JEPPIAAR ENGINEERING COLLEGE

Jeppiaar Nagar, Rajiv Gandhi Salai – 600 119

DEPARTMENT OF

MECHANICAL ENGINEERING

QUESTION BANK

VI SEMESTER

CE6306 – STRENGTH OF MATERIALS

Regulation – 2013

JEPPIAAR ENGINEERING COLLEGE

Vision of Institution

To build Jeppiaar Engineering College as an institution of academic excellence in technological and management education to become a world class university.

Mission of Institution

- To excel in teaching and learning, research and innovation by promoting the principles of scientific analysis and creative thinking.
- To participate in the production, development and dissemination of knowledge and interact with national and international communities.
- To equip students with values, ethics and life skills needed to enrich their lives and enable them to meaningfully contribute to the progress of society.
- To prepare students for higher studies and lifelong learning, enrich them with the practical and entrepreneurial skills necessary to excel as future professionals and contribute to Nation's economy.

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

JEPPIAAR ENGINEERING COLLEGE

DEPARTMENT OF MECHANICAL ENGINEERING

Vision of the Department

To create excellent professionals in the field of Mechanical Engineering and to uplift the quality of technical education on par with the International Standards.

Department Mission

1. **To reinforce** the fundamentals of Science and Mathematics to Mechanical Engineering **and critically and relatively investigate co**mplex mechanical systems and processes.
2. To engage in the **production, expansion and practice** of advanced engineering applications through knowledge sharing activities by interacting with global communities and industries.
3. To**equip** students with **engineering ethics, professional roles, corporate social responsibility** and life skills and **apply** them for the betterment of society.
4. **To promote** higher studies and lifelong learning and entrepreneurial skills and **develop** excellent professionals for empowering nation's economy.

PEO's

1. To **enrich** the technical knowledge of design, manufacturing and management of mechanical systems and **develop creative and analytical thinking** in research.
2. To **relate, strengthen and develop** the theoretical knowledge of the Mechanical Engineering by exhibiting various concepts applied through diverse industrial exposures and experts' guidance.
3. **Facilitate** the students to communicate effectively on complex social, professional and engineering activities with strict adherence to ethical principles.
4. **Create awareness for independent and life long learning and develop the ability to keep abreast of modern trends and adopt them for personal technological growth of the nation.**

PSO's

1. To understand the basic concept of various mechanical engineering field such as design, manufacturing, thermal and industrial engineering.
2. To apply the knowledge in advanced mechanical system and processes by using design and analysis techniques.
3. To develop student's professional skills to meet the industry requirements and entrepreneurial skills for improving nation's economy stronger.

CE6306 – STRENGTH OF MATERIALS
COURSE OUTCOMES

COURSE OUTCOME	Course Outcome
C202.1	Illustrate the mathematical knowledge to calculate the stresses and deformation behaviour of simple structure.
C202.2	Evaluate the shear force and bending moment of various beams with various loads.
C202.3	Examine the deflection of springs and deformation in the shaft.
C202.4	Evaluate the deflection of beams by using various methods.
C202.5	Estimate the stresses and deformation in cylinders and spheres.

CE6306 STRENGTH OFMATERIALS L T P C
3 10 4

OBJECTIVES:

To understandthe stresses developed in bars, compounds bars, beams, shafts, cylinders and spheres.

UNITI STRESS,STRAINANDDEFORMATION OFSOLIDS 9

Rigidbodiesanddeformablesolids–Tension,Compressionand ShearStresses–Deformationof simpleandcompoundbars– Thermal stresses–Elasticconstants–Volumetricstrains–Stresseson inclinedplanes–principal stressesandprincipalplanes–Mohr'scircleof stress.

UNITII TRANSVERSELOADING ON BEAMSAND STRESSES IN BEAM 9

Beams –types transverse loading onbeams– Shear force and bending moment in beams – Cantilevers–Simplysupportedbeamsandover – hanging beams.Theoryof simple bending–bendingstress distribution–Loadcarryingcapacity –Proportioningofsections–Flitchedbeams – Shearstressdistribution.

UNITIII TORSION 9

Torsion formulation stressesanddeformationincircularandhollowsshafts–Stepped shafts–Deflectioninshafts fixedatthebothends–Stressesinhelicalsprings– Deflectionofhelicalsprings, carriagesprings.

UNITIV DEFLECTIONOFBEAMS 9

DoubleIntegrationmethod–Macaulay'smethod–Areamomentmethodforcomputationofslopes anddeflections inbeams- Conjugatebeamandstrainenergy–Maxwell's reciprocaltheorems.

UNITV THIN CYLINDERS,SPHERESAND THICK CYLINDERS 9

Stressesinthincylindricalshellduetointernalpressurecircumferentialandlongitudinalstresses and deformationinthinandthickcylinders–sphericalshellssubjectedtointernalpressure–Deformation inspherical shells–Lame's theorem.

TOTAL(L:45+T:15):60PERIODS

OUTCOMES:

- Uponcompletionofthiscourse,thestudentscanabletoapplymathematicalknowledgeto calculate thedeformationbehaviorofsimplestructures.
- Criticallyanalyseproblemandsolve theproblems related tomechanical elementsandanalyse thedeformationbehaviorfordifferent typesofloads.

TEXT BOOKS:

1.Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007
2.Jindal U.C., "StrengthofMaterials", AsianBooksPvt.Ltd.,NewDelhi,2007

REFERENCES:

1.Egor.P.Popov“EngineeringMechanicsofSolids”PrenticeHall of India,NewDelhi,2001
2.SubramanianR.,"StrengthofMaterials",OxfordUniversityPress,OxfordHigherEducationSeries, 2007.
3.Hibbeler, R.C., "MechanicsofMaterials",PearsonEducation,LowPriceEdition,2007
4.FerdinandP.Been,RussellJohnson,J.r.andJohnJ.Dewole"MechanicsofMaterials",Tata McGrawHill Publishing‘co.Ltd., NewDelhi,2005.

JEPPIAAR ENGINEERING COLLEGE

Jeppiaar Nagar, Rajiv Gandhi Salai – 600 119

DEPARTMENT OFMECHANICAL ENGINEERING

QUESTION BANK

Subject : CE6303– Strength of Materials

Year / Sem : II / III

UNITI STRESS,STRAINANDDEFORMATION OFSOLIDS				
Rigid bodies and deformable solids–Tension,Compression and Shear Stresses – Deformation of simple and compound bars– Thermal stresses–Elastic constants–Volumetric strains–Stresses on inclined planes–principal stresses and principal planes–Mohr'scircleof stress.				
PART-A				
CO Mapping :C202.1				
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
1	Define stress.	**BTL-1**	Remembering	**PO1, PO12**
2	Define strain	**BTL-1**	Remembering	**PO1, PO12**
3	State hooke's law	**BTL-1**	Remembering	**PO1, PO2,PO12**
4	Define factor of safety.	**BTL-1**	Remembering	**PO1, PO12**
5	What is stability?	**BTL-1**	Remembering	**PO1, PO12**
6	Define modulus of elasticity.	**BTL-1**	Remembering	**PO1, PO2, PO12**
7	Define modulus of rigidity.	**BTL-1**	Remembering	**PO1, PO2, PO12**
8	State bulk modulus	**BTL-1**	Remembering	**PO1, PO12**
9	Define principal stresses	**BTL-1**	Remembering	**PO1, PO12**
10	State relationship between young's modulus and modulus of rigidity.	**BTL-4**	Analyzing	**PO1, PO3, PO12**
11	Give the relationship between bulk modulus and young's modulus.	**BTL-4**	Analyzing	**PO1, PO12**
12	What do you understand by a compound bar?	**BTL-1**	Remembering	**PO1, PO12**
13	Write two equations used to find the forces in compound bars made of two materials subjected to tension.	**BTL-1**	Remembering	**PO1, PO12**
14	Define strain energy density (or) modulus of resilience.	**BTL-1**	Remembering	**PO1, PO12**
15	What are the types of elastic constants?	**BTL-1**	Remembering	**PO1, PO12**
16	State the principal plane.	**BTL-1**	Remembering	**PO1, PO12**
17	Define poisson's ratio.	**BTL-1**	Remembering	**PO1, PO12**
18	Define shear stress and shear strain	**BTL-1**	Remembering	**PO1, PO12**
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
19	Determine the poisson's ratio and bulk modulus of a	**BTL-5**	Evaluating	**PO1, PO3, PO12**

	material for which young's modulus is $1.2X10^5N/mm^2$ and modulus of rigidity is $4.8X10^4N/mm^2$.			
20	A brass rod 2m long is fixed at both it ends. If the thermal stress in not to exceed $7605N/mm^2$, calculate the temperature through which the rod should be heated. Take: E=90GPa; alpha = $17X10^{-6}/K$	**BTL-5**	Evaluating	**PO1, PO3, PO12**
21	Define strain energy.	**BTL-1**	Remembering	**PO1, PO12**
22	What is resilience?	**BTL-1**	Remembering	**PO1, PO12**
23	Distinguish between suddenly applied load & impact load.	**BTL-4**	Analyzing	**PO1, PO12**
24	Derive a relation for change in length of a bar hanging freely under its our weights.	**BTL-6**	Creating	**PO1, PO12**
25	What do you mean by thermal stress?	**BTL-1**	Remembering	**PO1, PO12**
26	Draw the Mohr's circle for the state of pure shear it's a strained body and mark all salient points in it.	**BTL-1**	Remembering	**PO1, PO12**
27	Principle of superposition.	**BTL-5**	Evaluating	**PO1, PO12**
28	Define compound section.	**BTL-1**	Remembering	**PO1, PO12**
29	Find the magnitude of 'P" of a compound bar?	**BTL-1**	Remembering	**PO1, PO12**
30	How will you calculate the total elongation of a compound bar which is connected in series.	**BTL-5**	Evaluating	**PO1, PO12**
31	What is principle stress?	**BTL-1**	Remembering	**PO1, PO12**
PART-B&PART-C				
1	A rectangular block length 200mm, breath 150mm and thickness 50mm is subjected to axial force as follows; 300kN compressive in the direction of length, 500kN tensile in the direction of breadth, 200kN tensile in the direction of its thickness. Calculate the change in volume of the block also bulk modulus of the block's material. Assume $E=200KN/mm^2$ and Poisson's ratio=0.35.	**BTL-5**	Evaluating	**PO1, PO3,PO12**
2	In an experiment, a bar of 30mm diameter is subjected to a pull of 60kN. The measured extension on gauge length of 200mm is 0.09 mm and the change in diameter is 0.0039mm. calculate the Poisson's ratio and the values of three modulii.	**BTL-5**	Evaluating	**PO1, PO12**
3	As compound tube consists of a steel of 140mm internal diameter and 5mm thickness and an outer brass tube of 150mm internal diameter and 5mm thick. The two tubes are of same length. Compound tube carries an axial load of 600Kn. Find the stresses carried by each tube and amount of shortening. Length of the tube is 120mm. $E_s=2X10^5N/mm^2$, $E_b=1X10^5$ N/mm^2	**BTL-1**	Remembering	**PO1, PO12**
4	A reinforced concrete column 500mmX500mm in section is reinforced with 4 steel bars of 25mm diameter, one in each corner, the column is carrying a	**BTL-1**	Remembering	**PO1, PO12**

	load of 1000kN. Find the stresses in the concrete and steel bars. Take E for steel $=210X10^3$ N/mm^2 and E for concrete = $14X10^3 N/mm^2$.			
5	A steel rod of 20mm passes centrally through a copper tube of 50mm external diameter and 40mm internal diameter. The tube is closed at each end by rigid plates. if the temperature of the assembly is raised by 50^0C, calculate the stresses developed in copper and steel. Take $E_s=100kN/mm^2$, $E_c=100kN/mm^2$, $alphs_{s=12X10}^{-6}$ per ^{0C,} $alpha_c=18X10^{-6}$ per ^{0}C.	**BTL-5**	Evaluating	**PO1, PO12**
6	A compound bar is constructed from three bars each 50mm wide and 12mm thick fastened together to form a bar 50mm wide and 36mm thick. The middle bar is of aluminium for which E=70GPa and the outer bars are of brass for which E=100GPa. If the bars are initially fastened at 18^0C and the temperature of the whole assembly is then raised to 50^0c, determine the stresses set up in brass and aluminium. Take the coefficient of linear expression as $18X10^{-6}$ per^{0}C for brass and $22X10^{-6}$ per ^{0}C for aluminium. What will be the changes in these stresses if an external compressive load of 15kN is then applied on the bar?	**BTL-5**	Evaluating	**PO1, PO12**

UNITII TRANSVERSELOADING ON BEAMSAND STRESSES IN BEAM

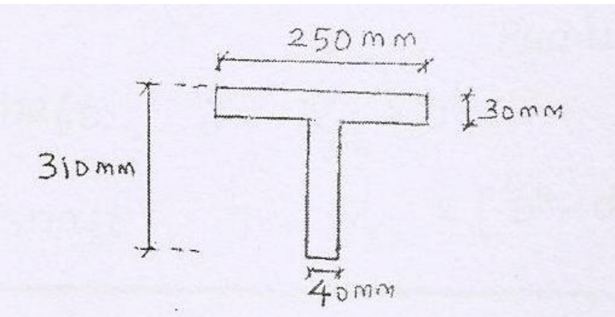
Beams –types transverse loading onbeams– Shear force and bending moment in beams – Cantilevers– Simplysupportedbeamsandover – hanging beams.Theoryof simple bending– bendingstress distribution– Loadcarryingcapacity –Proportioningofsections–Flitchedbeams – Shearstressdistribution.

