MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR

COURSE FILE

OF

STRENGTH OF MATERIALS

(MEUG 021306)

Faculty Name:

MR. ARVIND KUMAR MADHESHIYA

ASSISTANT PROFESSOR

DEPARTMENT OF MECHANICAL ENGINEERING

विज्ञान एवं प्रावैधिकी विभाग
Department of Science and Technology
Government of Bihar

CONTENTS

Department of Mechanical Engineering

Vision

- To strengthen the region through imparting superior quality technical education and research; which enables the fulfillment of industrial challenge and establish itself as a Centre of Excellence in the field of Mechanical Engineering.

Mission

- To build an academic environment of teaching and lifelong learning for students to make them competitive in context with advance technological, economic and ecological changes.
- To enable the students to enhance their technical skills and communications through research, innovation and consultancy projects.
- To share and explore the accomplishments through didactic, enlightenment, R & D programs with technical institution in India and abroad.

Mechanical Engineering Program Educational Objectives

Graduates will spread and enhance their technical capability and proficiency through vital domain of economic, environmental and social concerns affiliated with the mankind and industry.

- Graduates will able to work professionally with modern methods in the area of Thermal, Mechanical System Design, Manufacturing, Measurement, Quality control and other interdisciplinary fields of concerns.

- Graduates will practice Mechanical engineering in sensible, flexible and ethical manner to benefit the society, industry and nation toward the rapidly changing global technical standards.

- Graduates will serve as ambassadors for engineering by their knowledge, creativity, imagination and innovation and set new extremes in their profession through lifelong learning.

Mechanical Engineering Student Outcomes

Students who complete the B.E. degree in ME will be able to:

1. An ability to apply the knowledge of mathematics, basic sciences and engineering concepts to solve the complex engineering problems.
2. The ability to conduct experiments and to critically analyze and interpret the experimental data to reach at substantial outcomes.
3. An ability to design systems, components, or processes to meet appropriate needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
4. An ability to identify, formulates, and solves the complex engineering problems.
5. An ability to function on multi-disciplinary teams that leads the multi- disciplinary projects.
6. An understanding of professional and ethical responsibility.
7. An ability to communicate effectively with written, oral, and visual means.
8. An ability to understand the impact of engineering solutions in a global, environmental, economic and societal context.
9. An ability to recognize the need to engage in life-long learning.
10. An ability to attain knowledge of contemporary issues.
11. An ability to use the techniques, skills, and modern tools necessary for Mechanical engineering practice.
12. Possess ability to estimate costs, estimate quantities and evaluate materials for design and manufacturing purposes.

Course Description

Strength of Materials is a fundamental subject needed primarily for the students of Mechanical sciences. As the engineering design of different components, structures etc. used in practice are done using different kinds of materials, it is essential to understand the basic behavior of such materials. The objective of the present course is to make the students acquainted with the concept of load resultant, consequences and how different kinds of loadings can be withstood by different kinds of members with some specific materials.

Course Objectives

To provide basic knowledge in mechanics of materials so that the students can solve real engineering problems and design engineering systems.

Course Outcomes

- **CO1** To get the knowledge of properties of material, stress, thermal stress and various mechanical components.
- **CO2** Able to understand how different components will fail under load with help of theories of failure for brittle and ductile materials.
- **CO3** Able to apply concepts of stress, strain, principle stress in 1D, 2D and 3D objects and also able to apply stress functions, and calculate stresses in plates and shells, thick circular cylinders and discs and employ contact stresses and stress concentration knowledge
- **CO4** Able to analyze the different methods of unsymmetrical bending analysis and concept of shear center.
- **CO5** Able to evaluate force, stress and displacement in simple structures with use of energy methods.
- **CO6** Able to create stress-strain model for any mechanical component.

