MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)

Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

MUST KNOW CONCEPTS | MKC

Mechanical | **2019-20**

Course Code & Course Name : 19MEC04 & Strength of Materials

Year/Sem/Sec : II/IV/A, B & C

S.No.	Term	Notation (Symbol)	Concept / Definition / Meaning / Units / Equation / Expression	Units
Unit-I : Stress, Strain and Deformation of Solids				
1.	Load	P	The combined effect of external forces acting on a body.	N
2.	Stress	σ	It is a physical quantity that expresses the internal forces that neighboring particles of a continuous material exert on each other. It is given by $\sigma = P/A$	N/m^2
3.	Strain	e	A geometrical measure of deformation representing the relative displacement between particles in a material body	---
4.	Tensile strain		If there is an increase in length of the material line, the normal strain is called tensile strain	
5.	Compressive strain		If there is an decrease in length of the material line, the normal strain is called compressive strain	
6.	Volumetric strain		The volumetric strain is the unit change in volume, i.e. the change in volume divided by the original volume.	
7.	Hooke's Law		Within elastic limit, stress varies directly as strain. Stress /Strain = Constant I E –Young's modulus or Modulus of Elasticity	(N/m^2)
8.	Modulus of Elasticity	E	It is a quantity that measures an object or substance's resistance to being deformed elastically (i.e., non-permanently) when a stress is applied to it.	
9.	Elastic limit		The maximum extent to which a solid may be stretched without permanent alteration of size or shape.	
10.	Elasticity		It is the ability of a body to resist a distorting influence and to return to its original size and shape when that	

			influence or force is removed.	
11.	Shear modulus	C	It is the elasticity coefficient for shearing or torsion force	(N/m^2)
12.	Bulk modulus	K	The relative change in the volume of a body produced by a unit compressive or tensile stress acting uniformly over its surface	(N/m^2)
13.	Factor of Safety		It expresses how much stronger a system is than it needs to be for an intended load	
14.	Poisson's ratio	μ	Poisson's ratio is a measure of the Poisson effect, the phenomenon in which a material tends to expand in directions perpendicular to the direction of compression. Mathematically, the ratio of lateral strain to linear strain.	----
15.	Relation between elastic moduli		$E = 2C (1+1/\mu)$ $E = 3K(1-2/\mu)$ $E = 9KC/3K+C$	
16.	Composite bar		A composite bar is made up of two or more bars of equal lengths but of different materials rigidly fixed with each other and behaving as one unit for extension or compression.	
17.	Thermal stress, thermal strain		Stress created by any change in temperature to a material, Temperature strain is determined by the coefficients of thermal expansion and difference of temperatures between strained and strain less states.	
18.	Principal planes		It is that plane on which the principal stresses act and shear stress is zero.	
19.	Principal stresses		The stresses, acting on principal planes, are known as principal stresses.	
20.	Mohr's circle		It is graphical method of finding normal, tangential and resultant stresses on an oblique plane.	
21.	Strain energy	U	The energy stored in a body due to straining effect.	J
22.	Resilience		Total strain energy stored in a body.	
23.	Proof resilience		Maximum strain energy stored in a body.	
24.	Modulus of resilience		The proof of resilience per unit volume.	
25.	Ductility		Physical property of a material associated with the ability to be	

			hammered thin or stretched into wire without breaking	
Unit-II : Transverse Loading on Beams and Stresses in Beam				
26.	Beam		It is a structural member which is acted upon by a system of loads at right angles to the axis.	
27.	Cantilever beam		Fixed at one end and free at the other end	
28.	Simply supported beam		A beam supported or resting freely on the supports at its both ends	
29.	Transverse Loading		Load applied vertically to the plane of the longitudinal axis of a configuration	
30.	Shearing force		Numerically it is given by the algebraic sum of the forces to the left or right of the section.	
31.	Bending moment (BM)		Algebraic sum of the forces to the left or to the right of the section.	
32.	Shear force diagram		The diagram which shows the variation of the shear force along the length of a beam	
33.	Bending moment diagram		The diagram which shows the variation of the bending moment along the length of a beam	
34.	Point of contraflexure		The point where the BM is zero after changing its sign and also known as point of inflexion	
35.	Bending stresses		The stresses produced due to constant bending moment are known as bending stresses	
36.	Bending equation		$M/I = \sigma/y = E/R$ M = Moment of resistance; I = Moment of inertia of the section about neutral axis (NA); σ = bending stress; R = Radius of curvature; E = Young's modulus.	
37.	Section modulus	Z	The ratio of moment of inertia of a section about the neutral axis to the distance of the outermost layer from the NA	m^3
38.	Shear stresses		The stress produced in a beam, which is subjected to shear force	
39.	Overhanging beam		The end portion of a beam is extended beyond the support	
40.	Neutral axis		A line or plane through a beam or plate connecting points at which no extension	

