Subject: - Elements of Machine Design (22564)

Maratha Vidya Prasarak Samaj's

Rajarshi Shahu Maharaj Polytechnic, Nashik

Udoji Maratha Boarding Campus, Near Pumping Station, Gangapur Road, Nashik-13.

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SYLLABUS

Chapter No.	Name of chapter	Marks With Option
1	Fundamentals of Design	22
2	Design of Joints, Levers & Offset Links	12
3	Design of Shafts, Keys and Couplings	24
4	Design of Power screw and fasteners	26
5	Design of spring	12
6	Selection of Ant frictional bearing and gears	08
Total Marks: -		**104**

BOARD THEORY

PAPER PATTERN

FOR EMD (22564)

Q.1		Attempt any FIVE 5*2=10
	a)	Fundamentals of Design
	b)	Fundamentals of Design
	c)	Design of Joints, Levers & Offset Links
	d)	Design of Shafts, Keys and Couplings
	e)	Design of Power screw and fasteners
	f)	Design of spring
	g)	Selection of Ant frictional bearing and gears
Q.2		**Attempt any THREE 3*4=12**
	a)	Fundamentals of Design
	b)	Design of Joints, Levers & Offset Links
	c)	Design of Shafts, Keys and Couplings
	d)	Design of Power screw and fasteners

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Q.3		**Attempt any THREE** **3*4=12**
	a)	Fundamentals of Design
	b)	Design of Power screw and fasteners
	c)	Design of spring
	d)	Fundamentals of Design
	e)	Design of Power screw and fasteners
Q.4		**Attempt any TWO** **2*6=12**
	a)	Fundamentals of Design
	b)	Design of Joints, Levers & Offset Links
	c)	Design of Shafts, Keys and Couplings
Q.5		**Attempt any TWO** **2*6=12**
	a)	Design of Shafts, Keys and Couplings
	b)	Design of Power screw and fasteners
	c)	Selection of Ant frictional bearing and gears
Q.6		**Attempt any TWO** **2*6=12**
	a)	Design of Power screw and fasteners
	b)	Design of spring
	c)	Design of Shafts, Keys and Couplings

CLASS TEST - I

PAPER PATTERN

COURSE: - Elements of Machine Design (22564)

PROGRAMME: - Mechanical Engineering

Syllabus: -

Unit No.	Name of the Unit	Course Outcome (CO)
1	**Fundamentals of Design**	**CO-564.01**
2	**Design of Joints, Levers & Offset Links**	**CO-564.02**
3	**Design of Shafts, Keys and Couplings**	**CO-564.03**

Q.1	**Attempt any FOUR 4*2=8Marks**	Course Outcome (CO)
a)	Fundamentals of Design	CO-564.01
b)	Design of Joints, Levers & Offset Links	CO-564.02
c)	Design of Shafts, Keys and Couplings	CO-564.03
d)	Fundamentals of Design	CO-564.01
e)	Design of Joints, Levers & Offset Links	CO-564.02
f)	Design of Shafts, Keys and Couplings	CO-564.03
Q.2	**Attempt any THREE 3*4=12 Marks**	
a)	Design of Joints, Levers & Offset Links	CO-564.02
b)	Fundamentals of Design	CO-564.01
c)	Design of Shafts, Keys and Couplings	CO-564.03

CLASS TEST - II

PAPER PATTERN

COURSE: - Elements of Machine Design (22564)

PROGRAMME: - Mechanical Engineering

Syllabus: -

Unit No.	Name of the Unit	Course Outcome (CO)
4	**Design of Power screw and fasteners**	**CO-564.04**
5	**Design of spring**	**CO-564.05**
6	**Selection of Ant frictional bearing and gears**	**CO-564.06**

Q.1	**Attempt any FOUR** **4*2=8Marks**	Course Outcome (CO)
a)	Design of Power screw and fasteners	CO-564.04
b)	Design of spring	CO-564.05
c)	Selection of Ant frictional bearing and gears	CO-564.06
d)	Design of Power screw and fasteners	CO-564.04
e)	Selection of Ant frictional bearing and gears	CO-564.06
f)	Design of Power screw and fasteners	CO-564.04
Q.2	**Attempt any THREE** **3*4=12 Marks**	
a)	Selection of Ant frictional bearing and gears	CO-564.06
b)	Design of spring	CO-564.05
c)	Design of Power screw and fasteners	CO-564.04

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COURSE OUTCOME (CO)

COURSE: - Elements of Machine Design (22564)

PROGRAMME: - Mechanical Engineering

CO. NO.	Course Outcome
CO- 564.01	Signify understanding of basic concepts in design procedure in order to state the need for design.
CO- 564.02	Apply knowledge of stresses generated in designing mechanical joints and levers/links for given load.
CO- 564.03	Integrate knowledge of torque transmitted, allowable shear stress, crushing stress to design shaft, keys and couplings.
CO- 564.04	Compute the numerical for design of screw jack, toggle jack and ability to analyze the self-locking and overhauling of power screw and integrate the knowledge for designing the fasteners.
CO- 564.05	Enhancement in proficiency of selecting the spring as per the application.
CO- 564.06	Apply the knowledge of antifriction bearing for selecting particular type of bearing.

1. Fundamentals of Design

Position in Question Paper   **Total Marks-22**

Q.1. a) 2-Marks.

Q.1. b) 2-Marks.

Q.2. a) 4-Marks.

Q.3. a) 4-Marks.

Q.3. d) 4-Marks.

Q.4. a) 6-Marks.

Descriptive Question

1. What is factor of safety? State its importance in design of machine elements.
2. What are the factors to be considered for selection of materials for design of machine elements?
3. Define:
   a) Ductility
   b) Toughness
   c) Creep
4. Explain with neat sketches only
   a) Methods of reducing stress concentration in cylindrical members with shoulders.
   b) Methods of reducing stress concentration in cylindrical members with holes.
5. Give the composition of:
   a) 35 Mn 2 Mo 28
   b) 30 Ni 4 Crl
   c) 25 Cr 3 Mo 55
6. Explain the importance of Aesthetic considerations in design by giving two examples.
7. Define Endurance or fatigue limit and draw typical S-N curve for steel.
8. Define stress-concentration. Explain any 4 methods to reduce it with neat sketches.
9. Write general equation for:
   a) Bending moment

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   b) Torsion Equation and explain the various terms used in it.

10. Explain ergonomics and aesthetics in automobile design.

11. Define:
   a) Resilience
   b) Modulus of resilience. Show modulus of resilience on stress-strain diagram for ductile material.

12. Give the composition of:
   a) X2O Cr18 Ni2,
   b) 35C8
   c) Fe E 230
   d) FG 200

13. State and explain following theories:
   a) Maximum principle stress theory.
   b) Maximum shear stress theory.

14. Draw stress-strain diagram for (i) ductile material (ii) brittle material

15. Define endurance or fatigue limit and draw S-N curve for steel.

16. Define factor of safety w.r.t. mild steel and cast iron.

17. What is stress concentration? Illustrate methods to reduce it with sketches.

18. State the following material specifications.
   a) FeE 230
   b) FG 200
   c) 3SC8
   d) X20Cr18Ni12

19. State applications of maximum shear stress theory and principal normal stress theory.

20. State and describe in brief any six ergonomics considerations in design of machine elements.

21. Define term 'Stress Concentration'

22. Enlist the steps involved in general design procedure.

23. Explain importance of shape and size in aesthetic design.

24. Define "Machine Design".

25. State Six examples of ergonomic considerations in the design of a lathe machine.

26. Define factor of safety for ductile and brittle material.

27. Write the meaning of following material designation.
   a) 40C8   b) SG 700/2

c) Fe E200   d) X10Cr18Ni9

28. Explain maximum principal stress theory and maximum shear stress theory with their uses.

MCQ Question

(Total number of Question=Marks*3=22*3=66)

Note: Correct answer is marked with **bold.**

1. A steel with 0.8 per cent carbon is known as_____
   a) **Eutectoid steel**   c) Hypoeutectoid steel
   b) Hypereutectoid steel   d) None of these

