equation $R = \frac{F}{\delta} = \frac{Gd^4}{8D^3N_a}$

Where, G = shear modulus with $\mu_g = 80GPa, \sigma_g = 2GPa$, d = wire diameter with $\gamma_d = 0.008$, D = coil diameter with $\mu_D = 110mm, \sigma_D = 1.0mm$ Na = no. of active coils with $\mu_{Na} = 8.5, \sigma_{Na} = 0.1$. Find the mean value of wire diameter if the spring rate of 20Nmm $\pm$ 3Nmm is to be achieved with the reliability of 99%. Hint: std.deviation of Spring rate = 3Nmm/3= 1Nmm (6)

Que. No. 3

1. Explain various steps of retrofit design. (5)
2. Explain the significance of following charts from product quality point of view. (any five)

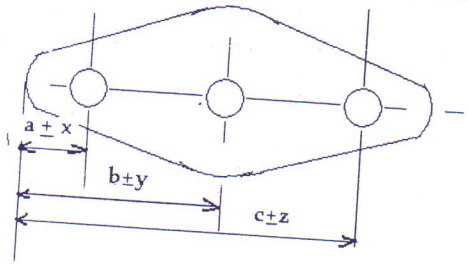
a) Pareto chart (b)X-bar chart (c) moving range chart (d) process capability chart (e)C-chart (d) Check sheet (e) histogram (f) Fish bone diagram (5)

Que, No.4

1. Evaluate the following statement: Soft prototyping is a necessary step leading to rapid prototyping. (3)
2. Explain the process of laminated object manufacturing with the help of following points: materials used, principle of operation, post processing (5)
3. Differentiate between Stereolithography and fused deposition modeling (2)

Que. No. 5

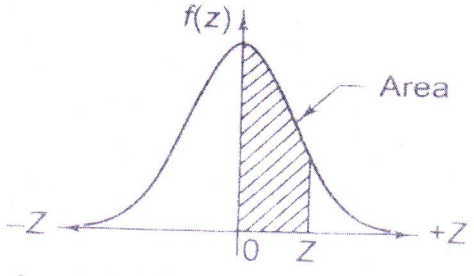
1. What is modular design? Explain with example. What is the major disadvantage of modular design? (4)
2. What are the major aspects of Design for manufacture? (4)
3. What are the major considerations while integrating adjacent parts to reduce the number of parts in an assembly? (3)
4. The part shown in the following figure is dimensioned as per the principles of DFM, which facilitates easier inspection. What is the effect of such dimensioning on the actual center distance between the holes after machining? How should the part be dimensioned as a design engineer to avoid such an effect? (3)



This part is mounted on another part with the pegs, which fit in the holes at the ends. The tolerance on the hole and peg diameter is open. What precaution the designer has to take to make the design robust? (1)

Table 24.6 Areas under normal curve from 0 to Z

	0	1	2	3	4	5	6	7	8	9
	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0754
.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2258	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
0.7	.2580	.2612	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2996	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3708	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	4Z51	.4265	.4279	.4292	.4306	.4319
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	4452	.4463	. 4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.4987	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
3.1	.4990	.4991	.4991	.4991	4992	.4992	.4992	.4992	.4993	.4993
3.2	.4993	.4993	.4994	.4994	.4994	.4994	.4994	.4995	.4995	.4995
3.3	.4995	.4995	.4995	4996	.4996	.4996	.4996	.4996	.4996	.4997
3.4	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4997	.4998
3.5	.4998	4998	.4998	4998	.4998	.4998	.4998	.4998	4998	.4998
3.6	.4998	.4998	.4999	.4999	4999	.4999	.4999	.4999	4999	.4999
3.7	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.8	.4999	4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999	.4999
3.9	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000	.5000