			or compression occurs when it is bent.	
41.	Modular ratio		Plays a significant role in the load shared by the materials. Mathematically it is given by E_1/E_2	
42.	Isotropy		Uniformity in all directions	
43.	Anisotropy		Anisotropy is the property of being directionally dependent, which implies different properties in different directions	
44.	Symmetrical section		Sections will be called symmetrical, if a given section is cut around axes such that one portion is the exact image of the other	
45.	Homogenous material		A material of uniform composition throughout that cannot be mechanically separated into different materials.	
46.	Heterogeneous material		A heterogeneous material is one whose individual components can be discerned.	
47.	Moment of resistance		The couple produced by the internal forces in a beam subjected to bending under the maximum permissible stress.	
48.	Flexural strength		It is a material property, defined as the stress in a material just before it yields in a flexure test	
49.	Plasticity		It is the ability of a solid material to undergo deformation, a non-reversible change of shape in response to applied forces	
50.	Stress-strain curve		Stress strain curve show the complete picture of mechanical behaviour of material. It shows us the strain corresponding to stress.	
Unit-III : Torsion				
51.	Torsion		The action of twisting or the state of being twisted, especially of one end of an object relative to the other.	
52.	Torsion Equation		$T/J = \tau/R = C\Theta/L$	
53.	Polar modulus	Z_p	Ratio of polar moment of inertia to the radius of the shaft.	m^3
54.	Strength of the shaft		The maximum torque or maximum power that can transmit	
55.	Torsional rigidity		Product of modulus of rigidity and polar moment of inertia ($C \times J$)	Nm^2
56.	Springs		Elastic bodies which absorb energy due	

			to resilience.	
57.	Types of spring		Laminated or Leaf springs, Helical Springs	
58.	Helix		An object having a three-dimensional shape like that of a wire wound uniformly in a single layer around a cylinder or cone, as in a corkscrew or spiral staircase.	
59.	Circular shaft		A shaft excavated as a cylinder.	
60.	Polar Moment of Inertia		It is a quantity used to describe resistance to torsional deformation	
61.	Leaf spring		A spring made of a number of strips of metal curved slightly upwards and clamped together one above the other.	
62.	Coil spring		A coil spring, also known as a, mechanical device which is typically used to store energy and subsequently release it, to absorb shock, or to maintain a force between contacting surfaces	
63.	Helical Spring		The helical springs are made up of a wire coiled in the form of a helix and are primarily intended for compressive or tensile loads.	
64.	Close- coiled helical spring		Helix angle is very small	
65.	Torque	T	A force that tends to cause rotation	Nm
66.	Stepped shaft		Taper in a series of steps rather than one continuous narrowing.	
67.	Shaft deflection		It is the bending of the shaft in the forward/backward direction to and away.	
68.	Torsional deflection		Angular displacement or deformation of a body when a twisting force is applied.	
69.	Solid bar		Bars with round or circular section	
70.	Flexural rigidity		Resistance offered by a structure while undergoing bending	
71.	Power		Rate of doing work	W
72.	Centroidal axis		Centroidal axis is any line that will pass through the centroid of the cross section.	
73.	Dead load		Relatively constant over time	
74.	Flitch beam		It is a compound beam used in the construction of houses, decks, and other	