2. 18/8 steel contains _____
   a) 18 per cent nickel and 8 per cent chromium
   b) **18 per cent chromium and 8 per cent nickel**
   c) 18 per cent nickel and 8 per cent vanadium
   d) 18 per cent vanadium and 8 per cent nickel

3. The ratio of linear stress to linear strain is called
   a) **Modulus of elasticity**   c) Modulus of rigidity
   b) Bulk modulus   d) Poisson's ratio

4. According to Indian standard specifications, a grey cast iron designated by 'FG200' means that the
   a) carbon content is 2%
   b) maximum compressive strength is 200 N/mm^2
   c) **minimum tensile strength is 200 N/mm^2**
   d) maximum shear strength is 200 N/mm^2

5. The material commonly used for machine tool bodies is ____
   a) mild steel   c) brass
   b) aluminum   d) **cast iron**

6. An aluminum member is designed based____
   a) **Yield stress**   c) proof stress
   b) elastic limit stress   d) ultimate stress

7. The Poisson's ratio for steel varies from_____
   a) 0.21 to 0.25   b) **0.25 to 0.33**

c) 0.33 to 0.38   d) 0.38 to 0.45

8. The energy stored in a body when strained within elastic limit is known as___
   a) resilience   **c) strain energy**
   b) proof resilience   d) impact energy

9. In a body, a thermal stress is one which arises because of the existence of___
   a) latent heat   c) total heat
   b) temperature gradient   d) specific heat

10. If d = diameter of solid shaft and τs = permissible stress in shear for the shaft
    material, then torsional strength of shaft is written as _____
    a) Pi*d^4* τs/32   c) Pi*d^4* τs/16
    b) Pi*d^3* τs/32   **d) Pi*d^3* τs/16**

11. If di and do are the inner and outer diameters of a hollow shaft, then its polar moment
    of inertia is _____
    a) pi*(do^4-di^4)/64   c) pi*(do^3-di^3)/32
    b) pi*(do^4-di^4)/32   d) pi*(do^3-di^3)/16

12. A load of 5 kN is to be raised by means of a steel wire. Find the minimum diameter
    required, if the stress in the wire is not to exceed 100 N/mm2.
    a) 7.979 mm   c) 7.777 mm
    b) 7.799 mm   d) 7.999 mm

13. What is bearing pressure?
    a) Compressive force acting on the contact area between two components having relative motion between them
    b) Tensile stress acting on the contact area between two components having relative motion between them
    c) Compressive force acting on the contact area between two components having no relative motion between them
    d) Compressive stress acting on the contact area between two components having relative motion between them

14. The notch sensitivity q is expressed in terms of fatigue stress concentration factor Kf
    theoretical stress concentration factor Kt as _____
    a) (Kf + 1)/ (Kt + 1)   c) (Kt + 1)/ (Kf + 1)
    b) (Kf - 1)/ (Kt - 1)   d) (Kt - 1)/ (Kf - 1)

15. Which of the following material has he maximum ductility?
    a) Mild steel   c) Zinc
    b) Copper   d) Aluminium

16. Steel containing upto 0.15% carbon is known as _____
  a) mild steel
  c) medium carbon steel
  b) dead mild steel
  d) high carbon steel

17. Shock resistance of steel is increased by adding
  a) nickel
  c) nickel and chromium
  b) chromium
  d) sulphur, lead and phosphorus

18. Deformation per unit length is called as _____
  a) strain
  c) modulus of elasticity
  b) stress
  d) none of the above

19. In design process, which process is followed after selecting the material?
  a) Selecting factor of safety
  c) Analysis of forces
  b) Synthesis
  d) Determining mode of failure

20. Which design consideration deals with appearance of the product?
  a) Ergonomics
  c) System design
  b) Aesthetics
  d) Creative design

21. The objective of considering ergonomics in machine design is to ____
  1. decrease physical stresses
  2. make user adapt to the machine
  3. make machine fit for the user
  4. improve appearance of the product
  a) only 2
  c) 1 and 3
  b) 3 and 4
  d) 1, 3 and 4

22. In stress-strain diagram, up to proportional limit _____
  a) stress is inversely proportional to strain
  b) force is directly proportional to displacement
  c) stress is directly proportional to strain
  d) strain is directly proportional to stress

23. Which of the following materials do not have a well-defined yield point?
  a) Heat treated steel
  c) Carbon fiber
  b) Concrete
  d) All of the above

24. In design process, which step is followed after defining the problem?
  a) Analysis
  c) Optimization
  b) Synthesis
  d) Evaluation

25. For brittle materials having static load, factor of safety is given as the ratio of _____
  a) endurance strength and design stress

b) design stress and allowable stress

c) working stress and allowable stress

d) ultimate strength and design stress

26. What is meant by Aesthetics?

a) Interaction between man machine working environment

b) Appearance of the product

c) Both a. and b.

d) None of the above

27. Series of numbers offered by arithmetic progression are called as_____

    a) Preferred Series

    b) Number Series

    c) Arithmetic series

    d) Progression Series

28. Which of the following is the definition of Compliance?

    a) Inverse of Rigidity

    b) Inverse of Stiffness

    c) Proportional to elastic Limit

    d) None of the mentioned

29. Yield strength is defined as the maximum stress at which a marked increase in elongation occurs without increase in_____

    a) Load

    b) Strength

    c) Toughness

    d) Hardness

30. For the materials which do not exhibit a well-defined yield points, the yield strength is defined as the stress corresponding to a permanent set of how much percentage of gauge length?

    a) 0.1

    b) 0.2

    c) 0.3

    d) 0.4

31. Which of the following are true about plasticity?

    a) Permanent Deformation

    b) Ability to retain deformation under load or after removal of load

    c) Plastic deformation is greater than elastic deformation

    d) All of the mentioned

32. Which of the following is measure of stiffness?

    a) Modulus of elasticity

    b) Modulus of plasticity

    c) Resilience

    d) Toughness

33. Which of the following facts are true for resilience?

    a) Ability of material to absorb energy when deformed elastically

    b) Ability to retain deformshation under the application of load or after removal of load

    c) Ability of material to absorb energy when deformed plastically

    d) None of the mentioned

34. Which of the following are true for toughness?

    a) Ability of material to absorb energy before fracture

    b) Measured by Izod & Charpy test

    c) Decreases with the increase in temperature

    d) All of the mentioned

35. Hardness is

    a) Surface property

    b) Resistance to abrasion

    c) Depends upon resistance to plastic deformation of the material

    d) All of the mentioned

36. Which of the following relationship is true? (p=Poisson's ratio)

    a) $E=2G(1+p)$ c) $E=2(G+p)$

    b) $E=G(2+p)$ d) No relation

37. According to principal stress theory, which option represents the correct relation between yield strength in shear (YSS) and the yield strength in tension (YST)?

    a) YSS=0.5YST   c) YST=0.5YSS

    b) YSS=0.577YST   d) YST=0.577YSS

38. Resilience of a material is important, when it is subjected to

    a) Combined loading   c) Thermal stresses

    b) Fatigue   **d) Shock loading**

39. Stress concentration is caused due to

    a) Variation in properties of material from point to point in a member

    b) Pitting at points or areas at which loads on a member are applied

    c) Abrupt change of section

    d) All of the above

40. The toughness of a material _____ when it is heated

    a) Does not change   **c) Decreases**

    b) Increases   d) None of the Above

41. The constant factor in case of R10 series of preferred numbers is

    a) 1.06   **c) 1.26**

    b) 1.12   d) 1.58

42. Shear stress theory is applicable for

    a) Ductile materials   c) Elastic materials

    b) Brittle materials   d) All of the above

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43. Stress concentration in static loading is more serious in
   a) Ductile materials
   b) Brittle materials
   c) Equally serious in both cases
   d) Depends on other factors

44. If a material fails below its yield point, failure would be due to
   a) Straining
   b) Fatigue
   c) Creep
   d) Sudden loading

45. The property of a material which enables it to be drawn into wires with the application of a tensile force, is called
   a) Plasticity
   b) Elasticity
   c) Ductility
   d) Malleability