PART-A

CO Mapping : C202.2

Q.No.	Questions	BT Level	Competence	PO
1	Define beam.	**BTL-1**	Remembering	**PO1, PO12**
2	Define shear force and bending moment at a section.	**BTL-1**	Remembering	**PO1, PO12**
3	Define the term point of contraflexure.	**BTL-1**	Remembering	**PO1, PO12**
4	What is SF and BM diagrams?	**BTL-1**	Remembering	**PO1, PO12**
5	Write the relation between SF andBM.	**BTL-1**	Remembering	**PO1, PO12**
6	What is the maximum BM in a SSB of span ‘L’ subjected to UDL of W over the entire span?	**BTL-1**	Remembering	**PO1, PO3, PO12**
7	Calculate the BM at fixed end of cantilever beam shown.	**BTL-5**	Evaluating	**PO1, PO2, PO12**
8	What will be the SF and BM diagrams for SSB of length ‘l’ subjected to central point load ‘W’?	**BTL-1**	Remembering	**PO1, PO12**

9	Draw SF and BM diagram for a cantilever beam of span ‘L’ carrying a point load ‘W’ at a distance of ‘a’ from free end.	**BTL-1**	Remembering	**PO1, PO2, PO12**
10	Write down the expression for shear stress distribution in a beam subjected to shear force F.	**BTL-1**	Remembering	**PO1, PO12**
11	Write the formula to find the shear stress distribution for a rectangular beam section and sketch the shear stress distribution.	**BTL-1**	Remembering	**PO1, PO12**
12	Sketch the shear stress distribution in a beam made of hallow circular section.	**BTL-1**	Remembering	**PO1, PO12**
13	Draw shear stress distribution of I symmetrical section.	**BTL-1**	Remembering	**PO1, PO12**
14	Draw shear stress distribution in the case of T symmetrical section.	**BTL-1**	Remembering	**PO1, PO12**
15	What is the value of maximum shear stress in a rectangular cross section?	**BTL-1**	Remembering	**PO1, PO12**
16	Write down the bending equations.	**BTL-1**	Remembering	**PO1, PO12**
17	What are the assumption made in theory of bending?	**BTL-1**	Remembering	**PO1, PO12**
18	Define “section modulus’.	**BTL-1**	Remembering	**PO1, PO12**
19	State theory of simple bending.	**BTL-1**	Remembering	**PO1, PO12**
20	Write section modulus for circular and hollow circular section?	**BTL-1**	Remembering	**PO1, PO12**
21	What are the different types of beams?	**BTL-1**	Remembering	**PO1, PO12**
22	What are the types of loads?	**BTL-1**	Remembering	**PO1, PO12**
23	List the various types of supports.	**BTL-1**	Remembering	**PO1, PO12**
24	What is meant by transverse loading of beam?	**BTL-1**	Remembering	**PO1, PO12**
25	What are filched beam?	**BTL-1**	Remembering	**PO1, PO12**
26	What is meant by positive or sagging bending moment?	**BTL-1**	Remembering	**PO1, PO12**
27	What is meant by negative or hogging bending moment?	**BTL-1**	Remembering	**PO1, PO12**
28	What is meant by modulus of rupture?	**BTL-1**	Remembering	**PO1, PO12**
29	Define moment of resistance.	**BTL-1**	Remembering	**PO1, PO12**
30	List out some properties of SF & BM diagram.	**BTL-1**	Remembering	**PO1, PO12**
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
PART-B&PART-C				
1	A cantilever beam of span 6mm carries a uniformly distributed load W per meter run. If the bending	**BTL-1**	Remembering	**PO1, PO2, PO12**

	stress is not to exceed 100N/mm^2, find the safe load W. the cross section of the beam is 100mm wide and 200mm deep.			
2	Drive the bending formula M/I=f/y=E/R.	**BTL-6**	Creating	**PO1, PO3, PO12**
3	A timber beam of rectangular section is to support a total load of 20kN uniformly distributed over a span of 3.6 m when the beam is simply supported. If the depth is twice the width of the section and the stresses in timber is not to exceed 3.5 N/mm^2, find the dimensions of the section?	**BTL-1**	Remembering	**PO1, PO2, PO12**
4	A water main of 1200 mm internal diameter and 12mm thick is running full. If the bending stress is not to exceed 56N/mm^2. Find the greatest span on which the pipe may be simply supported. Steel and water weigh 76.8kN/m^3 and 10kN/m^3 respectively.	**BTL-1**	Remembering	**PO1, PO2, PO12**
5	A simply supported beam of span 6m and of 1 section has flange 40mm X5mm. bottom flange of 60mm X 5mm depth of 100mm and web thickness 5mm. it carries a UDL of 2 kN/m over the full span. Calculate the maximum tensile stress and maximum compressive stress produced.	**BTL-5**	Evaluating	**PO1, PO2, PO12**
6	A beam of T section shown in figure is subjected to a shear force of 20kN. Find the stress at the. i. Neutral axis and ii. Junction of flange and web. Also sketch the stress distribution diagram. 	**BTL-1**	Remembering	**PO1, PO2, PO12**

UNITIII TORSION

Torsion formulation stressesanddeformationincircularandhollowsshafts–Stepped shafts– Deflectioninshafts fixedatthebothends–Stressesinhelicalsprings– Deflectionofhelicalsprings, carriagesprings.

PART-A

CO Mapping : C202.3

Q.No.	Questions	BT Level	Competence	PO
1	What are the assumptions made in torsion equations?	**BTL-1**	Remembering	**PO1, PO12**
2	Why hollow circular shafts are preferred when compared to solid circular shafts?	**BTL-1**	Remembering	**PO1, PO12**
3	Write the polar modulus for solid shaft and circular shaft.	**BTL-1**	Remembering	**PO1, PO12**
4	Write down the equation for maximum shear stress of a solid circular section in diameter ‘D’ when subjected to torque ‘T’.	**BTL-1**	Remembering	**PO1, PO12**
5	Define torsional rigidity.	**BTL-1**	Remembering	**PO1, PO12**
6	Write an expression for angle of twist for a hollow circular shaft with external diameter D, internal diameter d, length l and rigidity modulus (c).	**BTL-1**	Remembering	**PO1, PO12**
7	What is the power transmitted by circular shaft.	**BTL-1**	Remembering	**PO1, PO12**
8	Calculate the maximum torque that a shaft of 125mm diameter can transmit, if the maximum angle of twist is 1^0 in a length of 1.5m. take $c=70X10^3 N/mm^2$.	**BTL-5**	Evaluating	**PO1, PO12**
9	Differentiate between closed coli and open coil helical spring.	**BTL-5**	Evaluating	**PO1, PO12**
10	Give shear stress and deflection relation for closed coil helical spring.	**BTL-1**	Remembering	**PO1, PO12**
11	An open coiled helical spring of mean radius of coil of 20cm and helix angle 12^0 is subjected to an axial load of kN. What is the bending moment in coil?	**BTL-1**	Remembering	**PO1, PO12**
12	What kind of stress induced when axial load acts on closed and open coiled spring?	**BTL-1**	Remembering	**PO1, PO12**
13	The angle of helix of a spring is α, write down equations for torque and moment under an axial load ‘W’ at free end.	**BTL-1**	Remembering	**PO1, PO12**
14	Write down the equation for shear energy of a close coiled spring.	**BTL-1**	Remembering	**PO1, PO12**
15	What is meant by stiffness? What is the formula for the stiffness of a close coiled helical spring subjected to an axial load.	**BTL-1**	Remembering	**PO1, PO12**
16	What are the uses of closed coiled helical spring?	**BTL-1**	Remembering	**PO1, PO12**
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
17	Write the expression for maximum shear stress and deflection of a closed coil helical spring subjected to axial load (or) vertical load W?	**BTL-1**	Remembering	**PO1, PO12**

18	Write down the equation for deflection of an open coiled helical spring subjected to axial load W?	**BTL-1**	Remembering	**PO1, PO12**
19	A close coiled helical spring is to carry an axial load of 500N. its mean coil diameter is to be 10 times its wire diameter. Calculate these diameters if the maximum shear stress in the material is to be 80MPa.	**BTL-5**	Evaluating	**PO1, PO12**
20	Define polar modulus of a section.	**BTL-1**	Remembering	**PO1, PO12**
21	What do you meant by torsion?	**BTL-1**	Remembering	**PO1, PO12**
22	Write the governing equation for torsion of circular shaft?	**BTL-1**	Remembering	**PO1, PO12**
23	What type of stress induced in a structural member subjected to torsional load?	**BTL-2**	Understanding	**PO1, PO12**
24	Why the shear stress is maximum at the outer surface of the shaft than the inner core?	**BTL-2**	Understanding	**PO1, PO12**
25	What is torsional stiffness?	**BTL-1**	Remembering	**PO1, PO12**
26	Define spring also list out types of springs.	**BTL-2**	Understanding	**PO1, PO12**
27	What are the various types of springs?	**BTL-1**	Remembering	**PO1, PO12**
28	State any two major function of a spring.	**BTL-1BTL-2**	Remembering Understanding	**PO1, PO12**
29	What is solid length in spring?	**BTL-1**	Remembering	**PO1, PO12**
30	What is bucking of spring?	**BTL-2**	Understanding	**PO1, PO12**
31	Define Career Management.	**BTL-1**	Remembering	**PO1, PO12**