CO-PO MAPPING

Sr. No.	Course Outcome	PO
1.	**CO1** To get the knowledge of properties of material, stress, thermal stress and various mechanical components.	PO1, PO3
2.	**CO2** Able to understand how different components will fail under load with help of theories of failure for brittle and ductile materials.	PO1, PO2, PO7
3.	**CO3** Able to apply concepts of stress, strain, principle stress in 1D, 2D and 3D objects and also able to apply stress functions, and calculate stresses in plates and shells, thick circular cylinders and discs and employ contact stresses and stress concentration knowledge	PO2, PO6, PO8, PO9
4.	**CO4** Able to analyze the different methods of unsymmetrical bending analysis and concept of shear center.	PO2, PO4, PO11
5.	**CO5** Able to evaluate force, stress and displacement in simple structures with use of energy methods.	PO3, PO6 PO7, PO8, PO12
6.	**CO6** Able to create stress-strain model for any mechanical component.	PO3, PO4 P87, PO8, PO10

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1 To get the knowledge of properties of material, stress, thermal stress and various mechanical components.	√		√			√						
CO2 Able to understand how different components will fail under load with help of theories of failure for brittle and ductile materials.	√	√					√			√		
CO3 Able to apply concepts of stress, strain, principle stress in 1D, 2D and 3D objects and also able to apply stress functions, and calculate stresses in plates and shells, thick circular cylinders and discs and employ contact stresses and stress concentration knowledge		√				√		√	√			

CO4 Able to analyze the different methods of unsymmetrical bending analysis and concept of shear center.		√		√	√		√				√	
CO5 Able to evaluate force, stress and displacement in simple structures with use of energy methods.			√			√	√	√		√		√
CO6 Able to create stress-strain model for any mechanical component.		√	√				√			√		

02 1306 STRENGTH OF MATERIAL

L-T-P : 3-0-3 **Credit : 5**

1. **Introduction and fundamental concept :** Introduction, purpose & scope of the subject, basic assumption, types of forces (external & internal forces), classification of materials, st. venant's principles, principle of super position, generalized hook's law for isotropic & elastic material. Simple stresses & strain – Axial loads – safety concepts : general concepts; stress analysis of axially loaded base : axial strains and deformation in bars : Strains and deformation axially loaded bars – stress – strain relationship – Possion's ratio, analysis of bars of varying sections. Composite bars, thermal stresses, Relationship between elastic constants.

   Lecture : 13

2. **Torsion :** Torsion stress and deformation in circular member, design of circular member in torsion.

   Lecture : 4

3. **Shear force and bending moment diagram** of the transverse section of the beam.

   Lecture : 4

4. **Deflection of beams :** Deflection of integration, deflection by moments – area method.

   Lecture : 5

5. **Two dimensional stress analysis :** Plane stress components on general plane at a point, Mohr's circle of stress. **Lecture : 5**

6. **Introduction to advance mechanics of solid :** thin cylinder, thick cylinder – radial and hoop stresses, application of compound stress theories, elastic strain energy and its application : Elastic strain energy of a rod under various kinds of loading elastic strain energy for various states of stress. Simple application, Castiglione theorem. **Lecture : 11**

Text Books :

(1) Strength of material by GH Ry der
(2) Mechanics of solids by Kazimi
(3) Mechanics of solids by LS Srinath
(4) Mechanics of solids by Singh & Jha

Reference Books :