46. Stress concentration factor is defined as the ratio of
   a) Maximum stress to the endurance limit
   b) Nominal stress to the endurance limit
   c) Maximum stress to the nominal stress
   d) Nominal stress to the maximum stress

47. The fatigue stress concentration factor is defined as
   a) The ratio of endurance limit with stress concentration to the endurance limit without stress concentration
   b) The ratio of endurance limit without stress concentration to the endurance limit with stress concentration
   c) The product of the endurance limits with and without stress concentration
   d) All of the above

48. Which of the following property is desirable in parts subjected to shock and impact loads?
   a) Strength
   b) Stiffness
   c) Brittleness
   d) Toughness

49. In which of the following case stress concentration factor is ignored?
   a) Ductile material under static load
   b) Ductile material under fluctuating load
   c) Brittle material under static load
   d) Brittle material under fluctuating load

50. Which of the following reduces the stress concentration?
   a) Use of multiple notches
   b) Drilling additional holes
   c) Removal of undesired material
   d) Each of the mentioned

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51. The ratio of endurance strength and allowable stress is used to determine FOS for _____
    a) **fatigue loading**
    b) static loading of brittle materials
    c) static loading of ductile materials
    d) all of the above

52. Which of the following factors are not considered while selecting values for factor of safety?
    a) Cost
    b) Failure consequences
    c) Degree of uncertainty about loading and material
    d) **None of the above**

53. Match the following Group 1 items (Preferred series) and Group 2 items (Step ratios) and select the correct option
    1. R5 --- A. 1.12
    2. R20 -- B. 1.26
    3. R80 -- C. 1.58
    4. R10 -- D. 1.03
    a) 1 – D, 2 – C, 3 – A, 4 – B   c) 1 – A, 2 – C, 3 – D, 4 – B
    b) 1 – B, 2 – D, 3 – C, 4 – A   d) **1 – C, 2 – A, 3 – D, 4 – B**

54. What is the step ratio for R40 series?
    a) 1.44   c) 4.0
    b) **1.05**   d) 0.4

55. Which of the following is a ferrous alloy?
    a) Brass   c) **Cast steel**
    b) Aluminum alloys   d) All of these

56. Hardness of a material enables it to resist
    a) abrasion   c) plastic deformation
    b) penetration   d) **All of these**

57. The component deforming progressively under load at high temperatures is called as
    a) Resilience   c) Fatigue
    b) **Creep**   d) All of these

58. What is the percentage of carbon in plain carbon steel?
    a) 50 to 80%   c) Less than 9%
    b) **Less than 1.7%**   d) None of these

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59. Ergonomics is related to human
   a) comfort
   b) safety
   c) **both A and B**
   d) none of the above

60. The characteristics of standardization include
   a) material
   b) dimensions and shape of the component
   c) method of testing of the product
   d) **all of these**

61. The constant factor in case of R10 series of preferred numbers is
   a) 1.06
   b) 1.12
   c) **1.26**
   d) 1.58

62. The yield point in static loading is _____ as compared to fatigue loading.
   a) **Higher**
   b) Lower
   c) Same
   d) None of these

63. The value of stress concentration factor depends upon
   a) material of the part
   b) geometry of the part
   c) **material & geometry of part**
   d) none of these

64. The endurance limit for a mirror polished material will be _____ as compared to unpolished material.
   a) same
   b) less
   c) **more**
   d) Equal

65. The elasticity is the property of a material which enables it to
   a) **regain its original shape after deformation when the external forces are removed**
   b) draw into wires by the application of a tensile force
   c) resist fracture due to high impact loads
   d) retain deformation produced under load permanently

66. Ergonomics principle suggests that
   a) monitoring displays should be placed outside peripheral limitations
   b) glow-in-the-dark dials made of reflective substances are good for viewing in the nights
   c) **visual systems should be preferred over auditory systems in noisy locations**
   d) all of the above

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2. Design of Joints, Levers & Offset Links

Position in Question   **Total Marks-12**

   Q.1. c) 2-Marks.
   Q.2. b) 4-Marks.
   Q.4. b) 6-Marks.

Descriptive Question

1. What is a cotter joint? State any four applications of a cotter joint.

2. Design a knuckle joint to transmit 150 KN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression.

3. Design a foot brake lever from the following data:

   Length of lever from C.G. of the spindle to the point of application of the load = 1 meter.

   Max. load on the foot plate = 800 N Overhang from the nearest bearing = 100 mm Permissible tensile and shear stress = 70 MPa.

4. Differentiate key and cotter. Also explain why taper is provided on cotter. Give recommended value of taper.

5. The pull in the tie rod of an iron roof truss is 50kN. Design a suitable turn buckle (adjustable screwed joint). The permissible stresses are 75MPa in tension, 37.5MPa in shear and 90MPa in crushing. (Use the following data for ISO screw threads for screws, bolts and nut for course series).

Designation	Pitch (mm)	Major or nominal diameter Nut & Bolt $d = D$ (mm)	Effective or pitch diameter Nut & Bolt (dp) mm	Minor or core diameter (dc) mm Bolt	Nut	Depth of thread (bolt) mm	Stress area (mm^2)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Course Series							
M36	4	36.000	33. 402	31.093	31.670	2.454	817
M39	4	39.000	36.402	34.093	34.670	2.454	976
M42	4.5	42.000	39.077	36.416	37.129	2.760	1104

6. Write the design procedure for socket and spigot cotter joint with strength equation (any 4) with neat sketches.

7. The spindle of a drilling machine is subjected to a maximum load of 10kN. Determine

the diameter of solid C.I. column of the machine, if tensile stress is limited to 40N/mm². The distance between axis of spindle and axis of column is 330 mm; also find the direct stress and stress due to bending in the column. (Ref. Fig.)

10 kN
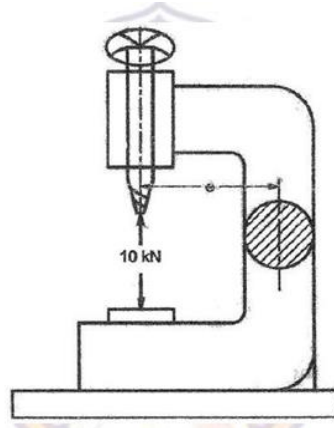
8. Write the general design procedure of bell crank lever.

9. List the applications of Turn Buckle

10. Differentiate between Knuckle joint and Cotter joint. (any four points of difference)

11. Name different Types of Lever

12. State the purpose of Cotter in Cotter Joint

13. Design single cotter joint to transmit 200 kN. Allowable stresses for the material are 75 MPa in tension and 50 MPa in shear

14. List four applications of knuckle joint.

15. Explain failure of cotter in bending with suitable sketch and strength equation.

16. Write general design procedure of the bell crank lever. (any four steps)

17. The pull in the tie rod of a roof truss is 44 kN. Design a suitable adjustable screw joint. The permissible tensile and shear stresses are 75 MPa and 37.5 MPa respectively.