PART-B & PART-C

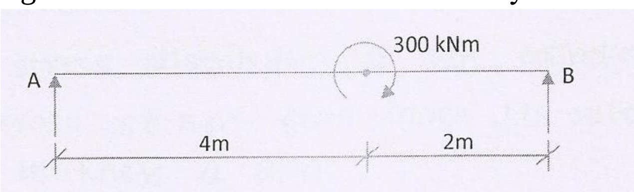
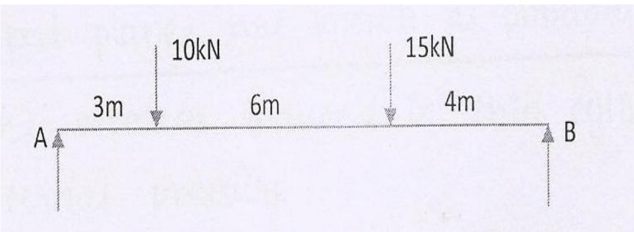
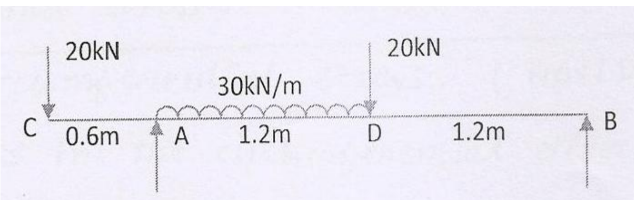
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
1	(i)obtained a relation for the torque and power, a solid shaft can transmit. (ii)a solid steel shaft has to transmit 100k.w at 160rpm. Taking allowable shear stress as 70MPa, find the suitable diameter of the shaft. The maximum torque transmitted in each revolving exceeds the mean by 20%	**BTL-1**	Remembering	**PO1, PO12**
2	A hollow steel shaft of outside diameter 75 mm is transmitting a power of 300kW at 2000 rpm. Find the thickness of the shaft if the maximum shear stress is not to exceed 40 N/mm^2.	**BTL-1**	Remembering	**PO1, PO12**

Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
3	A solid cylindrical shaft is to transmit 300kN power at 100 rpm. If the shear stress is not to exceed $60N/mm^2$, find its diameter. What percent saving in weight would be obtained if this shaft is replaced by a	**BTL-1**	Remembering	**PO1, PO12**

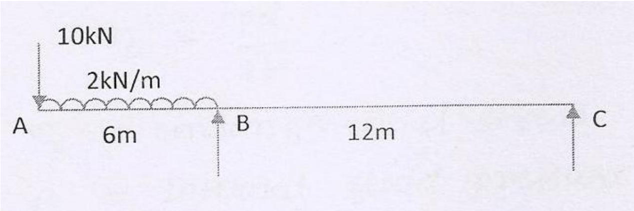
	hollow one whose internal diameter equals to 0.6 of the external diameter, the length, the material and maximum shear stress being the same.			
4	Derive an expression for the shear stress produced in a circular shaft which is subjected to torsion. What are the assumptions made in the derivations?	**BTL-6**	Creating	**PO1, PO12**
5	A closed coiled helical spring is to have a stiffness of 1.5 N/mm of compression under a maximum load of 60N. the maximum shearing stress produced in the wire of the spring is 125 N/mm^2. The solid length of the spring is 50mm. find the diameter of coil, diameter of wire and number of coils C=4.5 X 10^4.	**BTL-1**	Remembering	**PO1, PO12**
6	A closely coiled helical spring of round steel wire 10mm in diameter having 10 complete turns with a mean diameter of 12 cm is subjected to an axial load of 250N. determine. i.the deflection of the spring. ii.maximum shear stress in the wire. iii.stiffness of the spring and iv.frquency of vibration.	**BTL-5**	Evaluating	**PO1, PO12**
7	A close coiled helical spring is required to absorb 2250 joules of energy. Determine the diameter of the wire, the mean coil diameter of the spring and the number of coils necessary if (i) the maximum stress is not exceed 400MPa, (ii) the maximum compression of the spring is limited to 250mm and (iii) the mean diameter of the spring is eight times the wire diameter. For the spring material, rigidity modulus is 70GPa.	**BTL-5**	Evaluating	**PO1, PO12**

UNITIV DEFLECTIONOFBEAMS
DoubleIntegrationmethod–Macaulay’smethod–Areamomentmethodforcomputationofslopes anddeflections inbeams- Conjugatebeamandstrainenergy–Maxwell’s reciprocaltheorems.
PART-A
CO Mapping : C202.4

Q.No.	Questions	BT Level	Competence	PO
1	State any two assumption made in Euler's column theory.	**BTL-1**	Remembering	**PO1, PO12**
2	State slenderness ratio.	**BTL-1**	Remembering	**PO1, PO12**
3	Define crippling load (or) critical load (or) buckling load.	**BTL-1**	Remembering	**PO1, PO12**
4	A cantilever beam of spring 2m is carrying a point load of 20 kN at its free end. Calculate the slope at the free end. Assume EI=12 X 10^3kN-m^2.	**BTL-5**	Evaluating	**PO1, PO12**
5	Calculate the maximum deflation of a SSB carrying a point load of 100kN at midspan. Span = 6m, EI=20000kN-m^2.	**BTL-5**	Evaluating	**PO1, PO12**
6	What is the maximum deflection is a SSB subjected to UDL over the entire span?	**BTL-1**	Remembering	**PO1, PO12**
7	Give the effective length of the column's	**BTL-1**	Remembering	**PO1, PO12**
8	List four methods of determining slope and deflection of a loaded beam.	**BTL-1**	Remembering	**PO1, PO12**
9	Describe double integration method.	**BTL-1**	Remembering	**PO1, PO12**
10	What is the relation between slop, deflection and radius of curvature of a beam?	**BTL-1**	Remembering	**PO1, PO12**
11	State the expression for slope and deflection at the free end of a cantilever beam of length 'L' subjected to a uniformly distributed load of 'W' per unit length.	**BTL-1**	Remembering	**PO1, PO12**
12	In a SSB of 3m span carrying UDL throughout the length, the slope at the support is the maximum deflection in the beam?	**BTL-1**	Remembering	**PO1, PO12**
13	State Euler's formula for cripping load.	**BTL-1**	Remembering	**PO1, PO12**
14	What are the limitations of Euler's formula?	**BTL-1**	Remembering	**PO1, PO12**
15	What do you mean by flexural rigidity?	**BTL-1**	Remembering	**PO1, PO12**
16	Define the term slope.	**BTL-1**	Remembering	**PO1, PO12**
17	Define deflection.	**BTL-1**	Remembering	**PO1, PO12**
18	List out the relationship exist between slope, deflection, bending moment and the load.	**BTL-1**	Remembering	**PO1, PO12**
19	State the principle involved in finding the slope and deflection of beam using moments – area theorem.	**BTL-1**	Remembering	**PO1, PO12**
20	What is meant by elastic curve?	**BTL-1**	Remembering	**PO1, PO12**
21	When Macaulay's method is preferred?	**BTL-1**	Remembering	**PO1, PO12**
22	What are the boundary conditions for a simply supported end beam	**BTL-1**	Remembering	**PO1, PO12**
23	What are the boundary conditions for a fixed end?	**BTL-1**	Remembering	**PO1, PO12**
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
24	What is meant by determinate beams?	**BTL-1**	Remembering	**PO1, PO12**
25	Give examples for determinate & indeterminate	**BTL-1**	Remembering	**PO1, PO12**

	beam.			
26	Describe the boundary condition that can be used for finding out the values of the constant of integration in case of common types beams.	**BTL-6**	Creating	**PO1, PO12**
27	Write down the moment – curvature relationship?	**BTL-1**	Remembering	**PO1, PO12**
28	Explain the procedure for of finding the slope and deflection of a beam using machaulay's method?	**BTL-2**	Understanding	**PO1, PO12**
29	Write the equation of deflection of a bent beam	**BTL-1**	Remembering	**PO1, PO12**
30	Write the equation of deflection by moment area method?	**BTL-1**	Remembering	**PO1, PO12**
PART-B& PART-C				
1	A cantilever Ab, 2m long, is carrying a load of 20kN at free end and 30kN at a distance 1 m from the free end, find the slope and deflection at the free end. Take E=200GPa and I=150 X 10^6mm^4.	**BTL-1**	Remembering	**PO1, PO12**
2	Find the maximum deflection of the beam shown id fig. IE= 1 X 10^{11}kN/mm^2. Use Macaulay's method. 	**BTL-1**	Remembering	**PO1, PO12**
3	A beam AB of length 8m is simply supported at its ends and carries two point loads of 50kN and 40kN at a distance of 2m and 5m respectively from left support A. determine, deflection under each load, maximum deflection and the position at which maximum deflection occurs. Take E=2 X 10^5N/mm^2 and I=85 X10^6mm^4.	**BTL-5**	Evaluating	**PO1, PO12**
4	A beam is loaded as shown in fig. determine the deflection under the load points. Take E=200 GPA and I-160 X 10^6mm^4. 	**BTL-5**	Evaluating	**PO1, PO12**
5	In the beam shown in fig. determine the slope at the left end C and the deflection at 1 m from the left end. Take EI=0.65MNm^2. 	**BTL-1**	Remembering	**PO1, PO12**
6	Find the maximum downward and upward	**BTL-1**	Remembering	**PO1, PO12**

	deflections for the beam shown below in fig. EI = 40000 kNm^2.			



UNITV THIN CYLINDERS,SPHERESAND THICK CYLINDERS

Stressesinthincylindricalshellduetointernalpressurecircumferentialandlongitudinalstresses and deformationinthinandthickcylinders–sphericalshellssubjectedtointernalpressure–Deformation inspherical shells–Lame's theorem.

PART-A

CO Mapping : C202.5

Q.No.	Questions	BT Level	Competence	PO
1	What are assumptions involved in the analysis of thin cylindrical shells?	**BTL-1**	Remembering	**PO1, PO12**
2	Define principles planes and principal stresses.	**BTL-1**	Remembering	**PO1, PO12**
3	List out the stresses induced in thin cylindrical shell due to internal pressure.	**BTL-1**	Remembering	**PO1, PO12**
4	Define circumferential stress.	**BTL-1**	Remembering	**PO1, PO12**
5	List out the modes of failure in thin cylindrical shell due to an internal pressure?	**BTL-1**	Remembering	**PO1, PO12**
6	A storage tank of internal diameter 280mm is subjected to an internal pressure of 2.5MPa. find the thickness of the tank, if hoop and longitudinal stress are 75MPa and 45MPa respectively.	**BTL-1**	Remembering	**PO1, PO12**
7	A thin cylinder closed at both ends is subjected to an internal pressure of 2MPa. Its internal diameter is 1m and the wall thickness is 10mm. what is that maximum shear stress in the cylinder material?	**BTL-1**	Remembering	**PO1, PO12**
8	A spherical shell of 1m internal diameter undergoes a diametral strain of 10^{-4} due to internal pressure. What is the corresponding change in its internal volume?	**BTL-1**	Remembering	**PO1, PO12**
9	How will you find major principal stress and minor principal stress? Also mention how to locate the direction of principal planes.	**BTL-1**	Remembering	**PO1, PO12**
10	The principal stress at a point are 100N/mm^2 (tensile) and 50 N/mm^2 (compressive) respectively. Calculate the maximum shear stress at this point.	**BTL-5**	Evaluating	**PO1, PO12**
Q.No.	**Questions**	**BT Level**	**Competence**	**PO**
11	Give the expression for maximum shear stress in a two dimensional stress system.	**BTL-1**	Remembering	**PO1, PO12**
12	Give the expression for stress on a inclined plane when subjected to a axial pull.	**BTL-1**	Remembering	**PO1, PO12**