Area below normal curve

College of Engineering Pune

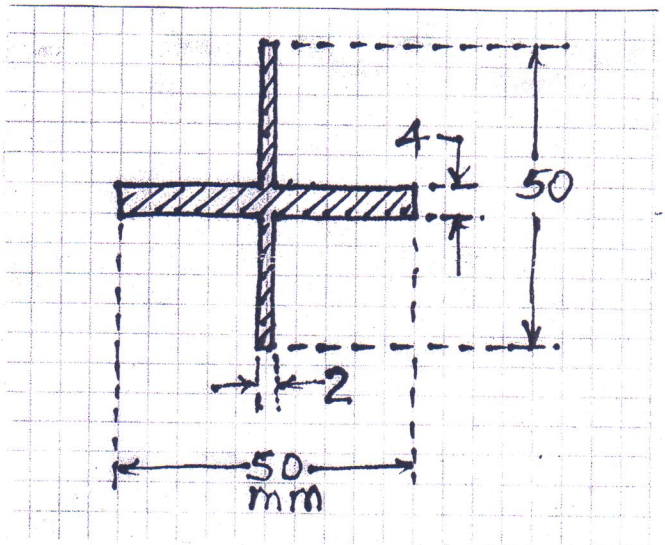
Department of Mechanical Engineering

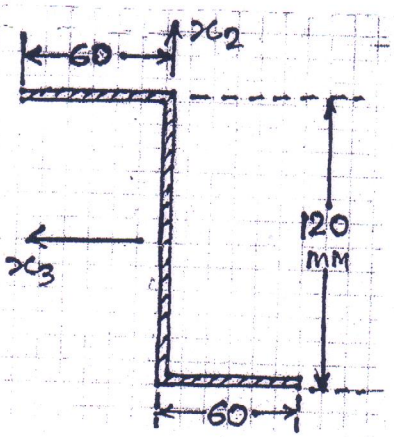
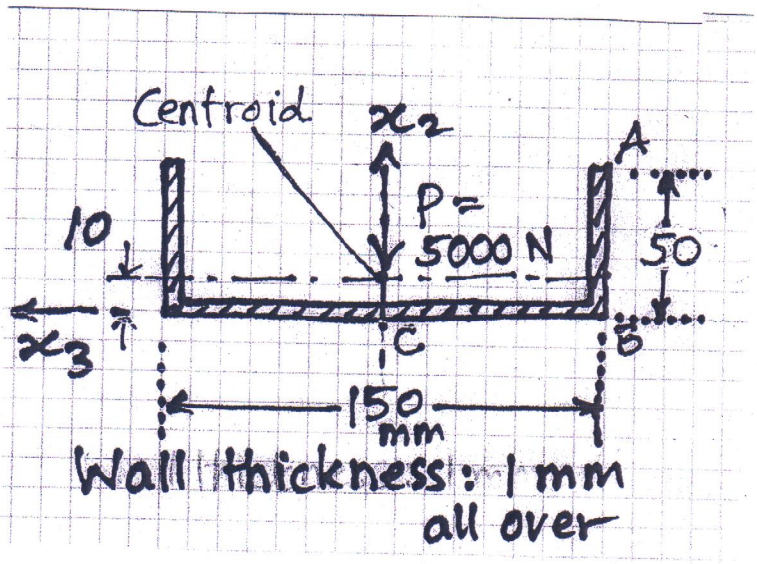
ENDSEM

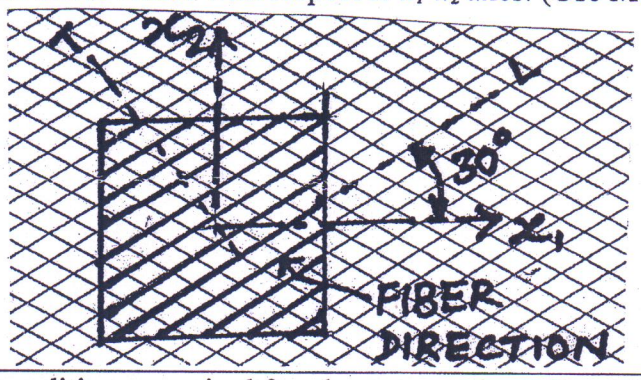
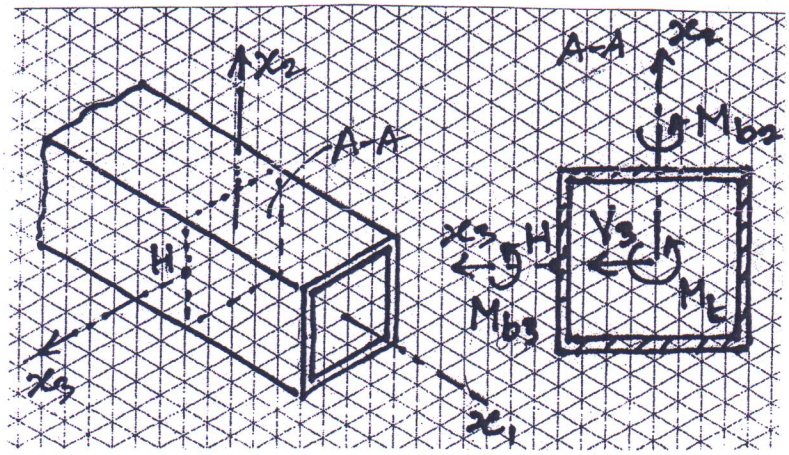
Stress Analysis (ME 5102), MTech (Design), 2011-12 (I)