MCQ Question

(Total number of Question=Marks*3=12*3=36)

Note: Correct answer is marked with **bold**

1. The length of cotter, in a sleeve and cotter joint, is taken as _____
   (where d is diameter of shaft/Rod)
   a) 1.5 d   c) 3 d
   b) 2.5 d   **d) 4 d**

2. In designing a sleeve and cotter joint, the outside diameter of the sleeve is taken as____ (where d is diameter of shaft/Rod)
   a) 1.5 d
   c) 3 d
   b) 2.5 d
   d) 4 d

3. A cotter joint is used to transmit _____
   a) Axial tensile load only
   b) axial compressive load only
   c) Combined axial and twisting loads
   d) axial tensile or compressive loads

4. In a turn buckle, if one of the rods has left hand threads, then the other rod will have_____
   a) right hand threads
   c) pointed threads
   b) left hand threads
   d) multiple threads

5. In levers, the leverage is the ratio of _____
   a) load lifted to the effort applied
   b) mechanical advantage to the velocity ratio
   c) load arm to the effort arm
   d) effort arm to the load arm

6. The bell crank levers used in railway signaling arrangement are of _____
   a) first type of levers
   c) third type of levers
   b) second type of levers
   d) None of Above

7. The cross-section of the arm of a bell crank lever is _____
   a) Rectangular
   c) I-section type
   b) Elliptical
   d) Any of above

8. In the levers of first type, the mechanical advantage is_____
   a) less than 1
   c) greater than 1
   b) equal to 1
   d) can't say

9. The distance between fulcrum and dead weights is 100mm. Dead weights are of 2945.2N. An effort of 294.52N acts on the other hand. Find the distance between the fulcrum and other end of the lever.
   a) 1000mm
   c) 10mm
   b) 100mm
   d) 10000mm

10. If joint is to fail by crushing of socket collar then estimate the diameter of socket collar. Given Permissible compressive stress= 126.67 N/mm².; Spigot dia=65mm; thickness of collar=15mm

a) **131mm**   c) 141mm

b) 139mm   d) 149mm

11. Determine the width of the cotter used in cotter joint connecting two rods subjected to axial load of 50kN and permissible shear stress in cotter is 50 N / (mm²). Given thickness of cotter=10mm

a) **50mm**   c) 25mm

b) 100mm   d) 150mm

12. Knuckle Joint can't be used to connect two intersecting rods.

a) Yes

b) **No, it can't be used**

c) It can be used with some modifications

d) It is expensive and hence isn't used

13. _____ of the following are important parts of knuckle joint.

a) Eye   c) Fork

b) Pin   d) **Each of the mentioned**

14. Find dia. of knuckle pin for knuckle joint transmitting power 60kN. The permissible stresses in tension, shear and compression are 70MPa, 55 MPa and 130 MPa respectively.

a) 26 mm   c) 30 mm

b) **28 mm**   d) 32 mm

15. Calculate the diameter of pin from shear consideration with maximum shear stress allowed is 40NN/mm² and an axial tensile force of 50kN is acting on the rod.

a) **39mm**   c) 49mm

b) 44mm   d) 52mm

16. In the links of suspension chains_____

a) a cotter joint is used   c) both are used

b) **a knuckle joint is used**   d) None is used

17. The loose knuckle pin in the fork will be subjected to _____

a) shearing   c) crushing

b) **bending**   d) tearing

18. The maximum effort applied by hand is _____

a) 200 N ~ 300 N   c) 400 N ~ 500 N

b) **300 N ~ 400 N**   d) All Above

19. Find dia. of tie rod of turn buckle subjected to pull of 5 kN. The rod and nut are made of Fe E 380and factor of safety is 5.

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a) 10 mm   **c) 14 mm**

b) 12 mm   d) 16 mm

20. A right-angled bell-crank is designed to raise a load of 5kN at short arm whose length is 100mm. Longer arm is of length 500mm. Calculate the reaction or force acting on the fulcrum.

  a) 5.1   c) 6.1

  b) 5.8   d) 6.8

21. In a steam engine, the valve rod is connected to an eccentric rod by means of

  a) Cotter joint   c) Universal joint

  b) Knuckle joint   d) Flange coupling

22. The rocker arms in internal combustion engines are of_____.

  a) **First type levers**   c) Third type levers

  b) Second type levers   d) None of these

23. A cotter joint is used to connect two _____ rods.

  a) **Co-axial**   c) Parallel

  b) Perpendicular   d) None of these

24. Stress induced on contact area between cotter and socket collar is _____

  a) Tensile stress   c) **Crushing stress**

  b) Direct shear stress   d) None of the above

25. A right angled bell-crank is designed to raise a load of 5kN at short arm whose length is 100mm. Also longer arm is of length 500mm. If permissible bearing pressure on pin is 10N/mm² and diameter of the 20mm, find the length of the pin.

  a) 35.5mm   c) 20mm

  b) 25.5mm   d) 30mm

26. A right angled bell-crank is designed to raise a load of 5kN at short arm whose length is 100mm. Also longer arm is of length 500mm. If permissible bearing pressure on pin is 10N/mm² and diameter of the 20mm, find the shear stress in the pin.

  a) 8.12   c) 9.12

  b) 8.51   d) 9.51

27. Which distance is more important from the fulcrum for a lever

  a) Distance of load to be lifted

  b) Distance of the force applied

  c) Distances of both load as well as of effort

  d) None

28. Mechanical advantage is

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a) **Distance object moved / Distance effort applied**

b) Distance effort applied / Distance object moved

c) Distance effort applied x Distance object moved

d) None

29. Another way of defining Mechanical advantage is

a) Input force/ Output force

c) Output force x Input force

b) Output force/ Input force

d) None

30. The diameter of knuckle pin in a knuckle joint is usually taken as (where d = Diameter of the rod)

a) 0.5 d

c) d

b) 0.8 d

d) 1.2 d

31. The taper on cotter varies from…….

a) 1 in 24 to 1 in 20

c) 1 in 32 to 1 in 24

b) 1 in 15 to 1 in 10

d) 1 in 48 to 1 in 24

32. Find dia. of rod for knuckle joint transmitting power 60kN. The permissible stresses in tension, shear and compression are 70MPa, 55 MPa and 130 MPa respectively.

a) 30 mm

c) 34 mm

b) 36 mm

d) 32 mm

33. Find dia. of rod for foot lever of 1m long and load of 800 N. The permissible stresses in tension and shear are 73MPa and 70 MPa respectively.

a) 38 mm

c) 36 mm

b) 42 mm

d) 40 mm

34. The draw of cotter should not be more than

a) 3 mm

c) 8 mm

b) 6 mm

d) 12 mm

35. When the fulcrum is in between the load and effort, the lever is said to be of

a) **First type**

c) Second type

b) Third type

d) Any one of these

36. Which among the following is a knuckle joint?

a) **Tension link in bridge structure**

c) Foundation bolt

b) Both a. and b.

d) None of the above

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3. Design of Shafts, Keys and Couplings

Position in Question Paper   **Total Marks-24**

  Q.1. d) 2-Marks.
  Q.2. c) 4-Marks.
  Q.4. c) 6-Marks.
  Q.5. a) 6-Marks.
  Q.6. c) 6-Marks.

Descriptive Question

1. A hollow shaft for a rotary compressor is to be designed to transmit maximum torque of 4750 N-m. The shear stress in the shaft is limited to 50 MPa. Determine the inside outside diameter of the shaft if the ratio of inside to outside diameter of the shaft is 0.4.

2. Design a bushed pin type flexible coupling for connecting a motor shaft to a pump shaft for the following service conditions.

   Power to be transmitted = 40 KW.
   Speed of the motor shaft = 1000
   RPM. Diameter of the motor shaft = 50 mm
   Diameter of the pump shaft = 25 mm
   The bearing pressure in the rubber bush and allowable stress in the pins are to be limited to 0.45 N/mm2 and 25 MPa respectively.

3. Draw neat sketch of a protected type flanged coupling showing all details.

4. Explain the following types of stresses
   a) Transverse shear stress
   b) Compressive stress
   c) Torsional shear stress

5. What are the considerations in design of dimensions of formed and parallel key having rectangular cross section?

6. A shaft 30 mm. diameter is transmitting power at a maximum shear stress of 80MPa. If a pulley is connected to the shaft by means of a key, find the dimension of the key so that stress in the key is not to exceed 50MPa and length of the key is 4 times the width.

7. Explain effect of keyways on strength of shaft. Name one type of key which does

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not affect strength of shaft.

8. A hollow shaft is to be designed to transmit 600 kW at 110 rpm. The maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MPa and angle of twist in a length of 3 mts not to exceed 1.4 degree. Find external diameter of the shaft if the internal diameter to external diameter is 3/8. Take modulus of rigidity 84 GPa.