13	Write the expressions for a normal stress on an inclined plane in a block which is subjected to two mutually perpendicular normal stress and shear stress?	**BTL-1**	Remembering	**PO1, PO12**
14	A bar of cross sectional area 600mm^{2}is subjected to a tensile load of 50kN applied at each end. Determine the normal stress on a plane inclined at 30^0 to the direction of loading.	**BTL-5**	Evaluating	**PO1, PO12**
15	What is the radius of mohr's circle? Give the use of mohr's circle.	**BTL-1**	Remembering	**PO1, PO12**
16	What are the planes along which the greatest shear stress occur?	**BTL-1**	Remembering	**PO1, PO12**
17	In case of equal like principal stress, what is the diameter of the mohr's circle?	**BTL-1**	Remembering	**PO1, PO12**
18	What is the ratio of circumferential stress to longitudinal stress of a thin cylinder	**BTL-1**	Remembering	**PO1, PO12**
19	In a thin cylinder will the radial stress vary over the thickness of wall?	**BTL-1**	Remembering	**PO1, PO12**
20	For thin cylinder, write down the equation for train along the circumferential direction and longitudinal direction.	**BTL-1**	Remembering	**PO1, PO12**
21	For thin cylinder, write down the expression for volumetric strain.	**BTL-1**	Remembering	**PO1, PO12**
22	In thin spherical shell, write down the expression for circumferential strain, volumetric strain and circumferential stress.	**BTL-1**	Remembering	**PO1, PO12**
23	In a thin cylindrical shell if hoop strain is 0.2 X 10^{-3} and longitudinal strain is 0.05 X 10^{-3}, find volumetric strain.	**BTL-1**	Remembering	**PO1, PO12**
24	Write the equation for the change in direction and length of a thin cylinder shell, when subjected to an internal pressure.	**BTL-1**	Remembering	**PO1, PO12**
25	Differentiate between thin cylinder and thick cylinder.	**BTL-5**	Evaluating	**PO1, PO12**
26	Distinguish between cylindrical shell and spherical shell.	**BTL-5**	Evaluating	**PO1, PO12**
27	What are major classification of a pressure vessel?	**BTL-1**	Remembering	**PO1, PO12**
28	Define hoop stress.	**BTL-1**	Remembering	**PO1, PO12**
29	Define longitudinal stress.	**BTL-1**	Remembering	**PO1, PO12**
30	What is the effect of reverting a thin cylindrical shell.	**BTL-1**	Remembering	**PO1, PO12**
PART-B& PART-C				
1	A cylindrical vessel 2 m long and 500 mm in diameter with 10 mm thick plates is subjected to an internal pressure of 3MPa. Calculate the change in volume of the vessel. Take E=200GPa and poisson's ratio = 0.3 for the vessel material.	**BTL-5**	Evaluating	**PO1, PO12**
2	A spherical shell of 2 m diameter is made up of 10 mm thick plates. Calculate the change in diameter and volume of the shell, when it is subjected to an	**BTL-5**	Evaluating	**PO1, PO12**

	internal pressure of 1.6 MPa. Take E=200GPa and 1/m =0.3.			
3	A cylindrical shell 3 m long which is closed at the ends, has an internal diameter of 1 m and a wall thickness of 20 mm. calculate the circumferential and longitudinal stress induced and also changes in the dimensions of the shell, if it is subjected to an internal pressure of 2.0 N/mm^{2}and 1/m =0.3.	**BTL-5**	Evaluating	**PO1, PO12**
4	Derive the expressions for hoop stress and longitudinal stress in a thin cylinder with ends closed by rigid flanges and subjected to an internal fluid pressure. Take the internal diameter and shell thickness of the cylinder to be 'd' and 't' respectively.	**BTL-6**	Creating	**PO1, PO12**
5	A thin cylindrical shell 1.5 m long, internal diameter 300 mm and wall thickness 10mm is filled up with a fluid at atmospheric pressure. If the additional fluid of 300 x 10^3 mm^3 is pumped in the shell, find the pressure exerted by the fluid on the shell. Take E=2 X10^5 N/mm^2 and 1/m=0.3. also find the hoop stress induced.	**BTL-1**	Remembering	**PO1, PO12**
6	A spherical shell of 800mm diameter and 10mm thickness is filled with fluid under pressure till volume increase by 120 cm^3. Calculate the pressure exerted by the fluid on the shell if E=2 x 10^6 kg/cm^{2}and 1/m=0.3.	**BTL-5**	Evaluating	**PO1, PO12**

UNITI STRESS,STRAINANDDEFORMATION OFSOLIDS

Rigidbodiesanddeformablesolids–Tension,Compressionand ShearStresses–Deformationof simpleandcompoundbars– Thermal stresses–Elasticconstants–Volumetricstrains–Stresseson inclinedplanes–principal stressesandprincipalplanes–Mohr'scircleof stress.

PART-A

1. Define stress.

The fore of resistance offered by a body against the deformation per unit area is called stress.It is denoted by sigma, it's unit is N/m^2.

$$\text{Stress } (\sigma) = \frac{\text{Force } (F)}{\text{Area } (A)}$$

2. Define strain.

Strain may be defined as the deformation per unit length.

$$\text{strain} = \frac{\text{change in length}}{\text{original length}} \quad \text{i.e. } e = \frac{\delta l}{l}$$

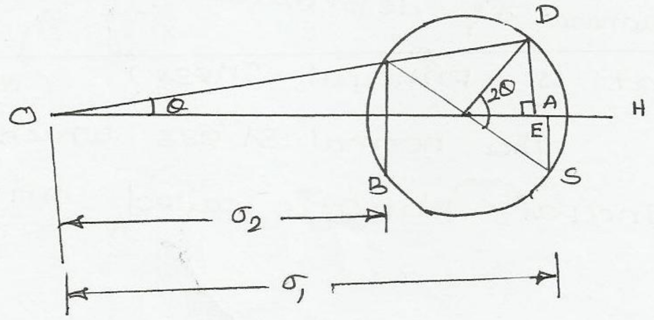
3. State Hooke's law. (April/May 2009) It states that when a material is loaded within its elastic limit, the stress is directly proportional to strain. stress $\propto$ strain $\sigma \propto e$. i.e. $\sigma = Ee$. $E = \frac{\sigma}{e}$. Unit is N/mm^2.
4. Define factor of safety. (April May 2010) It is defined as the ratio of ultimate tensile stress to the permissible stress (working stress) $$\text{Factor of safety} = \frac{\text{Ultimate stress}}{\text{Permissible stress}}$$
5. What is stability? (April May 2015) The stability may be defined as the ability of a material to withstand high load without major deformation.
6. Define modulus of elasticity. April May 2014 When a body is stressed within its elastic limit, the ratio of tensile stress to corresponding tensile strain is constant. This ratio is known as Young's Modulus. $$\text{Modulus of elasticity } (E) = \frac{\text{Tensile stress}}{\text{Tensile strain}}.$$
7. Define modulus of rigidity. (April May 2013) When a body is stressed within its elastic limit, the ratio of shearing stress to corresponding shearing strain is constant. This ratio is known as Modulus of rigidity $$\left.\begin{array}{c}\text{Modulus of rigidity (or)}\\ \text{shear modulus}\end{array}\right\} G = \frac{\text{Shearing stress}}{\text{Shearing strain}}.$$

8. State Bulk Modulus. (AP/MAY 2010, NOV/DE 2007) when a body is stressed within its elastic limit, the ratio of direct stress to corresponding volumetric strain is constant. This ratio is known as Bulk Modulus. $$\text{Bulk Modulus}, K = \frac{\text{Direct stress}}{\text{volumetric strain}}$$	
9. Define principal stresses. (April/May 2015), 2009. The normal stresses acting on the principal plane are known as principal stresses.	
10. State relationship between Young's modulus and Modulus of rigidity. (NOV/DEC 2014) (Jun 2007) $$E = 2G\left(1 + \frac{1}{m}\right)$$ where, E = Young's modulus, N/mm^2 G = Modulus of rigidity, N/mm^2 $1/m$ = Poisson's ratio.	
11. Give the relationship between the Bulk modulus and young's modulus. (April/may 2008) $E = 3K\left(1 - \frac{2}{m}\right)$, where E – Young's modulus K = Bulk modulus $1/m$ = Poisson's ratio.	
12. What do you understand by a compound bar? (April/May 2011) A compound bar is composed of two or more different materials which are joined together, so that the system is elongated (or) compressed as a single unit.	

13. Write two equations used to find the forces in compound bars made of two materials subjected to tension. (i) change in length of bar (1) = change in length of bar (2) $\frac{P_1 L_1}{A_1 E_1} = \frac{P_2 L_2}{A_2 E_2}$ (ii) Total load P = {Load carried by bar (1)} + {Load carried by bar (2)} $P = P_1 + P_2$
14. Define strain energy density (or) modulus of resilience (NOV/DE 2014) Strain energy density is defined as maximum strain energy that can be stored in a material within the elastic limit per unit volume.
15. What are the types of elastic constants? * Modulus of Elasticity (E) * Bulk Modulus (K) * Shear Modulus (G)
16. State principal plane. (April/May,11,2015) 2009, The plane which have no shear stress is known as principal plane. They carry only normal stresses.
17. Define Poisson's ratio. (NOV/DEC 2007) (May/Jun 2009), When a body is stressed within its elastic limit, the ratio of lateral strain to the longitudinal strain is constant for a given material. μ (or) $\frac{1}{m} = \frac{\text{lateral strain}}{\text{longitudinal strain}}$.

18. Define shear stress and shear strain.   The two equal and opposite forces act tangentially on any cross sectional plane of a body tending to slide one part of the body over the other part. The stress induced in that section is called shear stress and the corresponding strain is known as shear strain.
19. Determine the Poisson's ratio and bulk modulus of a material for which Yong's modulus is 1.2×10^5 N/mm² and modulus of rigidity is 4.8×10^4 N/mm²   Gn: $E = 1.2\times10^5$ N/mm² ; $G = 4.8\times10^4$ N/mm²   To find: (i) $1/m$ (ii) K (i) $E = 2G\left(1+\frac{1}{m}\right) \Rightarrow 1/m = 0.25$ (ii) $E = 3K\left(1-\frac{2}{m}\right) \Rightarrow K = 8\times10^4$ N/mm².
20. A brass rod 2m long is fixed at both it ends. If the thermal stress in not to exceed 76.5 N/mm², calculate the temperature through which the rod should be heated. Take $E = 90$ GPa ; $\alpha = 17\times10^{-6}$/K.   Gn: $E = 90\text{GPa} = 90\times10^9 \text{ N/m}^2 = 90\times10^3 \text{ N/mm}^2$; $\alpha = 17\times10^{-6}$/K $\sigma = 76.5$ N/mm² $\sigma = \alpha T E$ $76.5 = 17\times10^{-6}\times T\times 90\times10^3$ $T = 50$K
21. Define strain energy. (M/June 2012)   It is the energy absorbed or stored by a member when work is done on it.

22.	What is resilience? (A/M 2010), (M/J 2014)(A/M 2015) The strain energy stored by the body within elastic limit, when loaded externall is called resilience.
23.	Distinguish between suddenly applied load & Impact load. When the load is applied all of a sudden and not step wise is called as suddenly applied load. The load which falls from a height or strike and body with certain momentum is called impact load.
24.	Derive a relation for change in length of a bar hanging freely under its own weights. (NOV/DEC 2014) Change in length $dL = \frac{WL}{2AE}$ W - Load in N L - Length in mm. A - Area in mm^2 E - Young's modulus
25.	What do you mean by Thermal stress? (A/M 2015) It is the stresses induced in a body due to change in temperature.
26.	Draw the mohr's circle for the state of pure shear in a strained body and mark all salient points in it. (April/May 2015)



27. Principle of superposition.	

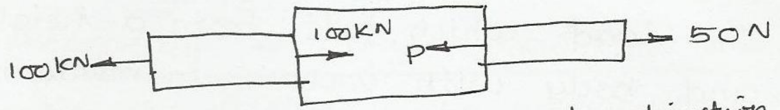
27. ~~Define~~ Principle of superposition.

The effect produced by several causes can be obtained by combining the effect due to individual causes (forces/actions).

28. Define compound section. (April/May 2015)

When a member consist of segments or components of different cross-sectional area but of the same material, it is called as compound section.

29. Find the magnitude of 'P' of a compound bar?



Sum of all the forces acting in left direction = sum of all the forces acting right direction

$$100 + P = 100 + 50$$

$$\boxed{P = 50KN}$$

30. How will you calculate the total elongation of a compound bar which is connected in series.

Using the following relations.

$$\delta l = \delta l_1 + \delta l_2 + \delta l_3 + \dots \delta l_n$$

$$= \frac{P_1 L_1}{A_1 E_1} + \frac{P_2 L_2}{A_2 E_2} + \dots \frac{P_n L_n}{A_n E_n}$$

where δl_i - deformation on individual bar.

31. What is principal stress? (May 2009)

The normal stress which is acting on the principal plane is called principal stress.