Duration: 3 hours | Maximum marks: 100

- Three A-4 size formula sheets allowed
- None of the question is long. In case you are writing pages after pages, probably you are on the wrong track. Think before you start answering a question.
- Exchange of formula sheets, calculator, etc. not allowed
- Answer all parts of a question at the same place of your answer copy
- Answers should be presented along with the proper SI units and make sure that the order (exponent) is right. Incorrect units or the order are treated as serious errors.
- Use only engineering exponents.

Q1(a)	What is uniqueness theorem in elastostatics. How is it useful?	**2**
(b)	A cross member, as shown in the figure, is subjected to two moments: Torsional moment $M_t=350\ Nm$ Bending moment $M_{b3}=400\ Nm$ (i). Determine rotation per meter length in **degrees** (ii). The radius of curvature under the bending load (iii). Comment whether this member can be uses as a compliant member. If yes, for what purpose? *($E=207\ GPa$, $v=0.3$)* 	**+8** **+5** **+1** **=16**

Q2(a)	What is Saint Venant's Principle? Describe an application.	**4**
(b)	A Z-section is subjected to bending moment $M_{b3}=200$ *Nm as shown.* ($I_{23}=216x10^3$ *mm*^{4}, $E=207$ *GPa*, $v=0.3$):	
	• Determine I_{22} and I_{33}	**+2**
	• Determine the orientation of neutral plane	**+4**
	• Determine the point at which the magnitude of the stress is the highest and report the value.	**+6**
	 Wall thickness 1 mm all over	**=16**
Q3(a)	State the equations developed from (i) Conservation of linear momentum (Euler's First law) and (ii) conservation of angular momentum (Euler's Second Law). No proof required.	**4**
(b)	Determine the shear stress developed in the various segments of the channel shown in the figure. Also, report the shear stress values at points *A, B, C.*	**+12**
		**=16**

Q4(a)	Describe the symmetry of orthotropic materials (fiber composite materials).	**3**
(b)	Following strain tensor is known on a uniaxial lamina, as shown in the figure of FRP with respect to x_1-x_2 axes: $\epsilon = \begin{bmatrix} 400 & 50 \\ 50 & 200 \end{bmatrix} \mu m/m$ (i). Determine strain tensor with respect to L-T directions (Use Mohr circle approach). (ii). Determine stress tensor with respect to L-T directions if $Q_{11}=30$ *GPa*, $Q_{12}=5$ *GPa* , $Q_{22}=7$ *GPa* and $Q_{66}=3$ *GPa* (iii). Determine stress tensor with respect to x_1-x_2 axes. (Use Mohr circle approach)  	**+5** **+5** **+5** **=18**
Q5(a)	Describe the conditions, required for plane stress class of problems.	**3**
(b)	At a section of a square tube (*30 mm x 30 mm and wall=1mm all over*) following generalized loads act: $M_{b2}=300$ *Nm;* $M_{b3}=200$ *Nm:* $M_t=200$ *Nm* *Axial force* $F= 5000$ *N;* $V_3= 3000$ *N* To determine the state of stress at H, the midpoint on the side wall as shown in the figure, do the following: (i) Sketch the stress cube at point *H carefully*, (ii) show the axes on it, (iii) show the nonzero stress components on it, (iv) determine contribution of each generalized force, and (v) superpose. Determine whether the stress field at point H causes yielding; use Tresca Yield Criterion when $\sigma_{ys}=300$ *MPa.*  	**+12** **+3** **=18**

Q6(a)	How will you find principal directions at a marked point on the model of photo-elastic study?	**+4**
(b)	Show the active arms in the bridge if we bond two strain gauges on the specimen you used in the lab one at the top and the other one at the bottom surface right under the top strain gauge. We will use the half bridge circuit to have better accuracy with the higher magnitude of the output signal.	**+4**
(c)	The values of nominal stress and nominal strain of a material are given in the table below and is also plotted. Draw the curve between true stress and true strain. Detach the graph and attach it with your answer copy.	**+8** **=16**

Nominal strain	Nominal stress (MPa)	True strain	True stress (MPa)
0.02	110		
0.04	120		
0.06	128		
0.08	134		
0.10	138