(1) Mechanics of solids by Timoshinko & Gere
(2) Mechanics of solids by Popov

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

B.Tech. 3rd (THIRD) Semester (2017 Batch) TIME TABLE WITH EFFECT FROM 23/07/2018

DAY	I (09.00-10.00AM)	II (10.00-11.00AM)	III (11.00-12.00PM)	IV (12.00-01.00PM)		V (02.00-03.00PM)		VI (03.00-04.00PM)		VII (04.00-05.00PM)	
MON	MAT SC (HKC) 36	M-III (SKJ) 36	SOM (AKM) 36	OBIP (ANK) 36	R	OBIP (ANK) TEST 36	MAT SC.(HKC) TEST 36	M-III (SKJ) TEST 36	SOM (AKM) TEST 36	FM (GK) TEST 36	THDM (AK) TEST 36
TUE	THDM (AK) 36	OBIP (ANK) 36	MAT SC (HKC) 36	FLD MECH (GK) 36	E	---------- SOM LAB(AK+AKM) ----------					
						FLD MECH (T)(GK) 36		FLD MECH (T)(GK) 36			
WED		FLD MECH (GK) 36	OBIP (ANK) 36	THDM (AK) 36	C	---------- SOM LAB(AK+AKM) ----------					
						M-III (T) (SKJ) 36		FLD MECH (T) (GK) 36		FLD MECH (T) (GK) 36	
THU	SOM (AKM) 36	---------- FLD MECH LAB (GK + SK) ----------			E	MAT SC (HKC) 36		THDM (T) (AK) 36		M-III (T) (SKJ) 36	
		MAT SC (T) (HKC) 36	MAT SC (T) (HKC) 36	THDM (T) (AK) 36							
FRI	FLD MECH (GK) 36	---------- FLD MECH LAB (GK + SK) ----------			S	M-III (SKJ) 36		THDM (T) (AK) 36		THDM (T) (AK) 36	
		MAT SC (T) (HKC) 36	MAT SC (T) (HKC) 36	THDM (T) (AK) 36							
SAT		SOM (AKM) 36	THDM (AK) 36	M-III (SKJ) 36	S						

Course Code / Subject Name	Faculty Name
24101 / Organizational Behaviour & Industrial Psychology (OBIP)	Prof. Anil Kumar (ANK)
01107 / Fluid Mechanics (FLD MECH)	Prof. Gulshan Kumar (GK)
02102 / Material Science (MAT SC)	Prof. Hemant Kr. Choudhary (HKC)
21103/ Mathematics-iii (M-III)	Dr. Shyam Kr. Jha (SKJ)
02106 / Strenght of Material (SOM)	Prof. Arvind Kr. Madheshiya
02107 / Thermodynamics (THDM)	Prof. Amit Kumar

Gulshan Kumar 21/07/2018

Prof.-in-charge (TT)
(Dept. of Mech. Engg.)

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

B.Tech. 5th (FIFTH) Semester (2016 Batch) TIME TABLE WITH EFFECT FROM 23/07/2018

DAY	I (09.00-10.00AM)	II (10.00-11.00AM)	III (11.00-12.00PM)	IV (12.00-01.00PM)		V (02.00-03.00PM)		VI (03.00-04.00PM)		VII (04.00-05.00PM)	
MON	IS-T1 47	M/C TLS (SK) 47	F.MACH (SG) 47	ST.PWR(NBK) 47	R	IS(T1) TEST 47	F.MACH (SG) TEST 47	ST.PWR (NBK) TEST 47	DOM (SAR) TEST 47	M/C TLS (SK) TEST 47	PMIR (RKR) TEST 47
TUE	IS-T1 47	F.MACH (SG) 47	M/C TLS (SK) 47	PMIR (RKR) 47	E	FLD MACHINERY LAB (SG+GK) / ST.PWR S. LAB (NBK+SAR)					
WED		ST.PWR (NBK) 47	M/C TLS (SK) 47	DOM (SAR) 47	C	---------- ST.PWR S. LAB (NBK+SAR) ----------					
THU		DOM (SAR) 47	PMIR (RKR) 47	IS(T1) 47	E	---------- DOM LAB (SAR) ----------					
						M/C TLS(T) (SK) 47		M/C TLS(T) (SK) 47			
FRI	F.MACH (SG) 47	ST.PWR (NBK) 47	PMIR (RKR) 47	DOM (SAR) 47	S	---------- DOM LAB (SAR) ----------					
						M/C TLS(T) (SK) 47		M/C TLS(T) (SK) 47			
SAT		---------- FLD MACHINERY LAB (SG+GK) ----------			S						

Course Code / Subject Name	Faculty Name
24102 / PERSONAL MANAGEMENT AND INDUSTRIAL RELATION (PMIR)	Prof. Ravi Kant Ranjan (RKR)
06105 / Information Security (IS)	T1- Prof. Savyasachi
02110 / Fluid Machinary (F. MACH)	Prof. Shobhit Gusain (SG)
02112 / Steam Power System (ST. PWR)	Prof. Nibha Kumari (NBH)
02113 / Dynamics of Machinery (DOM)	Prof. Sarvesh Kumar (SAR)
02114 / Machine Tools and Machinery (M/C TLS)	Prof. Santosh Kumar (SK)

Gulshan Kumar
21/07/2018

Prof.-in-charge (TT)
(Dept. of Mech. Engg.)