			primarily wood-frame structures.	
75.	Moment of inertia		A quantity expressing a body's tendency to resist angular acceleration.	
Unit-IV : Deflection of Beams				
76.	Deflection of beam		The deflection is measured from the original neutral surface of the beam to the neutral surface of the deformed beam.	
77.	Methods of determining beam deflection		1. Double integration method 2. Moment area method 3. Macaulay's Method	
78.	Macaulay's Method		Used in finding slopes and deflections at any point of a beam.	
79.	SSB Point load at center		Deflection is given by Wl^3 / 48EI	mm
80.	SSB-Eccentric point load		Deflection = $Wa^2b^2/3EIL$	
81.	SSB-UDL		$5Wl^3/384EI$	
82.	Maximum deflection allowed on a beam		The maximum deflection is limited to the beam's span length divided by 250.	
83.	Causes of beam deflection		Deflection in beams is caused by gravity	
84.	Moment area theorem		Engineering tool to derive the slope, rotation and deflection of beams and frames	
85.	Mohr's theorem I		The change of slope between any two points is equal to the net area of the B.M diagram between these points divided by EI	
86.	Mohr's theorem II		The total deflection between any two points is equal to the moment of the area of BM diagram between the two points about the last point.	
87.	Maximum deflection condition		The slope dy/dx is zero	
88.	Deflection- moment area method		$y = a\bar{x}/EI$	
89.	Deflection- cantilever-UDL		$wL^4/8EI$	mm

90.	Deflection-cantilever-gradually varying load		$wL^4/30EI$	mm
91.	Conjugate beam		It is an imaginary beam of length equal to that of the original beam	
92.	Conjugate beam method		Used to find the slope and deflections of such beams whose EI is not uniform throughout of its length.	
93.	Propped beam		One end is fixed and other is provided support, in order to resist the deflection of the beam	
94.	Proportional limit		The greatest stress at which the material is capable of sustaining the applied load without deviating from the proportionality	
95.	Stability		An ability of a material to withstand high load without deformation.	
96.	Stiffness		Extent to which an object resists deformation in response to an applied force	
97.	Fixed beam-point load at center		Deflection = $WL^3/192EI$	mm
98.	Fixed beam-eccentric Point Load		$y = Wa^3b^3/3EIL^3$	mm
99.	Fixed beam		Both ends are fixed	
100.	Continuous beam		Beam which is more supported on more than two supports	
Unit-V : Thin Cylinders, Spheres and Thick Cylinders				
101.	Strut		Struts generally work by resisting longitudinal compression, but they may also serve in tension.	
102.	Examples of struts		Connecting rods, Piston rods	
103.	Column		An upright pillar, typically cylindrical, supporting an arch, entablature, or other structure or standing alone as a monument.	
104.	Slenderness		Measure of propensity of a column to buckle.	
105.	Slenderness ratio		l/K; l = Effective length of the column, K = Least Radius of Gyration	
106.	Short columns		Length < 8 times diameter or	

			slenderness ratio < 32	
107.	Medium columns		Length 8 to 30 times diameter or slenderness ratio between 32 and 120	
108.	Long columns		Length > 30 times diameter or slenderness ratio >120.	
109.	Stresses associated with failure of column		Direct compressive stress, Bucking stress, and combined of direct compressive and buckling stresses.	
110.	Failure of a column		Short Column: Fails due to crushing Long Column: Fails due to crushing and buckling.	
111.	Buckling		The sudden large deformation of structure due to a slight increase of an existing load	
112.	Bending		Bending: Bending in a beam happens about the axis of the applied bending moment.	
113.	Hoop stress		Act in a tangential direction to the circumference of the shell.	
114.	Longitudinal stress		The stress acting on a pipe wall along the longitudinal direction.	
115.	Thin cylinder		A cylinder or spherical shell is considered to be thin when the metal thickness is small compared to internal diameter	
116.	Thick cylinder		Thick cylinder is cylinder whose wall thickness is greater than 1/20 times of its internal diameter	
117.	Operating pressure for thin & thick cylinders		Thin cylinders --- 30 MN/m^2 or more Thick cylinders--- 250 MN/m^2 or more.	
118.	Need for wire winding of thin cylinder		1. To increase the pressure –carrying capacity of the cylinder 2. To reduce the chances of bursting of the cylinder in longitudinal direction.	
119.	Critical load		Greatest load that will not cause lateral deflection (buckling)	
120.	Crippling Load		The load over which a column prefers to deform laterally rather than compressing itself.	
121.	Crushing		Common type of failure for short member under compression	
122.	Effective length		Height between the points of contraflexure of the buckled column	
123.	Radius of gyration		Radial distance of a point, from the axis of rotation at which, if whole mass of the body is assumed to be concentrated	

124.	Efficiency of a joint		Represents strength of a joint to the strength of the base material.	
125.	Ultimate stress		The maximum stress the body is capable of withstanding	
Placement Questions				
126.	Compressive strain		If there is an decrease in length of the material line, the normal strain is called compressive strain	
127.	Volumetric strain		The volumetric strain is the unit change in volume, i.e. the change in volume divided by the original volume.	
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