9. Prove that for a square key the permissible crushing stress is twise the permissible shear stress.

10. Write the general design procedure of a flange coupling (unprotected type).

11. Draw a neat labelled sketch of protective type flange coupling.

12. Determine the diameter of hollow shaft having inside diameter 0.6 times outside diameter. The shaft is driven by 900 mm diameter overhung pulley placed vertically. The weight of pulley is 600 N. The overhung is 250 mm, the tension in the tight and slack side are 2900 N and 1000 N respectively. Assume Fs = 85 N/mm2.

13. Compare the weight and strength of hollow shaft of same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have same material and length.

14. What are the advantages and disadvantages of muff coupling (02 each)?

15. A 45 mm diameter shaft is made of steel with yield strength of 400 N/mm2. A key of size 14 mm wide and 9 mm thick made of steel with yield strength of 340 N/mm2 is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety as 2.

16. Classify 'Key'

17. List the requirements of good Coupling

18. List different Shaft Materials

19. Hollow shaft is required to transmit 50 kW power at 600 rpm. Calculate its inside and outside diameters if its ratio is 0.8. Consider yield strength of material as 380N/mm^2 and factor of safety as 4.

20. Name four types of keys.

21. A lathe receives power from an overhung shaft situated exactly above the lathe pulley by meance of the belt drive. A pulley weighing 400 N and of diameter 270 mm is fixed on the shaft at a distance of 300 mm to the right of the left-hand bearing. The centre to centre distance between the two shaft supporting bearing is

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900 mm. The maximum power required by machine is 5 kW at 200 rpm. The belt tension ratio is 2.5. Determine the diameter of shaft. Allowable shear stress for shaft material is 40 N/mm2.

22. A flanged protective type coupling is required to transmit 7.5 KW at 720 r.p.m. Assume the following stresses for the coupling components. Permissible shear stress for shaft, bolt and key material = 33 N/mm2 Permissible crushing stress for bolt and key material = 60 N/mm2 Find: (i) Diameter of shaft (ii) Dimensions of key (iii) Diameter of bolt

23. A hollow transmission shaft having inside diameter 0.6 times the outside diameter, is made of plain carbon steel 40C8 and having permissible shear stress equal to 65 MPa. A belt pulley, 1000 mm in diameter is mounted on the shaft, which overhangs the left hand bearing by 250 mm. The belts are vertical transmit power to the machine shaft below the pulley. The tension on tight and slack side of the belt are 3 kN and 1 kN respectively, while the weight of the pulley is 500 N. The angle of wrap of the belt on pulley is 180°. Calculate outside and inside diameter of the shaft.

MCQ Question

(Total number of Question=Marks*3=12*3=36)

Note: Correct answer is marked with **bold**

1. A sunk key fits in the keyway of the _____ only.
   a) **Hub**
   b) Sleeve
   c) Both hub and sleeve
   d) Neither hub nor sleeve

2. A shaft is designed on the basis of _____
   a) rigidity
   b) stiffness
   c) **Both a, b**
   d) None

3. The standard length of the shaft is_____
   a) 5 m
   b) 6 m
   c) 7 m
   d) **All of these**

4. In power transmission equation, $P = \dfrac{2\pi NT}{60 x 1000}$
   a) P is in kw and T is the maximum torque
   b) P is in NM/sec and T is the maximum torque
   c) P is in NM/sec and T is mean torque

d) P is in kw and T is mean torque

5. When a shaft is subjected to combined twisting moment (T) and bending moment (M), then the equivalent twisting moment is equal to____

a) $\frac{1}{2}\sqrt{(M^2+T^2)}$

b) $\sqrt{(M^2+T^2)}$

c) $\frac{1}{2}\sqrt{M+(M^2+T^2)}$

d) $\sqrt{M+(M^2+T^2)}$

6. A key way lowers _____
   a) the strength of the shaft
   b) the rigidity of the shaft
   c) **both the strength and rigidity of the shaft**
   d) the ductility of the shaft

7. A key made from a cylindrical disc having segmental cross-section is known as___
   a) feather key
   b) gib head key
   c) woodruff key
   d) **flat saddle key**

8. The type of stresses developed in the key is/are_____
   a) shear stress alone
   b) bearing stress alone
   c) **both shear and bearing stresses**
   d) shearing, bearing and bending stresses

9. A shaft coupling should _____
   a) Be easy to connect or disconnect
   b) Transmit full power of the shaft
   c) Hold the shafts in perfect alignment
   d) **All of these**

10. A universal coupling is used to connect two shafts_____
    a) Which are not in exact alignment
    b) Which are perfectly aligned
    c) **Whose axes intersect at a small angle**
    d) Have lateral misalignment

11. Oldham coupling is used to connect two shafts_____
    a) Which are not in exact alignment
    b) Which are perfectly aligned
    c) Whose axes intersect at a small angle
    d) **Have lateral misalignment**

12. A muff type coupling _____
    a) **Is a simple type rigid coupling**

b) Is a simple type of flexible coupling

c) Is used for coplanar shafts

d) Is used for non-coplanar shafts

13. A bushed pin flexible type coupling is used to join two shafts which_____

   a) Are not in exact alignment

   b) Are not coplanar

   c) Change position during operation

   d) Are inclined

14. In case of sunk key, the key way is cut in _____

   a) shaft only

   b) bub only

   c) both shaft and hub

   d) helical along the shaft

15. The sleeve or muff coupling is designed as a

   a) Dun cylinder

   b) Hollow shaft

   c) Solid shaft

   d) Thick cylinder

16. In a flange coupling, the flanges are coupled together by means of

   a) Bolts and nuts

   b) Studs

   c) Headless taper bolts

   d) None of these

17. The shaft is always stepped with _____ diameter at the middle portion and _____ diameter at the shaft ends.

   a) Minimum, maximum

   b) Maximum, minimum

   c) Minimum, minimum

   d) Zero, infinity

18. _____ is used for a shaft that supports rotating elements like wheels, drums or rope sleaves.

   a) Spindle

   b) Axle

   c) Shaf

   d) None of the listed

19. Is it necessary for an axle to be _____ with respect to rotating element?

   a) Stationary

   b) Moving

   c) Moving or stationary

   d) None of the listed

20. Which of the following act on shafts?

   a) Torsional moment

   b) Bending Moment

   c) Both torsional and bending

   d) None of the mentioned

21. When the shaft is subjected to pure bending moment, the bending stress is given by?

   a) None of the listed

   b) $32M/\pi d^3$

   c) $16M/\pi d^3$

   d) $8M/\pi d^3$

22. When the shaft is subjected to pure torsional moment, the torsional stress is given by?

   a) None of the listed

   b) $32M/\pi d^3$

    c) **16M/πd³**　　　　　　　　　　　　d) 8M/πd³

23. If allowable shear stress in the shaft is 70N/mm² and torsional and bending moments are M=1185000N-mm and m=330000N-mm, find the diameter of the shaft.

a) 36.8mm　　　　　　　　　　　c) **44.7mm**

b) 39.7mm　　　　　　　　　　　d) 40.3mm

24. Calculate the shaft diameter on rigidity basis if torsional moment is 196000N-mm, length of shaft is 1000mm. Permissible angle of twist per meter is 0.5' and take G=79300N/mm².

a) None of the listed　　　　　　　c) 35.8mm

b) 41.2mm　　　　　　　　　　　d) 38.8mm

25. The main advantage of sunk key is that it is a _____ drive.

a) Positive　　　　　　　　　　　c) Neutral

b) Negative　　　　　　　　　　　d) None of the listed

26. Woodruff key permits _____ movement b/w shaft and the hub.

a) Axial　　　　　　　　　　　　c) Eccentric

b) Radial　　　　　　　　　　　d) None of the listed

27. A muff coupling is connecting two shafts. The torque involved is 650N-m. The shaft diameter is 45mm with length and breadth of the key being 14mm and 80mm respectively. Find the shear stress induced in the key.

a) 30.2N/mm²　　　　　　　　　　c) 34.4N/mm²

b) 25.8N/mm²　　　　　　　　　　d) None of the listed

28. A muff coupling is connecting two shafts. The torque involved is 650N-m. The shaft diameter is 45mm with length and height of the key being 14mm and 80mm respectively. Find the compressive stress induced in the key.

a) 70.1 N/mm²　　　　　　　　　　c) 45.5N/mm²

b) 51.6N/mm²　　　　　　　　　　d) None of the listed

29. If shaft diameter is 40mm, calculate the diameter of sleeves in clamp coupling.

a) 100mm　　　　　　　　　　　c) 60mm

b) 80mm　　　　　　　　　　　　d) 40mm

30. If shaft diameter is 40mm, calculate the length of sleeves in clamp coupling.

a) 80mm　　　　　　　　　　　　c) 100mm

b) 140mm　　　　　　　　　　　d) 120mm

31. If 8 bolts are emplaced in a clamp coupling with shaft diameter 80mm d, calculate the tensile force on each bolt if coefficient of friction is 0.3 and torque transmitted is 4000N-m.