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

B.Tech. 7th (Seventh) Semester (2015 Batch) TIME TABLE WITH EFFECT FROM 23/07/2018

DAY	I (09.00-10.00AM)	II (10.00-11.00AM)	III (11.00-12.00PM)	IV (12.00-01.00PM)		V (02.00-03.00PM)		VI (03.00-04.00PM)		VII (04.00-05.00PM)
MON		CAD-M (JY) 53	AUT.MEC (SAR)53	ICE (PBH) 53		OR (SG) TEST 53	AUTO. MEC (SAR) TEST 53	RAC (PBH) TEST 53	ICE (PBH) TEST 53	CAD/M (JY) TEST 53
TUE	RAC(PBH) 53	AUT.MEC (SAR) 53	ICE (PBH) 53	OR (SG) 53		----------I.C. ENGINE LAB (HKC)/CAD-M(JKY) ---------				
WED	AUT.MEC (SAR) 53	CAD-M (JY) 53	OR (SG) 53	RAC (PBH) 53		----------I.C. ENGINE LAB (HKC)/CAD-M(JKY) ----------				
THU	ICE (PBH) 53	RAC (PBH)53	OR (SG)53	AUT.MEC (SAR) 53		---------- RAC LAB (PBH + RKR) ----------				
FRI	AUT.MEC (T) (SAR)53	MINOR PROJECT (MDI + PBH + RKR+HKC+ NBH+NKD+SG+SAR) 53				OR (T) (SG) 53		OR (T) (SG) 53		AUT.MEC (T) (SAR)53
SAT	CAD-M (JY) 53	MINOR PROJECT (GK + AKM+NK+IF+AKN +MKS+JY+AK+SK) 53				---------- RAC LAB (PBH + RKR) ----------				
						OR (T) (SG) 53		OR (T) (SG) 53		AUT.MEC (T) (SAR)53
						AUT.MEC (T) (SAR)53				

Course Code / Subject Name	Faculty Name
02123 / Operation Research (OR)	Prof. Shobhit Gusain (SG)
02124 / Automotive Mechnics (AUT. MEC)	Prof. Sarvesh Kumar (SAR)
02120 / Refrigeration and Air Conditioning (RAC)	Prof. Prabhanshu (PBH)
02130 / Computer Aided Design and Manufacturing (CAD/M)	Prof. Jigesh Yadav (JY)
02122 / Internal Combustion Engine and Gas Turbine (ICE)	Prof. Prabhanshu (PBH)
02114 / Machine Tools and Machinery (M/C TLS)	Prof. Santosh Kumar (SK)

Gautam Kumar
21/07/2018
Prof.-in-charge (T.T)

TIME TABLE (Session 2018-19) Odd Semester

MIT Muzaffarpur

FACULTY:- Mr. Arvind Kumar Madheshiya (Mechanical Engineering Department)

TIME / DAY	L-1 09.00-10.00	L-2 10.00-11.00	L-3 11.00-12.00	L-4 12.00-01.00	LUNCH BRAK	L-5 02.00-03.00	L-6 03.00-04.00	L-7 04.00-05.00
Monday			**SOM** **(36)L** B. TECH(ME)-III					
Tuesday						**SOM LAB** **(36)LAB** B. TECH(ME)-III M-1		
Wednesday						**SOM LAB** **(36)LAB** B. TECH(ME)-III M-2		
Thursday	**SOM** **(36)L** B. TECH(ME)-III							
Friday								
Saturday		**SOM** **(36)L** B. TECH(ME)-III				**MD LAB** **(AKM+SK)** B. TECH(ME)-IV		