PART-B

1.A rectangular block length 200mm, breath 150mm and thickness 50mm is subjected to axial force as follows; 300kN compressive in the direction of length, 500kN tensile in the direction of breadth, 200kN tensile in the direction of its thickness. Calculate the change in volume of the block also bulk modulus of the block's material. Assume E=200KN/mm^2 and Poisson's ratio=0.35.

Refer: "Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999", Page No from 62 to 65.

2.In an experiment, a bar of 30mm diameter is subjected to a pull of 60kN. The measured extension on gauge length of 200mm is 0.09 mm and the change in diameter is 0.0039mm. calculate the Poisson's ratio and the values of three modulii.(MAY 2010)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No from 62 to 65.*

3.As compound tube consists of a steel of 140mm internal diameter and 5mm thickness and an outer brass tube of 150mm internal diameter and 5mm thick. The two tubes are of same length. Compound tube carries an axial load of 600Kn. Find the stresses carried by each tube and amount of shortening. Length of the tube is 120mm. E_s=2X10^{5}N/mm^2, E_b=1X10^5 N/mm^2. (MAY/JUNE 2009)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No from 62 to 65.*

4.A rainforced concrete column 500mmX500mm in section is reinforced with 4 steel bars of 25mm diameter, one in each corner, the column is carrying a load of 1000kN. Find the stresses in the concrete and steel bars. Take E for steel =210X10^3 N/mm^2 and E for concrete = 14X10^{3}N/mm^2.(NOV/DEC 2005)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No from 62 to 65.*

5.A steel rod of 20mm pases centrally through a copper tube of 50mm external diameter and 40mm internal diameter. The tube is closed at each end by rigid plates. if the temperature of the assembly is raised by 50^{0}C, calculate the stresses developed in copper and steel. Take E_s=100kN/mm^2, E_c=100kN/mm^2, $\alpha_{s=12X10}$$^{-6}$ per ^{0C,} α_c=18X10^{-6} per ^{0}C.(NOV/DEC 2005)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No from 62 to 65.*

6.A compound bar is constructed from three bars each 50mm wide and 12mm thick fastened together to form a bar 50mm wide and 36mm thick. The middle bar is of aluminium for which E=70GPa and the outer bars are of brass for which E=100GPa. If the bars are initially fastened at 18^{0}C and the temperature of the whole assembly is then raised to 50^{0}c, determine the stresses set up in brass and aluminium. Take the coefficient of linear expression as 18X10^{-6} per^{0}C for brass and 22X10^{-6} per ^{0}C for aluminium. What will be the changes in these stresses if an external compressive load of 15kN is then applied on the bar? (APRIL/MAY 2008)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No from 62 to 65.*

UNITII TRANSVERSELOADING ON BEAMSAND STRESSES IN BEAM

Beams –types transverse loading onbeams– Shear force and bending moment in beams – Cantilevers– Simplysupportedbeamsandover – hanging beams.Theoryof simple bending– bendingstress distribution– Loadcarryingcapacity –Proportioningofsections–Flitchedbeams – Shearstressdistribution.

PART-A

1. Define Beam. (May 2012)

Beam is a structural member which is supported along the length and subjected to external loads acting transversely.

2. Define shear force and bending moment at a section (N/D 2014)(A/M 2015)

Shear force: SF at a cross section of a beam is defined as algebraic sum of all forces acting either side of a beam

Bending Moment: BM at a cross section is the algrebraic sum of the moment of all forces acting either side of a beam

3. Define the term point of contraflexure (April/May 2015)

The point where the BM changes its sign or zero is called point of contraflexure.

4. What are SF and BM diagrams?

SF diagrams show the variation of forces along the length of the beam.

BM diagrams show the variation of bending moment along the length of the beam.

5. Write the relation between SF and BM.

The rate of change of BM is equal to the SF at the section. $\frac{dM}{dx} = -F$

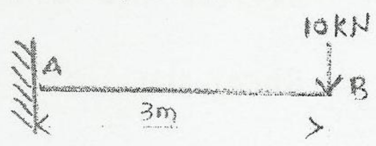
6. What is the maximum B.M in a SSB of span 'L' subjected to UDL of W over the entire span?

$$M_{max} = \frac{WL^2}{8}$$

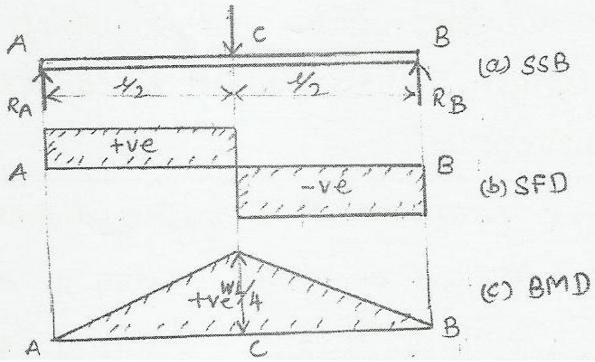
7. Calculate the BM at fixed end of cantilever beam shown.

B.M at A = 10×3 = 30KN-m.

The B.M at fixed end is 30KN-m.



8. What will be the S.F and B.M diagrams for SSB of length 'l' subjected to central point load 'W'?



9. Draw S.F and B.M diagram for a cantilever beam of span 'L' carrying a point load 'W' at a distance of 'a' from free end.

SF CALCULATION:

S.F at C = 0

S.F at B = W KN

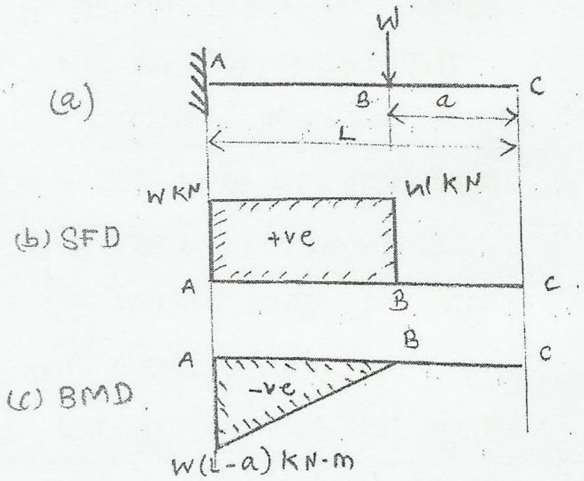
S.F at A = W KN.

BM CALCULATION

BM at C = 0

BM at B = 0

BM at A = W×(L−a) KN-m

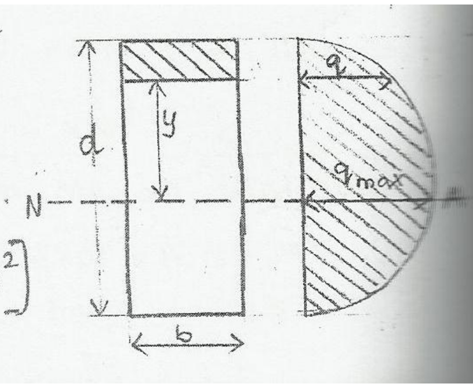


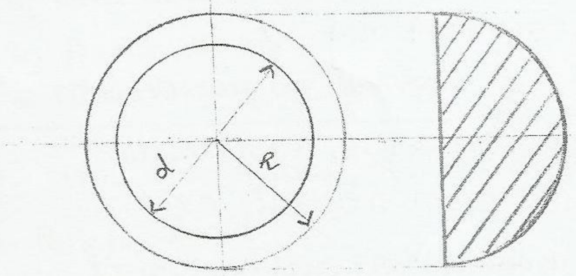
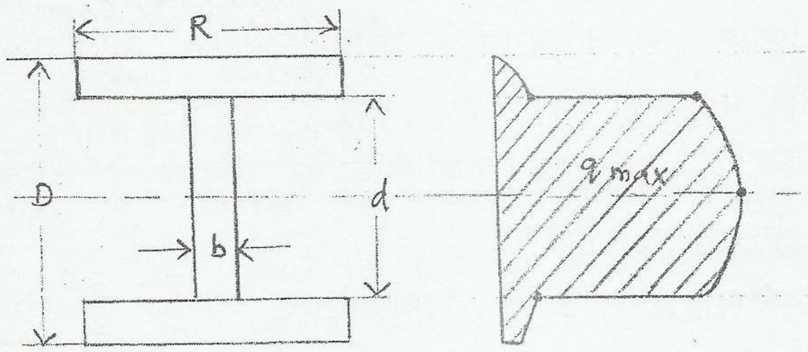
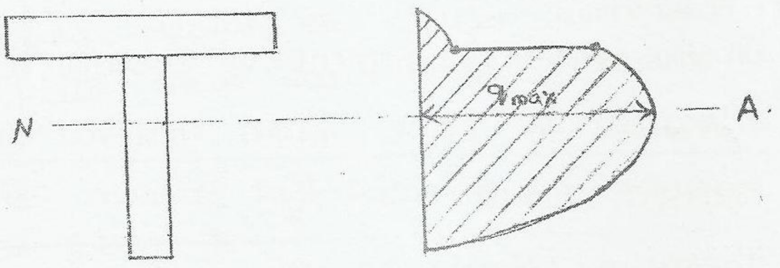
10. Write down the expression for shear stress distribution in a beam subjected to shear force F.

Shear stress distribution, $q = F.\dfrac{A\bar{y}}{Ib}$.

11. Write the formula to find the the shear stress distribution for a rectangular beam section and sketch the shear stress distribution.

Shear stress distribution, $q = \dfrac{F}{2I}\left[\dfrac{d^2}{4} - y^2\right]$



12. Sketch the shear stress distribution in a beam made of hollow circular section. 
13. Draw shear stress distribution of I-symmetrical section. 
14. Draw the shear stress distribution in the case of 'T'-section. 
15. What is the value of maximum shear stress in a rectangular cross section? $q_{max} = \frac{3}{2} \times \frac{F}{bd}$

16. Write down the bending equations.

The bending equation is $\frac{M}{I} = \frac{\sigma_b}{y} = \frac{E}{R}$

M = Bending moment

I = Moment of inertia of the section.

σ_b = Bending stress at that section.

y = Distance from neutral axis

E = Young's modulus of the material.

R = Radius of curvature of beam

17. What are the assumptions made in theory of bending?
(May/Jun 2014) (April/May 2015)

(i) The material is perfectly homogeneous and isotropic. It obey's Hooke's law.

(ii) The value of young's modulus is same in tension as well as in compression.

(iii) The resultant force on transverse section of beam is zero

(iv) The radius of curvature of the beam is very large compared to cross section dimension of beam.

18. Define 'section modulus'.

It is the ratio of moment of Inertia of the section to the distance of plane from neutral axis.

Section modulus, $Z = I/y$

19. State theory of simple bending. (April/May 2013)

If a beam is bend only due to application of constant bending moment and not due to shear, then it is called simple bending.

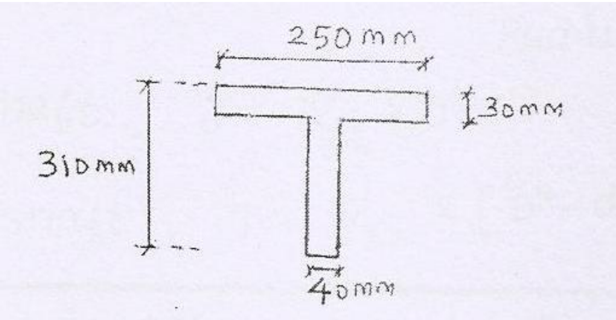
20. Write section modulus for circular and hollow circular section? For circular section, $Z = \frac{\pi D^3}{32}$; For hollow circular section, $Z = \frac{\pi}{32}\left[\frac{D^4 - d^4}{D}\right]$
21. What are the different types of beams? (May 2009) * Simply supported beam. * Cantilever beam. * Fixed beam. * Over Hanging beam.
22. What are the types of loads? (April May 2011) * Point load. * Uniformly distributed load. * Uniformly varying load.
23. List the various types of supports. * Simple supports * Fixed support. * Roller support. * Hinged support.
24. What is meant by transverse loading of beam? If the load is acting perpendicular to longitudinal axis of the beam then it is called transverse loading of beam.
25. What are flitched beam? (NOV/DEC 2014) It is a compound beam used in the construction of houses, decks etc. flitch beams is made up of a steel plate and sandwiched between two wood beams
26. What is meant by positive or Sagging Bending moment (BM)? BM is said to positive if moment on left side of beam is clockwise or right side of the beam is counter clock wise.