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a) 51234.4N   **c) 41666.7N**

b) 45968.3N   d) None of the listed

32. If 8 bolts are emplaced in a clamp coupling with shaft diameter 80mm d, calculate the diameter of each bolt if coefficient of friction is 0.3 and torque transmitted is 4000N-m. Permissible tensile stress is 80N/mm².

     a) 27mm   c) 23mm

     b) 25mm   d) 21mm

33. If shaft diameter is 60mm, how many bolts are recommended for rigid flange coupling?

     a) 2   **c) 4**

     b) 3   d) 5

34. Determine the diameter of the bolts used in rigid flange coupling if transmitted torque is 270N-m, pitch circle diameter=125mm and four bolts are emplace in the coupling. Permissible shear stress in the bolts is 70N/mm².

     a) 3.8mm   **c) 4.4mm**

     b) 3.6mm   d) 4mm

35. Find the shear stress in a flange at the junction of hub in rigid flanged coupling if torsional moment is 2980N-m and diameter of hub being 125mm. Also, the thickness of flange is 25mm.

     a) 6.77N/mm²   **c) 4.84N/mm²**

     b) 10.24N/mm²   d) 4.22N/mm²

36. Calculate the force acting on each pin in flexible coupling if torque transmitted is 397N-m and PCD=120mm with number of pins 6.

     a) 1400.3N   c) 1320.3N

     b) 1102.8N   d) None of the listed

37. Which of the following statement is wrong?

     a) A key is used as a temporary fastening

     b) A key is subjected to tensile stresses

     c) A key is always inserted parallel to the axis of the shaft

     d) A key prevents relative motion between the shaft and boss of the pulley

38. A saddle key _____ power through frictional resistance only.

     a) Transmits   c) Either A or B

     b) Does not transmit   d) None of these

39. A tapered key which fits in a key way in the hub and is flat on the shaft, is known as

     a) Feather key   b) Gib-head key

c) Wood ruff key **d) Flat saddle key**

40. Which one of the following loading is considered for the design of axles?
   a) Bending moment only
   b) Twisting moment only
   c) Combined bending moment and twisting moments
   d) Combined action of bending moment, twisting moment and axial thrust

41. In designing a sleeve coupling, outer diameter of the sleeve is taken as (where d = Diameter of the shaft)
   a) d + 17 mm   c) 2d + 20 mm
   b) 2d + 13 mm   d) 3.5d

42. When the material of key and shaft is same, and the width of key is one-fourth of the diameter of shaft (d), then length of key will be
   a) 0.8 d   **c) 1.57 d**
   b) 1.2 d   d) 1.8 d

43. The usual proportion for the width of key is (where d = Diameter of shaft or diameter of hole in the hub)
   a) d/8   **c) d/4**
   b) d/6   d) d/2

44. A hollow shaft will transmit a _____ torque than a solid shaft of the same mass and same material.
   a) Smaller   c) Medium
   b) Greater   d) None of these

45. A woodruff key is _____
   a) A tapered key with head at one end
   b) Fitted in pairs at right angles
   c) Capable of tilting in a recess milled out in the shaft
   d) All of the above

46. The taper on key is given on _____
   a) Bottom side only   c) On both sides
   b) Top side only   d) Any side

47. The angle of twist of shaft is _____
   a) Directly proportional to (shaft diameter)^2
   b) Inversely proportional to (shaft diameter)^2
   c) Directly proportional to (shaft diameter)^4
   d) Inversely proportional to (shaft diameter)^4

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48. In designing a key, it is assumed that the distribution of forces along the length of key
   a) Varies linearly
   b) Is uniform throughout
   c) Varies exponentially, being more at the torque-input end
   d) Varies exponentially, being less at the torque-input end

49. A circular shaft can transmit a torque of 5 kN-m. If the torque is reduced to 4 kN-m, then the maximum value of bending moment that can be applied to the shaft is
   a) 1 kN-m
   b) 2 kN-m
   c) 3 kN-m
   d) 4 kN-m

50. In a flange coupling, the bolts are subjected to
   a) Tensile stress
   b) Compressive stress
   c) Shear stress
   d) None of these

51. A shaft is subjected to fluctuating loads for which the normal torque (T) and bending moment (M) are 1000 N-m and 500 N-m respectively. If the combined shock and fatigue factor for bending is 1.5 and combined shock and fatigue factor for torsion is 2, then the equivalent twisting moment for the shaft is
   a) 2000 N-m
   b) 2050 N-m
   c) 2100 N-m
   d) 2136 N-m

52. A flange coupling is used to connect two shafts
   a) Which are perfectly aligned
   b) Which are not in exact alignment
   c) Have lateral misalignment
   d) Whose axes intersect at a small angle

53. A crankshaft is a _____ shaft.
   a) Transmission
   b) Machine
   c) Machine frame
   d) None of these

54. A coupling used to connect two perfectly aligned shafts, is
   a) Muff coupling
   b) Compression coupling
   c) Flange coupling
   d) All of these

55. If a shaft made from ductile material is subjected to combined bending and twisting moment, calculations based on which one of the following failure theories will give the most conservative value?
   a) Maximum principal stress theory
   b) Maximum shear stress theory
   c) Maximum strain energy theory

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d) Maximum distortion energy theory

56. The taper on a rectangular sunk key is

a) 1 in 16　　　　　　　　　　　c) 1 in 48

b) 1 in 32　　　　　　　　　　　**d) 1 in 100**

57. For a shaft diameter of 100 mm, the number of bolts in a flange coupling should be

a) 4　　　　　　　　　　　　c) 8

b) 6　　　　　　　　　　　　　d) 10

58. Two shafts A and B are made of the same material. The diameter of shaft A is twice as that of shaft B. The power transmitted by the shaft A will be _____ of shaft B.

a) Twice　　　　　　　　　　　**c) Eight times**

b) Four times　　　　　　　　　d) Sixteen times

59. A hollow saddle key is

a) A taper key which fits half in the key way of hub and half in the key way of shaft

b) A taper key which fits in a key way of the hub and is flat on the shaft

c) A taper key which fits in a key way of the hub and the bottom of the key is shaped to fit the curved surface of the shaft

d) Provided in pairs at right angles and each key is to withstand torsion in one direction only

60. A tapered key which fits in a key way in the hub and the bottom of which is shaped to fit the curved surface of the shaft, is known as,

a) Hollow saddle key　　　　　c) Soft key

b) Hollow key　　　　　　　　　d) None of these

61. The bending moment 'M' and a torque 'T' is applied on a solid circular shaft. If the maximum bending stress equals to maximum shear stress developed, then 'M' is equal to

a) T/2　　　　　　　　　　　c) 2 T

b) T　　　　　　　　　　　　　d) 4 T

62. The distribution of the forces along the length of key fitted in a shaft

a) Varies linearly

b) Is uniform throughout

c) Varies exponentially, being more near the torque-input end

d) Varies exponentially, being less near the torque-input end

63. In designing a flange coupling, the pitch circle diameter of bolts is taken as (where d = Diameter of the shaft)

a) 2 d   **c) 3 d**

b) 4 d   d) 5 d

64. The sleeve or muff coupling is designed as a _
   a) dun cylinder   c) solid shaft
   b) thick cylinder   **d) hollow shaft**