MUZAFFARPUR INSTITUTE OF TECHNOLOGY
MUZAFFARPUR
B. TECH. 4th SEMESTER 2016 BATCH
MECHANICAL BRANCH

Sl. No.	College Roll No.	Name
1	17M01	HİMANSHU KUMAR
2	17M02	KESHAY KUMAR
3	17M03	SUMIT KUMAR THAKUR
4	17M04	SHIVAM
5	17M05	DHEERAJ KUMAR
6	17M06	RAHUL RAJ
7	17M07	AVINASH KUMAR
8	17M08	RAHUL KUMAR
9	17M09	SATISH KUMAR
10	17M10	NARENDRA KUMAR KAMAT
11	17M11	RAUSHAN KUMAR
12	17M12	SAUBHIK KUMAR MAHTO
13	17M13	DHIRAJ KUMAR
14	17M14	PRABHAKAR PANDEY
15	17M15	PRATYUSH CHANDRA
16	17M16	HIMASHU KUMAR
17	17M17	ANIKET KUMAR
18	17M18	AYUSH KUMAR
19	17M19	SAURAV KUMAR
20	17M20	MD AFZAL
21	17M21	VIKASH KUMAR
22	17M22	HARIDA YESH TEJAS JHA
23	17M23	RAJ KUMAR
24	17M24	ABHIMANYU KUMAR
25	17M25	SUDHANSHU RANJAN
26	17M26	MANJEET RAJ
27	17M27	ANJALI GUPTA
28	17M28	AJAY KUMAR
29	17M29	ABHIMANYU KUMAR

MUZAFFARPUR INSTITUTE OF TECHNOLOGY
MUZAFFARPUR
B. TECH. 4th SEMESTER 2016 BATCH
MECHANICAL BRANCH

30	17M30	AJIT KUMAR
31	17M31	RAHUL KUMAR
32	17M32	GAURAV KUMAR
33	17M33	SHIVAM SAGAR
34	17M34	NITISH KUMAR
35	17M35	VEER KUMAR
36	17M36	BIRENDRA KUMAR PANDIT
37	17M37	SANTOSH KUMAR
38	17M38	PRASHANT KUMAR
39	17M39	ALOK KUMAR
40	17M40	AYUSHI DIVYA
41	17M41	MAYANK GAUTAM
42	17M42	RAMAN MAHTO ANAND
43	17M43	KISHAN RAJ
44	17M44	RAJANISH KUMAR SHARMA
45	17M45	PRITI KUMARI
46	17M46	SHUBHAM KUMAR
47	17M47	ASHWANI KUMAR
48	17M48	AMAR KUMAR RISHI DEV
49	17M49	RAHUL KUMAR
50	17M50	GAURAV KUMAR
51	17M51	RAJNISH KUMAR RANJAN
52	17M52	SHATRUNJAY KUMAR
53	17M53	SAURAV KUMAR
54	17M54	NAND KISHOR BHARTI
55	17M55	CHANDAN KUMAR
56	17M56	RITISH KUMAR
57	17M57	SALIF KHAN
58	17M58	PRIYA RANA
59	17M59	ROHIT RANJAN
60	17M60	HARSH RAJ
61	17M61	AMIT KUMAR CHOUDHARY

MUZAFFARPUR INSTITUTE OF TECHNOLOGY
MUZAFFARPUR
B. TECH. 4th SEMESTER 2016 BATCH
MECHANICAL BRANCH

62	17M62	SUNIL PUSHPAM
63	17M63	MOHIT RAJ

Test No.- 01
Session 2018-19 (Odd Semester)

Subject: - Strength of Material
Semester- 3rd (B. Tech) **Branch- Mechanical Engg.**
Time – 1:00 Hours **Maxi. Marks: - 30**