27. What is meant by negative or hogging BM? BM is said to negative if moment on left side of the beam is counter clock wise or right side of the beam is clock wise.
28. What is meant by modulus of rupture? The bending stress at failure or rupture is called modulus of rupture.
29. Define moment of resistance. capacity of section to resist bending moment and is given by the product of section modulus and allowable bending stress..
30. List out some properties of SF & BM diagram (i) * SFD will consist of rectangle if the beam is loaded with point load. * BMD will consist of inclined line, if the beam is loaded with points load. (ii) * SFD – inclined line – for UDL. * BMD – Parabolic line – " "
PART-B& PART-C
1.A cantilever beam of span 6mm carries a uniformly distributed load W per meter run. If the bending stress is not to exceed 100N/mm^2, find the safe load W. the cross section of the beam is 100mm wide and 200mm deep. (NOV/DEC2006) *Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No:50 to 51and 53 to 56.*
2.Drive the bending formula M/I=f/y=E/R. (NOV/DEC2006) *Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No:50 to 51and 53 to 56.*
3.A timber beam of rectangular section is to support a total load of 20kN uniformly distributed over a span of 3.6 m when the beam is simply supported. If the depth is twice the width of the section and the stresses in timber is not to exceed 3.5 N/mm^2, find the dimensions of the section?(NOV/DEC2008) *Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No:50 to 51and 53 to 56.*
4.A water main of 1200 mm internal diameter and 12mm thick is running full. If the bending stress is not to exceed 56N/mm^2. Find the greatest span on which the pipe may be simply supported. Steel and water weigh 76.8kN/m^3 and 10kN/m^3 respectively.(NOV/DEC2006)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No:50 to 51and 53 to 56.*
5.A simply supported beam of span 6m and of 1 section has flange 40mm X5mm. bottom flange of 60mm X 5mm depth of 100mm and web thickness 5mm. it carries a UDL of 2 kN/m over the full span. Calculate the maximum tensile stress and maximum compressive stress produced.(MAY/JUNE2009) *Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No:50 to 51and 53 to 56.*

6.**A beam of T section shown in figure is subjected to a shear force of 20kN. Find the stress at the.**

- **iii. Neutral axis and**
- **iv. Junction of flange and web. Also sketch the stress distribution diagram. (APRIL/MAY2005)**



*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No:50 to 51and 53 to 56.*

UNITIII TORSION

Torsion formulation stressesanddeformationincircularandhollowsshafts–Stepped shafts– Deflectioninshafts fixedatthebothends–Stressesinhelicalsprings– Deflectionofhelicalsprings, carriagesprings.

PART-A

1. What are the assumptions made in torsion equations?

(i) The material of the shaft is homogeneous, perfectly elastic and obeys Hooke's law.

(ii) Twist is uniform along the length of the shaft.

(iii) The stress does not exceed the limit of proportionality.

(iv) The shaft circular in section remains circular after loading.

(v) strain and deformations are small.

2. Why hollow circular shafts are preferred when compared to solid circular shafts? (i) The torque transmitted by hollow shaft is greater than the solid shaft. (ii) For same material, length and given torque, the weight of hollow shaft will be less compared to solid shaft.	
3. Write the polar modulus for solid shaft and circular shaft. Polar modulus $(Z_p) = \frac{\text{Polar moment of Inertia } (J)}{\text{Radius } (R)}$ For solid shaft, $J = \pi/32 \times D^4$ For Hollow shaft, $J = \pi/32 \times [D^4 - d^4]$	
4. Write down the equation for maximum shear stress of a solid circular section in diameter 'D' when subjected to torque 'T'. For solid shaft, $T = \pi/16 \times \tau \times D^3$ $\tau = \frac{16 \times T}{\pi \times D^3}$ where, τ - Shear stress, N/mm^2 T - Torque, N-mm D - Diameter, mm.	
5. Define Torsional rigidity. (NOV/Dec 2014) (April/May 2015) The torsion equation is $\frac{T}{J} = \frac{C\theta}{l}$ $\theta = \frac{Tl}{CJ}$ Since C, l, J are constant for given shaft, θ is directly proportional to T. The term CJ is known as Torsional rigidity and it is represented by K (K)	

6. Write an expression for angle of twist for a hollow circular shaft with external diameter D, internal diameter d, length l and rigidity modulus (c)

$$\frac{T}{J} = \frac{C\theta}{l}, \text{ where } J = \pi/32 \, [D^4 - d^4]$$

7. What is the power transmitted by circular shaft subjected to a torque of 700 KN-m at 110 rpm.

$$\text{Power, } P = \frac{2\pi NT}{60} = \frac{2 \times \pi \times 110 \times 700}{60} = 8063.42 KW$$

$$\boxed{P = 8063.42 KW}$$

8. Calculate the maximum torque that a shaft of 125mm diameter can transmit, if the maximum angle of twist is 1° in a length of 1.5m. Take $C = 70 \times 10^3 \text{ N/mm}^2$

Gn: $D = 125mm$; $\theta = 1° \times \pi/180 = 0.017 \text{ rad}$; $l = 1500mm$

$C = 70 \times 10^3 \text{ N/mm}^2$

To find: T_{max}.

$$\frac{T}{J} = \frac{C\theta}{l} \Rightarrow T = \frac{J}{l} \times C\theta, \text{ where } J = \frac{\pi}{32} \times D^4$$

$$T = \frac{\frac{\pi}{32} \times [124]^4 \times 70 \times 10^3 \times 0.017}{1500}.$$

$$\boxed{T = T_{max} \doteq 19.01 \times 10^6 \text{ N-mm}}$$

9. Differentiate between closed coil and open coil helical spring (NOV/DEC 2014)

close-coiled helical spring	open-coil helical spring
* Adjacent coils are very close to each other	* Large gap between adjacent coils.
* only tensile load can carry	* Tensile and compressive loads can carry.
* Helix angle is negligible	* Helix angle considerable.

10. Give shear stress and deflection relation for close coil helical spring.

Deflection, $\delta = \frac{64 W R^3 n}{C d^4}$; Shear Stress, $\tau = \frac{16 W R}{\pi d^3}$

$\therefore \quad \delta = \frac{4 \pi R^2 n}{C d} \times \tau$.

11. An open coiled helical spring of mean radius of coil of 20cm and helix angle 12° is subjected to an axial load of 10 N. What is the bending moment in coil?

Gn : R = 200mm ; $\alpha = 12°$; W = 10 N.

Sol : $M = WR \sin \alpha \quad \Rightarrow \quad M = 415.82$ N-mm .

12. What kind of stress induced when axial load acts on closed ~~and~~ open coiled spring?

On closed spring : Shear stress

On open spring : Bending stress and stress.

13. The angle of helix of a spring is α, write down equations for torque and moment under an axial load 'W' at free end.

Torque, $T = WR \cos \alpha$; Moment, $M = WR \sin \alpha$.

14. Write down the equation for shear energy of a close coiled spring.

Shear energy, $U = \frac{\tau^2}{4C} \times$ Volume of Spring.

15. What is meant by stiffness? What is the formula for the stiffness of a close coiled helical spring subjected to an axial load?

The stiffness is defined as the load required to produce unit deflection.

Stiffness, $k = \frac{C d^4}{64 R^3 n}$. N/mm .

16. What are the uses of closed coiled helical spring?

Railway wagons, cycle seating, pistols, brakes, etc..

17. Write the expression for maximum shear stress and deflection of a closed coil helical spring subjected to axial load (or) vertical load W?

Max. Shear Stress $\tau = \frac{16WR}{\pi d^3}$; Deflection $\delta = \frac{64 WR^3 n}{Cd^4}$

18. Write down the equation for deflection of an open coiled helical spring subjected to axial load, W.

Deflection, $\delta = \frac{64 WR^3 n \sec\alpha}{d^4} \left[\frac{\cos^2\alpha}{C} + \frac{2\sin^2\alpha}{E} \right]$

19. A close coiled helical spring is to carry an axial load of 500N. It's mean coil diameter is to be 10 times its wire diameter. Calculate these diameters if the max. shear stress in the material is to be 80MPa.

Gn: $W = 500N$; $D = 10d$; $\tau = 80MPa = 80\ N/mm^2$.

Sol: $\tau = \frac{16WR}{\pi d^3} \Rightarrow 80 = \frac{8 \times 500 \times 10d}{\pi d^3} \Rightarrow \boxed{d = 12.62mm}$

$D = 10 \times 12.62 = 126.2mm$ $\boxed{D = 126.2mm}$

20. Define polar modulus of a section.

It is the ratio of polar moment of inertia to the maximum radius of a circular section.

21. What do you meant by Torsion? (May/Jun 2014)

Loading of a circular or non-circular member that tends to cause it to rotate or twist. Such load is called torque, torsional moment, rotational moment, twisting moment.

22. write the governing equation for torsion of circular shaft ? $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$ L- Length of shaft T- Torque. J- Polar MI, G- modulus of rigidity. τ- Shear Stress, R- Radius of shaft.	
23. What type of stress induced in a structural member subjected to torsional load? shear stress. The variation of shear stress is linear and it vary from zero at the neutral axis and reaches the max. value at the extreme fiber of the shaft.	
24. why the shear stress is maximum at the outer surface of the shaft than the inner core? When the circular shaf is subjected to torsional loading, the shear stress is maximum at the extreme fiber of the shaft. This is due to the reason that, the extreme fiber are much strained than the inner surface near centroidal axis of the member.	
25. What is torsional stiffness? The measure of torsional stiffness is the angle of twist of one part of a shaft relative to another part when a certain torque is applied.	
26. Define spring also list out types of springs. It is an elastic member, which deflect under the action of load & regain its original shape after the removal of load.	

27. What are the various types of Springs? (May/June 2014)

* Leaf spring. * Spiral spring.
* Helical Spring. * Disc spring.

28. State any two major function of a Spring.

* To absorb the Shock energy.
* To measure forces in spring balance & engine indicator.

29. What is solid length in spring?

The Length of a spring under its maximum compression is called its solid length.

30. What is buckling of spring?

The helical compression spring behaves like a common and buckles at a comparative small load when the length of the spring is more than 4 times the mean coil diameter.

PART-B& PART-C

1.(i)obtained a relation for the torque and power, a solid shaft can transmit.