65. A transmission shaft includes
   a) counter shaft   c) over head shaft
   b) line shaft   **d) all of these**

66. Two shafts A and B under pure torsion are of identical length and identical weight and are made of the same material. The shaft A is solid and the shaft B is hollow. We can say that
   a) shaft B is better than shaft A   c) both the shafts are equally good
   b) shaft A is better than shaft B   d) None of above

67. A shaft is subjected to a maximum bending stress of 80 N/mm2 and maximum shearing stress equal to 30 N/mm2 at a particular section. If the yield point in tension of the material is 280 N/mm2 and the maximum shear stress theory of failure is used, then the factor of safety obtained will be
   a) 2.5   c) 3.0
   b) 2.8   d) 3.5

68. Which of the following statement is correct?
   a) A parallel sunk key is a taperless key
   b) A parallel sunk key may be rectangular or square in cross-section
   c) A flat saddle key is a taper key which fits in a key way of the hub and is flat on the shaft
   d) all of the above

69. Which material is used for bushes in the bushed pin type of flexible coupling?
   a) Gun metal   **c) Rubber**
   b) Plastic   d) Aluminium

70. Which property is not required for shaft materials?
   a) High shear and tensile strength   c) High fatigue strength
   b) Good machinability   **d) Good castability**

71. The product of the tangential force acting on the shaft and its distance from the axis of the shaft (i.e. the radius of the shaft) is known as
   a) bending moment   c) torsional rigidity
   b) twisting moment   d) flexural rigidity

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72. A shaft revolving at ω rad / s transmits torque (T) in N-m. The power developed is

a) $T * \omega$ **watts**

b) $\frac{2*\pi*T*\omega}{75}$ $watts$

c) $2 * \pi * T * \omega$ watts

d) $\frac{2*\pi*T*\omega}{4500}$ $watts$

Position in Question Paper   **Total Marks-26**

Q.1. e) 2-Marks.

Q.2. d) 4-Marks.

Q.3. b) 4-Marks.

Q.3. e) 4-Marks.

Q.5. b) 6-Marks.

Q.6. a) 6-Marks.

Descriptive Question

1. Compare welded joints with screwed joints. (Any six points) (4)
2. Define following terms w.r.t. bolts:
   a) Major diameter   c) Pitch
   b) Minor diameter   d) Lead (4)
3. a) Show that the efficiency of a self-locking screw is less than 50%.
   b) What is self-locking property of threads and where it is necessary? (8)
4. a) The extension springs are in considerably less use than compression springs. Why?
   b) Explain the terms self-locking and overhauling of screw. (8)
5. State the strength equation of double parallel fillet weld and single transverse fillet weld with neat sketches. (4)
6. Draw profiles to square and Acme threads with full details. Which one is stronger? (4)
7. A bracket as shown in Figure is fixed to a vertical steel column by means of five standard bolts. Determine:
   a) The diameter of the fixing bolts.
   b) The thickness of the arms of the bracket.

All dimensions in mm.
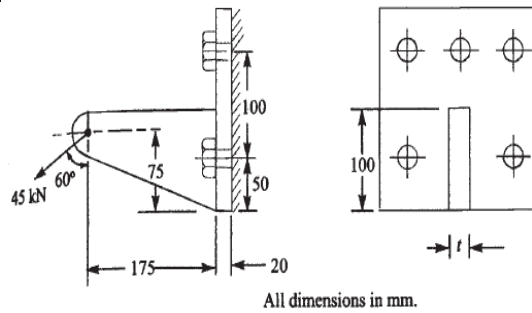
8. Assume safe working stress of 70 MPa in tension and 50 MPa in shear. (4)

9. Show that efficiency of square threaded power screw is never greater than 50%. (4)

10. Why square thread is preferred over 'v' thread for power transmission? (4)

11. Draw symbolic representation of following types of weld:
    a) Double V butt joint
    b) Double 'U' butt joint
    c) Single level butt
    d) Spot (4)

12. A plate 100 mm wide and 10 mm thick is to be welded by another weld by means of double parallel fillet welds. The plates are subjected to a static load of 80 kN. (Take permissible = 55 N/mm2). (4)

13. Give the design procedure of screw and nut of a screw jack. (8)

14. Explain:
    a) self-locking
    b) overhauling of a power screw. (4)

15. Explain with neat sketch, the bolt of uniform strength. (4)

16. State any four advantages and disadvantages of welded joints over screwed joint. (4)

17. A bracket as shown in fig no. 1 is fixed to the wall by means of four bolts.
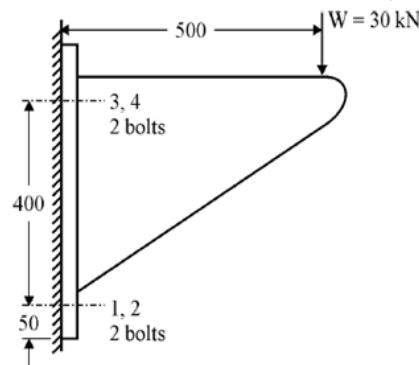
18. Find the size of the bolts if $\sigma t = 70N/mm2$ for bolt material. (8)

19. Two steel plates 120 mm wide and 12.5 mm thick are to be connected together by double transverse fillet weld. The maximum tensile stress for the plate and welding material is not to exceed 70 N/mm2. Find the length of weld required for maximum

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static loading. (4)

20. State the strength equations of double parallel fillet weld and double transverse fillet weld with neat sketches. (6)

21. Write strength equations for Design of Screw spindle of toggle Jack

22. A power screw on a machine has single start square thread with a non-rotating bronze nut. Axial force on the screw is 15 kN. Allowable stresses for screw material in compression and shear are 85 MPa and 37 MPa respectively. Allowable bearing pressure for the screw nut pair is 5 MPa. Find (i) Core diameter of screw (ii) Length of the nut (iii) Efficiency of power screw in coefficient of friction between screw and nut is 0.12.

23. Draw neat labelled sketches of Acme and square thread profile

24. List any four applications of power screw.

25. Draw freehand sketches of thread profiles (any four) with full details.

26. The lead screw of lathe has Acme thread of 60 mm outside diameter and 8 mm pitch. It supplies drive to a tool carriage which need an axial force of 2000 N. A collar bearing with inner and outer radius as 30 mm and 60 mm respectively is provided. The coefficient of friction for the screw thread is 0.12 and for collar it is 0.10. Find the torque required to drive the screw and the efficiency of the screw.

27. A plate 75 mm wide and 12.5 mm thick is to be joined with another plate by single transverse and parallel fillet weld, Maximum tensile and shear stresses are 70 N/mm2 and 56 N/mm2 respectively. Find the length of each parallel fillet weld if joint is subjected to 90 kN.

MCQ Question

(Total number of Question=Marks*3=26*3=78)

Note: Correct answer is marked with **bold**

1. Neither hub nor sleeve Depending upon the holding arrangement, power screws operate in how many different arrangements.
   a) **2**   c) 4
   b) 3   d) 5

2. V threads are highly recommended for fastening as well as power transmission purpose.
   a) Yes   **b) Never**

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c) In some cases   d) Can't be stated

3. Which of the following are true for buttress threads?

   a) Combination of square and trapezoidal threads

   b) Transmit motion in one direction only

   c) They are used in vices

   d) All of the mentioned

4. Tr 40 x 14(P 7), here 14 indicates

   a) Pitch   c) Diameter

   b) Lead   d) None of the mentioned

5. If nominal diameter of screw thread=50mm and pitch=10mm then the mean diameter of the screw thread will be?

   a) 40mm   c) 60mm

   b) 45mm   d) 55mm

6. If the load itself begin to the screw and descend down, unless a restraining torque is applied then the condition is termed as

   a) Halting   c) Front driving

   b) Overhaulting   d) None of the mentioned

7. Self-locking takes place when

   a) Coefficient of friction is equal to or greater than the tangent of the helix angle

   b) Coefficient of friction is lesser than or equal to the tangent of the helix angle

   c) Coefficient of friction is equal to or greater than the tangent of the helix angle

   d) None of the mentioned

8. Efficiency of the screw _____ with increase of coefficient of friction.

   a) decreases   c) has no effect

   b) increases   d) cannot be determined

9. If friction angle is 30' then the maximum efficiency of the screw is

   a) 33%   c) 50%

   b) 66%   d) Noe of the mentioned

10. Maximum possible efficiency of a self-locking screw is

    a) 50%   c) 66%

    b) 75%   d) 33%

11. In trapezoidal threads, f (coefficient of friction) can be taken as

    a) f sec θ   c) f sin θ

    b) f cos θ   d) f cosec θ

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12. Screws used for power transmission should have
   a) Very fine threads
   c) Low efficiency
   b) High efficiency
   d) Strong teeth