NOTE: Attempt all the questions. **(1.5x4=6 Marks)**

Q.1 Explain the following:

a) Concept of stress
b) Thermal stress
c) Principle stress
d) Poisson's ratio

NOTE: Attempt any two questions. **(7x2 = 14 Marks)**

Q. 2 Explain Von-Mises criteria of theories of failure in detail.

Q. 3 A steel rod 15 m long is at a temperature of 15^0C. Find the free expansion of the length when the temperature is raised to 65^0C. Find the temperature stress produced when:

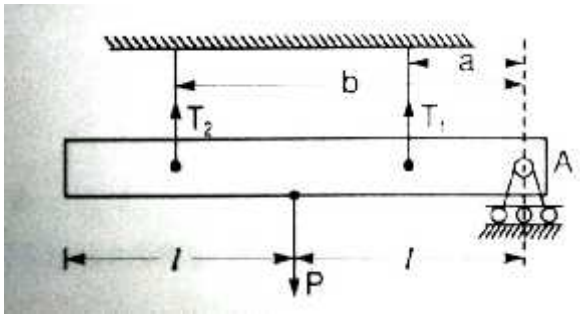
a) The expansion of rod is prevented;
b) The rod is permitted to expand by 6 mm.

Take: $\alpha = 12 \times 10^{-6}$ per ^{0}C,
and $E = 200$ GN/mm^2

Q. 4 Derive the expressions of compatibility equation in 3-dimenssions and also draw the element with all label of stresses.

NOTE: Attempt any one questions. **(10x1 = 10 Marks)**

Q. 5 A Below figure shows a rigid bar hinged at A and supported in a horizontal position by two identical steel wires. Neglect the weight of beam. Find out the tensions T_1 and T_2 induced in these steel wires by a vertical load P applied as shown in figure.



Q. 6 Derive the expression for principle stresses with analytical method and show that the sum of normal stresses at two mutually perpendicular plane will be always constant.

Test -02
Session 2016-17 (Odd Semester)

Subject: - Strength of Material
Semester- 3rd (B. Tech) **Branch- Mechanical Engg.**
Time – 1:00 Hours **Maxi. Marks: - 30**

NOTE: Attempt all the questions. **(1.5x4=6 Marks)**

Q.1 Explain the following:

a) What is shear center? Define clearly.

b) State Castigliano's theorem for concentrated loads.

c) List the all assumptions made in simple theory of bending.

d) Define Impact loading. Explain how impact loading is more dangerous for mechanical components.

NOTE: Attempt any two questions. **(7x2 = 14 Marks)**

Q. 2 Differentiate between thick cylinder and thin cylinder and also find out the change in volume of a Thin cylinder shell due to an internal pressure.

Q. 3 A block of material is subjected to a tensile strain of 12×10^{-6} and a compressive strain of 15×10^{-6} on planes at right angles to each other. There is also a shear strain of 12×10^{-6} and there is no strain on planes at right angles to the above planes. Calculate the principal strain magnitude and direction.

Q. 4 Differentiate the stress, strain, and strain energy symmetry. How the number of independent elastic constant reduces to 21 from 81 considering all above symmetry for anisotropic materials?

NOTE: Attempt any one questions. **(10x1 = 10 Marks)**

Q. 5 Establish relationship between length of column and equivalent length for different end conditions.

Q. 6 Determine the deflection at C and D in the beam by Macaulay's method as shown in figure 1. Take: $E = 200 \times 10^6$ kN/m^2 and $I = 20 \times 10^{-5}$ m^4.

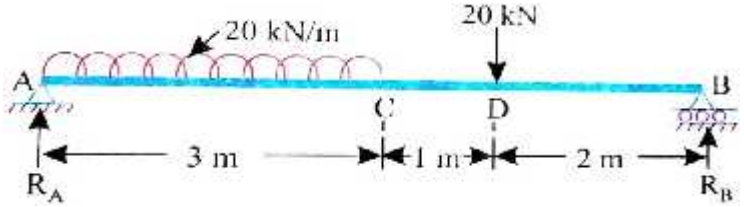


Figure 1

MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR

Subject: Strength of Materials
Week Test: 01

Note: Attempt all the questions. **Total Marks: 10**
Calculator is allowed.