(ii)a solid steel shaft has to transmit 100k.w at 160rpm. Taking allowable shear stress as 70MPa, find the suitable diameter of the shaft. The maximum torque transmitted in each revolving exceeds the mean by 20%.(MAY2010)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*",Page No: from 311 to 317.*

2.A hollow steel shaft of outside diameter 75 mm is transmitting a power of 300kW at 2000 rpm. Find the thickness of the shaft if the maximum shear stress is not to exceed 40 N/mm^2.(NOV/DEC2006)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*",Page No: from 311 to 317.*

3.A solid cylindrical shaft is to transmit 300kN power at 100 rpm. If the shear stress is not to exceed 60N/mm^2, find its diameter. What percent saving in weight would be obtained if this shaft is replaced by a hollow one whose internal diameter equals to 0.6 of the external diameter, the length, the material and maximum shear stress being the same.(MAY/JUNE2007)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No: from 311 to 317.*

4.Derive an expression for the shear stress produced in a circular shaft which is subjected to torsion. What are the assumptions made in the derivations? (NOV/DEC 2010)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*",Page No: from 311 to 317.*

5.A closed coiled helical spring is to have a stiffness of 1.5 N/mm of compression under a maximum load of 60N. the maximum shearing stress produced in the wire of the spring is 125 N/mm^2. The solid length of the spring is 50mm. find the diameter of coil, diameter of wire and number of coils C=4.5 X 10^4. (NOV/DEC 2009)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No: from 311 to 317.*

6.A closely coiled helical spring of round steel wire 10mm in diameter having 10 complete turns with a mean diameter of 12 cm is subjected to an axial load of 250N. determine.
i.the deflection of the spring.
ii.maximum shear stress in the wire.
iii.stiffness of the spring and
iv.frquency of vibration. TAKE C=0.8 X 10^5N/mm^2 (MAY/JUNE 2007, APRIL/MAY 2010, NOV/DEC 2009, APRIL/MAY 2008, NOV/DEC 2007, NOV/DEC 2008)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No: from 311 to 317.*

7.A close coiled helical spring is required to absorb 2250 joules of energy. Determine the diameter of the wire, the mean coil diameter of the spring and the number of coils necessary if (i) the maximum stress is not exceed 400MPa, (ii) the maximum compression of the spring is limited to 250mm and (iii) the mean diameter of the spring is eight times the wire diameter. For the spring material, rigidity modulus is 70GPa.(APRIL/MAY 2008)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No: from 311 to 317.*

UNITIV DEFLECTIONOFBEAMS

DoubleIntegrationmethod–Macaulay'smethod–Areamomentmethodforcomputationofslopes anddeflections inbeams- Conjugatebeamandstrainenergy–Maxwell's reciprocaltheorems.

PART-A

1. State any two assumptions made in Euler's column theory.

(i) The cross section of the column is uniform throughout its length.

(ii) The length of the column is greater as comparted to its cross sectional dimensions.

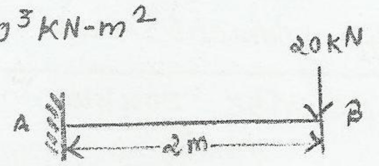
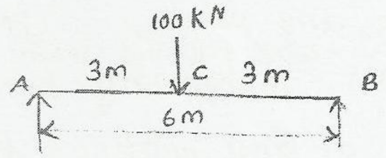
2. State slenderness ratio. (May 2009)

The ratio between actual length and least radius of gyration of column is known as slenderness ratio.

$$\text{slenderness ratio} = \frac{\text{Actual length } (l)}{\text{Least radius of gyration } (K)}$$

3. Define crippling load (or) critical load (or) buckling load.

The load at which the column just buckles is known as buckling load (or) critical load (or) crippling load.

4. A cantilever beam of spring 2m is carrying a point load of 20KN at its free end. Calculate the slope at the free end. Assume $EI = 12 \times 10^3$ KN-m^2  Slope at free end, $\theta_B = \frac{WL^2}{2EI}$ $\theta_B = 0.0033 rad$
5. Calculate the maximum deflection of a SSB carrying a point load of 100KN at midspan. span = 6m; $EI = 20{,}000$ KN m^2.  Gn: $L = 6m$; $EI = 20000$ KNm^2 To find: y_{max}. Maximum deflection, $y_{max} = \frac{WL^3}{48EI}$ $y_{max} = \frac{100 \times 6^3}{48 \times 20000}$ $y_{max} = 22.5mm$
6. What is the maximum deflection in a SSB subjected to UDL over the entire span? $y_{max} = \frac{5WL^4}{384 EI}$
7. Give the effective length of the columns (June 2009) (a) When both end are hinged. (b) when both end are fixed. (c) one end is fixed while the other end is free (d) one end is fixed and other end is hinged condition (a) Effective length, $L = l$ (Actual length) (b) Effective length, $L = \frac{l}{2}$ (c) Effective length, $L = 2l$ (d) Effective length, $L = l/\sqrt{2}$

8. List four methods of determining slope and deflection of a loaded beam. (April / May 2012)

(i) Double Integration method (ii) Macaulay's method
(iii) Moment area method (iv) conjugate beam method

9. Describe Double integration method: (Nov / Dec 2014)

The bending moment at any point is given by

$$M = EI \frac{d^2y}{dx^2}$$

Integrating bending moment equation once, give slope at any point, $\int M = EI \frac{dy}{dx}$ [slope equation]

Integrating bending moment equation twice, give deflection at any point, $\iint M = EI \cdot y$ [deflection - equation]

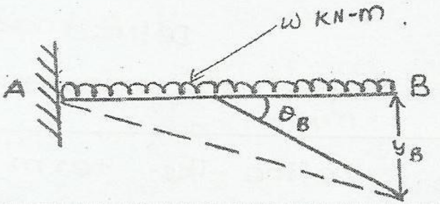
10. What is the relation between slope, deflection and radius of curvature of a beam?

$\frac{1}{R} = \frac{d^2y}{dx^2}$; R - Radius of curvature

11. State the expression for slope and deflection at the free end of a cantilever beam of length 'L' subjected to a uniformly distributed load of 'w' per unit length.

Slope at B, $\theta_B = \frac{wL^3}{6EI}$

Max. deflection, $y_B = \frac{wL^4}{8EI}$



12. In a SSB of 3m span carrying UDL throughout the length, the slope at the support is 1°. What is the maximum deflection in the beam?	
Soln: Slope $\theta_A = \frac{wL^3}{24EI} = 1° = \frac{\pi}{180}$; $L = 3m$	
W.K.T. Max. deflection, $y_{max} = \frac{5}{384} \cdot \frac{wL^4}{EI}$	
$y_{max} = \frac{wL^3}{24EI} \times \frac{5L}{16}$	
$y_{max} = 0.0164m$	
13. State Euler's formula for crippling load.	
crippling load, $P = \frac{\pi^2 EI}{L^2}$	
where E = Young's modulus, I = moment of Inertia, L = Equivalent length (or) Effective length.	
14. What are the limitations of Euler's formula?	
crippling stress $= \frac{\pi^2 E}{[L/K]^2}$	
$L = l$, if column with both end hinged, then crippling stress $= \frac{\pi^2 E}{(l/k)^2}$	
l/k = slenderness ratio.	
If slenderness ratio is small, the crippling stress will be high. For column material, crippling stress cannot be more than the crushing stress. So, slenderness ratio cannot be lesser than a certain limit.	
15. What do you mean by flextural rigidity?	
Defined as the product of Young's modulus and the moment of Inertia of the section.	
16. Define the term slope.	
It is defined as the rotation of the beam axis from its original position.	

17. Define deflection. The displacement of a particular point located in the longitudinal axis of the beam in the vertical direction is called deflection.	
18. List out the relationship exist between slope, deflection, bending moment and the load. Slope = $\frac{dy}{dx}$, Shear force = $\frac{d^3y}{dx^3}$ Bending moment = $EI\frac{d^2y}{dx^2}$ Load = $\frac{d^4y}{dx^4}$	
19. State the principle involved in finding the slope and deflection of beam using Moment-Area theorem. Moment-Area method uses the elastic curve equation or moment curvature expression, but the integration is carried out by doing so, the kinematic boundary conditions are not considered	
20. What is meant by elastic curve? The deflection shape of a beam under load is called elastic curve of the beam.	
21. When Mecaulay's method is preferred? (A/M 15) This method is preferred for determining the deflection of a beam subjected to several concentrated loads or discontinuous load.	
22. What are the boundary conditions for a simply supported beam end beam. * Deflection at the supports is zero. * Slope exist at all points except at the point where deflection is maximum. * BM - is zero at the supports.	

23. What are the boundary conditions for a fixed end?

* Both deflection and slope at the fixed supports are zero.

24. What is meant by determinate beams?

The beams whose external reacts can be determined with the help of equations of static equilibrium alone are called determinate beams.

25. Give examples for determinate & indeterminate beams.

Determinate beam – Cantilever & Simply supported beam.

Indeterminate beam – Fixed end beam, continuous beam

26. Describe the boundary conditions that can be used for finding out the values of the constant of integration in case of common types of beams.

Support	Deflection	Slope	Moment.
Fixed end	zero	zero	Yes.
Free end	yes	Yes	NO
Roller	zero	zero	zero.

27. Write down the moment - curvature relationship?

$$EI \frac{d^2y}{dx^2} = M.$$

EI – flexural rigidity

y – deflection

M – Bending Moment.

28. Explain the procedure ~~fo of for~~ of finding the slope and deflection of a beam using Machaulay's method?

- Find the reaction at the supports.
- Take a section at a distance 'x' from the left such that it covers all loads in the beam
- From moment - curvature expression that relates the bending moment.
- Integrate the moment curvature expression twice to obtain the expression for slop and deflection
- Apply boundary conditions and the constant involved in the moment - curvature expression
- Find the slope and deflection at various point by substituting the value for 'x'.

29. Write the equation of deflection of a bent beam.

EI = Mx EI - Flexural rigidity
Mx - Bending moment at section x-x

30. Write the equation of deflection by moment area method?

$$y = \frac{A\bar{x}}{EI}$$

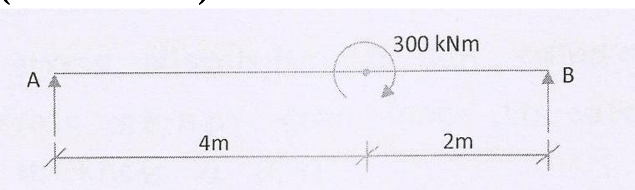
A - Area of BM diagram
$\bar{x}$ - Distance of CG.
EI - Flexural rigidity.

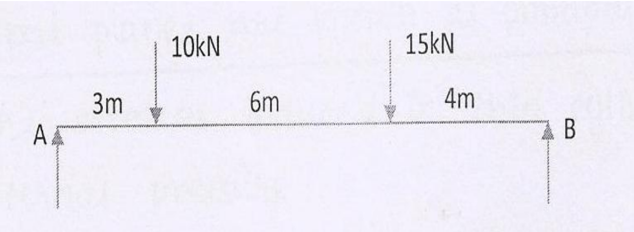
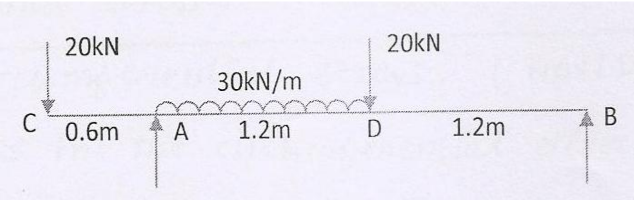
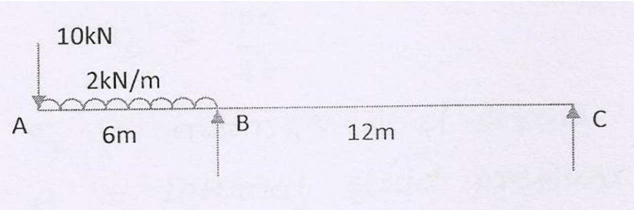
PART-B& PART-C

1.A cantilever Ab, 2m long, is carrying a load of 20kN at free end and 30kN at a distance 1 m from the free end, find the slope and deflection at the free end. Take E=200GPa and I=150 X 10^{6}mm^{4}. (MAY 2010)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No from 497 to 498.*

2.**Find the maximum deflection of the beam shown id fig. IE= 1 X 10^{11}kN/mm^{2}. Use Macaulay's method. (Nov/Dec 2006)**



*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 497 to 498.*
3.**A beam AB of length 8m is simply supported at its ends and carries two point loads of 50kN and 40kN at a distance of 2m and 5m respectively from left support A. determine, deflection under each load, maximum deflection and the position at which maximum deflection occurs. Take E=2 X 10^5N/mm^2 and I=85 X$10^6$$mm^4$. (MAY/JUNE 2007)**   *Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 497 to 498.*
4.**A beam is loaded as shown in fig. determine the deflection under the load points. Take E=200 GPA and I-160 X $10^6$$mm^4$. Nov/Dec 2007)**      *Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No from 497 to 498.*
5.**In the beam shown in fig. determine the slope at the left end C and the deflection at 1 m from the left end. Take EI=0.65MNm^2. (APRIL/MAY 2008)**      *Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 497 to 498.*
6.**Find the maximum downward and upward deflections for the beam shown below in fig. EI = 40000 kNm^2. Nov/Dec 2009)**      *Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007*", Page No from 497 to 498.*

UNITV THIN CYLINDERS,SPHERESAND THICK CYLINDERS
Stressesinthincylindricalshellduetointernalpressurecircumferentialandlongitudinalstresses and deformationinthinandthickcylinders–sphericalshellssubjectedtointernalpressure–Deformation inspherical shells–Lame's theorem.
PART-A

1. What are assumptions involved in the analysis of thin cylindrical shells ? (April may 2011)

(i) The material of cylinder is Homogeneous, isotropic and obey Hook's law.