Question No.1. When a tensile or compressive force (P) acts on a body, the change in its length is given by

(a)$\frac{P}{A}$ (b)$\frac{A}{P}$ (c)$\frac{P}{A}$ (d)$\frac{P}{L}$

(1.5 Marks**)**

Question No.2. Poisson's ratio for steel is

(a) 0.13 (b) 0.23 (c) 0.30 (d) 0.43

(1.5 Marks**)**

Question No.3. The ratio of lateral strain to linear strain is known as……..….

(1.5 Marks**)**

Question No.4. Relation between E (Young's Modulus), K (Bulk modulus of elasticity), and G (modulus of rigidity) is given by

(a)$\frac{9K}{3K+G}$ (b)$\frac{3K+G}{6K}$ (c)$\frac{6K}{K+3G}$ (d)$\frac{3K}{3K+G}$

(1.5 Marks**)**

Question No.5. Explain the concept of stress. **(4** Marks**)**

(Space for Answer)

MUZAFFARPUR INSTITUTE OF TECHNOLOGY, MUZAFFARPUR

Subject: Strength of Materials
Week Test: 02

Note: 1. Attempt all the questions. 2. Calculator is allowed. **Total Marks: 10**

Question No.1. Robert Hooke discovered experimentally that within elastic limit

(a) Stress = strain (b) stress × strain = 1 (c) $\frac{s}{s}$ = a constant (d) None of these

(1 Mark**)**

Question No.2. Maximum stress (σ_{max}) induced in a bar of length *l*, rotating at an angular velocity ω, is given by

(a) $\frac{1}{2}\rho\omega^2 l^2$ (b) $\frac{1}{8}\rho\omega^2 l^2$ (c) $\rho\omega^2 l^2$ (d) $\rho\omega l^2$

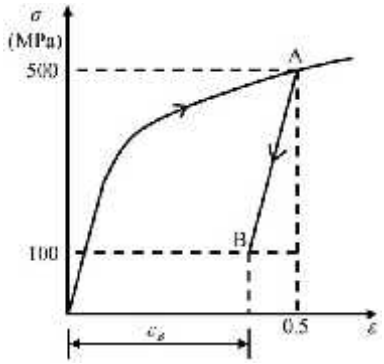
(2 Marks**)**

Question No.3. The elongation of a circular linearly tapered rod is given by

(a) $\frac{4P}{\pi d_1 d_2}$ (b) $\frac{2P}{\pi d_1 d_2}$ (c) $\frac{4P}{E d_1 d_2}$ (d) $\frac{4P}{\pi d_1^2 d_2}$

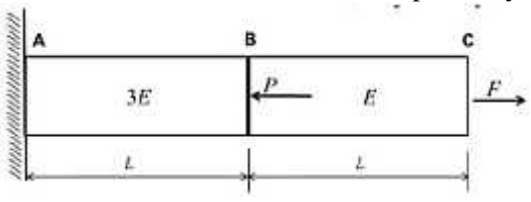
Where, P = axial pull, and d_1, d_2 = diameters at the two ends. **(2** Marks**)**

Question No.4. The true stress (σ) - true strain (ε) diagram of a strain hardening material is shown in figure. First, there is loading up to point A, i.e., up to stress of 500 MPa and strain of 0.5. Then from point A, there is unloading up to point B, i.e., to stress of 100 MPa. Given that the Young's modulus E = 200 GPa, the natural strain at point B (ε_B) is _____ (correct to three decimal places).



(2 Marks**)**

Question No.5. A horizontal bar with a constant cross-section is subjected to loading as shown in the figure. The Young's moduli for the sections AB and BC are 3*E* and *E*, respectively.



For the deflection at C to be zero, the ratio *P/F* is _____ **(3** Marks**)**

(Space for Answer)