(ii) The hoop stress distribution in thin cylinder is uniform over the cross section from inner to outer surface since the thickness is thin.

(iii) weight of fluid and material of cylinder is not taken into accent.

2. Define prinlciple planes and principal stresses (April May 2014)

The planes which have no shear stress are known as principal planes. The magnitude of normal stress, acting on a principal planes are known as principal stresses.

3. List out the stresses induced in thin cylinderical shell due to internal pressure.

(a) circumferential (or) Hoop's stress.

(b) Longitudinal stress.

4. Define circumferential stress. (Nov/Dec 2014)

The stress in the circumferential direction due to tendency of bursting the cylinder along the longitudinal axis is called hoop stress.

$$\sigma_c = \frac{pd}{2t}$$

where, σ_c = circumferential stress

p = Internal fluid pressure

d = diameter of thin cylinder.

t = Thickness of thin cylinder.

5. List out the modes of failure in thin cylindrical shell due to an internal pressure?

(i) It may split up into two semi circular halves along the cylinder axis.

(ii) It may split up into two cylinder.

6. A storange tank of internal diameter 280mm is subjected to an internal pressure of 2.5MPa. Find the thickness of the tank, if hoop and longitudinal stress are 75MPa and 45MPa respectively.

Gn: $d = 280mm$; $p = 2.5MPa$; $\sigma_c = 75MPa$; $\sigma_l = 45MPa$

Hoop stress is greater than longitudinal stress, so we can use $\sigma_c = \frac{Pd}{2t} \Rightarrow 75 = \frac{2.5 \times 280}{2 \times t}$

$\boxed{t = 4.66mm}$

7. A thin cylinder closed at both ends is subjected to an internal pressure of 2MPa. Its internal diameter is 1m and the wall thickness is 10mm. What is that maximum shear stress in the cylinder material?

Gn: $P = 2MPa = 2\ N/mm^2$; $d = 1000mm$; $t = 10mm$.

To find: τ_{max}.

Hoop stress, $\sigma_c = \frac{Pd}{2t} = \frac{2 \times 1000}{2 \times 10} = 100\ N/mm^2$

Longitudinal stress $\sigma_a = \frac{Pd}{4t} = \frac{2 \times 1000}{4 \times 10} = 50\ N/mm^2$

Max. shear stress, $\tau_{max} = \frac{\sigma_{max} - \sigma_{min}}{2}$.

$\tau_{max} = \frac{100 - 50}{2}$

$\boxed{\tau_{max} = 25\ N/mm^2}$

8. A spherical shell of 1m internal diameter undergoes a diametral strain of 10^{-4} due to internal pressure. What is the corresponding change in its internal volume?

Change in volume, $dV = e_v \times V$

$= e \times 3 \times V \Rightarrow 3 \times 1 \times 10^{-4} \times \pi/6\,(1000)^3$

$dV = 157.079\,mm^3$

9. How will you find major principal stress and minor principal stress? Also mention how to locate the direction of principal planes.

(i) Major principal stress : $\sigma_{n1} = \frac{\sigma_1 + \sigma_2}{2} + \frac{1}{2}\sqrt{(\sigma_1 - \sigma_2)^2 + 4q^2}$

(ii) Minor principal stress : $\sigma_{n2} = \frac{\sigma_1 + \sigma_2}{2} - \frac{1}{2}\sqrt{(\sigma_1 - \sigma_2)^2 + 4q^2}$

(iii) Position of principal planes : $\tan 2\theta = \frac{2q}{\sigma_1 - \sigma_2}$

10. The principal stress at a point are 100 N/mm^2 (tensile) and 50 N/mm^2 (compressive) respectively. Calculate the maximum shear stress at this point.

Max. Shear stress $\sigma_{max} = \frac{\sigma_1 - \sigma_2}{2} \Rightarrow \frac{100 - (-50)}{2} = 75\,N/mm^2$

$\sigma_{max} = 75\,N/mm^2$

11. Give the expression for maximum shear stress in a two dimensional stress system.

Maximum shear stress, $\sigma_{max} = \frac{1}{2}\sqrt{(\sigma_1 - \sigma_2)^2 + 4q^2}$

12. Give the expression for stresses on a inclined plane when subjected to a axial pull.

(i) Normal stress, $\sigma_n = \sigma \cos^2\theta$

(ii) Shear stress, $\sigma_t = \sigma/2 \sin 2\theta$.

(iii) Resultant stress, $\sigma_{res} = \sqrt{\sigma_n^2 + \sigma_t^2}$

13. Write the expressions for a normal stress on an inclined plane in a block which is subjected to two mutually perpendicular normal stress and shear stress? Normal stress, $\sigma_n = \left(\frac{\sigma_1+\sigma_2}{2}\right)+\left(\frac{\sigma_1-\sigma_2}{2}\right)\cos 2\theta + q\sin 2\theta$.	
14. A bar of cross sectional area 600mm² is subjected to a tensile load of 50KN applied at each end. Determine the normal stress on a plane inclined at 30° to the direction of loading. Ans: $A = 600 mm^2$; $P = 50 KN$; $\theta = 30°$. $\sigma = \frac{Load}{Area} = \frac{50\times10^3}{600} = 83.33 N/mm^2$ Normal stress, $\sigma_n = \sigma\cos^2\theta = 62.5 N/mm^2$.	
15. What is the radius of Mohr's circle? Give the use of Mohr's circle. Radius of mohr's circle is equal to maximum shear stres Mohr's circle is used to find out the normal, tangenti resultant stresses and principal stress and their planes	
16. What are the planes along which the greatest shear stresses occur? Greatest shear stress occurs at the planes which is inclined at 45° to its normal.	
17. In case of equal like principal stresses, what is the diameter of the Mohr's circle? Zero.	
18. What is the ratio of circumferential stress to longitudinal stress of a thin cylinder? The ratio $\frac{\sigma_c}{\sigma_a} = 2$	

19. In a thin cylinder will the radial stress vary over the thickness of wall?

No, in thin cylinder radial stress developed in its wall is assumed to be constant, since the wall thickness is very small as compared to diameter of cylinder.

20. For thin cylinder, write down the equation for strain along the circumferential direction and longitudinal direction.

circumferential direction, $e_c = \frac{\delta d}{d} = \frac{Pd}{2tE}\left(1 - \frac{1}{2m}\right)$

Longitudinal strain, $e_a = \frac{Pd}{2tE}\left(\frac{1}{2} - \frac{1}{m}\right)$

21. For thin cylinder, write down the expression for volumetric strain.

Volumetric strain, $e_v = \frac{Pd}{2tE}\left(\frac{5}{2} - \frac{2}{m}\right)$.

22. In thin spherical shell, write down the expression for circumferential strain, volumetric strain and circumferential stress.

circumferential strain, $e_c = \frac{Pd}{4tE}\left(1 - \frac{1}{m}\right)$

volumetric strain, $e_v = 3 \times e_c = \frac{3Pd}{4tE}\left(1 - \frac{1}{m}\right)$

circumferential stress, $\sigma_c = \frac{Pd}{4t}$.

23. In a thin cylindrical shell if hoop strain is 0.2×10^{-3} and longitudinal strain is 0.05×10^{-3}, find volumetric strain.

Gn: $e_c = 0.2 \times 10^{-3}$; $e_a = 0.05 \times 10^{-3}$.

To find: e_v. volumetric strain, $e_v = 2e_c + e_a$

$= 2(0.2 \times 10^{-3}) + 0.05 \times 10^{-3}$

$\boxed{e_v = 0.45 \times 10^{-3}}$

24. Write the equation for the change in diameter and length of a thin cylinder shell, when subjected to an internal pressure.

change in diameter, $\delta d = \frac{Pd^2}{2tE}\left(1 - \frac{1}{2m}\right)$

change in length, $\delta l = \frac{Pdl}{2tE}\left(\frac{1}{2} - \frac{1}{m}\right)$

25. Differentiate between thin cylinder and thick cylinder (M/J 2014)

Thin cylinder	Thick cylinder
* Ratio of wall thickness to the diameter of cylinder is less than $1/20$	* Ratio of wall thickness to the diameter of cylinder is more than $1/20$
* circumferential stress is assumed to be constant throughout the wall thickness	* circumferential stress varies from from inner to outer wall thickness.

26. Distinguish between cylindrical shell and spherical shell.

Cylindrical shell	Spherical shell.
* circumferential stress is twice the longitudinal stress	* only hoop stress present.
* It withstands low pressure than spherical shell for the same diameter.	* It withstands more pressure than cylindrical shell for same diameter.

27. What are major classification of a pressure vessel?

* Thin walled pressure vessels
* Thick walled pressure vessels.

28. Define hoop stress.

The stress is acting in the circumference of the cylinder wall (or) the stresses induced perpendicular to the axis of cylinder.

29. Define Longitudinal stress. (May / Jun 2012)

The stress is acting along the length of the cylinder is called longitudinal stress.

30. What is the effect of rivetting a thin cylinder cylinderical shell?

Riveting reduces the area of offering resistance. Due to this, the circumferential and longitudinal stress is are more. It reduce the pressure carrying capacity of the shell.

PART-B& PART-C

1.**A cylindrical vessel 2 m long and 500 mm in diameter with 10 mm thick plates is subjected to an internal pressure of 3MPa. Calculate the change in volume of the vessel. Take E=200GPa and poisson's ratio = 0.3 for the vessel material. (May 2010, Nov/Dec2007, Nov/Dec 2008)**

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 321 to 330.*

2.**A spherical shell of 2 m diameter is made up of 10 mm thick plates. Calculate the change in diameter and volume of the shell, when it is subjected to an internal pressure of 1.6 MPa. Take E=200GPa and 1/m =0.3. (Nov/Dec 2010)**

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 321 to 330.*

3.**A cylindrical shell 3 m long which is closed at the ends, has an internal diameter of 1 m and a wall thickness of 20 mm. calculate the circumferential and longitudinal stress induced and also changes in the dimensions of the shell, if it is subjected to an internal pressure of 2.0 N/mm^{2}and 1/m =0.3. (May/June 2007, Nov/Dec2008)**

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 321 to 330.*

4.**Derive the expressions for hoop stress and longitudinal stress in a thin cylinder with ends closed by rigid flanges and subjected to an internal fluid pressure. Take the internal diameter and shell thickness of the cylinder to be 'd' and 't' respectively. (May 2010)**

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 321 to 330.*

5.**A thin cylindrical shell 1.5 m long, internal diameter 300 mm and wall thickness 10mm is filled up with a fluid at atmospheric pressure. If the additional fluid of 300 x 10^3 mm^3 is pumped in the shell, find the pressure exerted by the fluid on the shell. Take E=2 X10^5 N/mm^2 and 1/m=0.3. also find the hoop stress induced. (May 2005, June 2008)**

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 321 to 330.*

6.**A spherical shell of 800mm diameter and 10mm thickness is filled with fluid under pressure till volume**

increase by 120 cm^3. Calculate the pressure exerted by the fluid on the shell if E=2 x 10^6 kg/cm^2 and 1/m=0.3. (Nov/Dec 2009)

*Refer: "*Bansal, R.K., "StrengthofMaterials",Laxmi Publications(P)Ltd., 2007.*", Page No from 321 to 330.*