13. When screw threads are to be used in a situation where power is being transmitted in one direction only, then the screw threads suitable for this will be
   a) Knuckle threads
   c) Acme threads
   b) Square threads
   d) Buttress threads

14. The load cup of a screw jack is made separate from the head of the spindle to
   a) Prevent the rotation of load being lifted
   b) Enhance the load carrying capacity of the jack
   c) Reduce the effort needed for lifting the working load
   d) Reduce the value of frictional torque

15. A bolt _____
   a) Has a head on one end and a nut fitted to the other
   b) Has head at one end and other end fits into a tapped hole in the other part to be joined
   c) Has both the ends threaded
   d) Is provided with pointed threads

16. A stud _____
   a) Has a head on one end and a nut fitted to the other
   b) Has head at one end and other end fits into a tapped hole in the other part to be joined
   c) Has both the ends threaded
   d) Has pointed threads

17. A tap bolt _____
   a) Has a head on one end and a nut fitted to the other
   b) Has head at one end and other end fits into a tapped hole in the other part to be joined
   c) Has both the ends threaded
   d) Has pointed threads

18. Cap screws are _____
   a) Similar to small size tap bolts except that a greater variety of shapes of heads are available
   b) Slotted for a screw driver and generally used with a nut
   c) Used to prevent relative motion between parts

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d) Provided with detachable caps

19. An alien bolt is _____
    a) Self-locking bolt
    b) Same as stud
    c) Provided with hexagonal depression in head
    d) Used in high-speed components

20. Ball bearing type screws are found in following application
    a) Screw jack
    b) Aeroplane engines
    c) Crane
    d) Steering mechanism

21. Machine screws are _____
    a) Similar to small size tap bolts except that a greater variety of shapes of heads are available
    b) Slotted for a screw driver and generally used with a nut
    c) Used to prevent relative motion between two parts
    d) Similar to stud

22. Rivets are generally specified by _____
    a) Thickness of plates to be riveted
    b) Length of rivet
    c) Diameter of head
    d) Nominal diameter

23. Which of the following is a permanent fastening?
    a) Bolts
    b) Keys
    c) Cotters
    d) Rivets

24. Transverse fillet welded joints are designed for
    a) Tensile strength
    b) Compressive strength
    c) Shear strength
    d) Bending strength

25. Jam nut is a locking device in which
    a) One smaller nut is tightened over main nut and main nut tightened against smaller one by loosening, creating friction jamming
    b) A slot is cut partly in middle of nut and then slot reduced by tightening a screw
    c) A hard fibre or nylon cotter is recessed in the nut and becomes threaded as the nut is screwed on the bolt causing a tight grip
    d) Through slots are made at top and a cotter pin is passed through these and a hole in the bolt, and cotter spitted and bent in reverse direction at another end

26. The pitch of threads on a Jock nut in comparison to pitch of nut is
    a) Same
    b) Coarser
    c) Finer
    d) Very fine

27. Buttress threads are usually found on
   a) Screw cutting lathes
   b) Feed mechanisms
   c) Spindles of bench vices
   d) Railway carriage couplings

28. Eye bolts are used for
   a) Foundation purposes
   b) Absorbing shock and vibrations
   c) Transmission of power
   d) Lifting and transportation of machines and cubicles

29. If d is the normal diameter of a bolt in mm, then the initial tension in kg in a bolt used for making a fluid tight joint as for steam engine cover joint is calculated by the relation
   a) 124 d
   b) 138 d
   c) 151 d
   d) 168 d

30. If threads on a bolt are left hand, threads on nut will be
   a) Right hand with same pitch
   b) Left hand with same pitch
   c) Could be left or right hand
   d) Right hand with fine pitch

31. For tight leakage joints, following type of thread is best suited
   a) Metric
   b) Buttress
   c) Square
   d) NPT

32. A bolt of uniform strength can be developed by
   a) Keeping the core diameter of threads equal to the diameter of unthreaded portion of the bolt
   b) Keeping the core diameter smaller than the diameter of the unthreaded portion
   c) Keeping the nominal diameter of threads equal to the diameter of unthreaded portion of the bolt
   d) None of the above

33. A screw is said to be over hauling screw, if its efficiency is
   a) More than 50%
   b) Less than 50%
   c) Equal to 50%
   d) None of these

34. If shearing stress in nut is half the tensile stress in a bolt, then nut length should be equal to
   a) Diameter of bolt
   b) $0.75 \times$ diameter of bolt
   c) $1.25 \times$ diameter of bolt
   d) $1.5 \times$ diameter of bolt

35. The number of slots in a 25 mm castle nut is
   a) 8
   b) 4

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c) 2   **d) 6**

36. The crest diameter of a screw thread is same as

    a) Major diameter
    b) Minor diameter
    c) Pitch diameter
    d) Core diameter

37. The following type of nut is used with alien bolt

    a) Hexagonal nut
    b) Slotted nut
    c) Castle nut
    d) Any one of the above

38. Set screws are

    a) Similar to small size tap bolts except that a greater variety of shapes of heads are available
    b) Slotted for a screw driver and generally used with a nut
    c) Used to prevent relative motion between parts
    d) Similar to stud

39. A self-locking screw has

    a) Fine threads
    b) Course threads
    c) Coefficient of friction is greater than tangent of load angle
    d) Hole for inserting split pin

40. In order to obtain bolt of uniform strength

    a) Increase shank diameter
    b) Increase its length
    c) Drill an axial hole through head up to threaded portion so that shank area is equal to root area of thread
    d) Tighten die bolt properly

41. Split nut is a locking device in which

    a) One smaller nut is tightened over main nut and main nut tightened against smaller one by loosening, creating friction jamming
    b) A slot is cut partly in middle of nut and then slot reduced by tightening screw
    c) A hard fibre or nylon cotter is recessed in the nut and becomes threaded as the nut is screwed on the bolt causing a tight grip
    d) Through slots are made at top and a cotter pin is passed through these and a hole in the bolt, and cotter pin splitted and bent in reverse direction at the other end

42. When a nut is tightened by placing a washer below it, the bolt will be subjected to following type of loads

    a) Compression
    b) Tension

c) Shear   d) Combined loads

43. When the screw in a mechanical screw jack rotates, the load kept on the top of it moves
    a) Axially upwards
    b) Axially downwards
    c) Axially upwards or downwards
    d) None of these

44. A bolt of M 24 × 2 means that
    a) The pitch of the thread is 24 mm and depth is 2 mm
    b) Cross-sectional area of the threads is 24 mm²
    c) The nominal diameter of bolt is 24 mm and pitch is 2 mm
    d) The effective diameter of bolt is 24 mm and there are 2 threads per cm

45. The most important dimension in the design of a nut is
    a) Pitch diameter   c) Outside diameter
    b) Inside diameter   **d) Height**

46. The stress in the threaded part of the bolt will be _____ as compared to the shank.
    a) Same   c) Lower
    b) Higher   d) None of these

47. Which of the following statement is correct?
    a) The distance from a point on one thread to the corresponding point on the next thread is called pitch
    b) The distance which a screw thread advances axially in one rotation of the nut is called lead
    c) In single start threads, lead is equal to pitch
    d) All of the above

48. The pitch diameter is the _____ diameter of an external or internal screw thread.
    a) Effective   c) Largest
    b) Smallest   d) None of these

49. The efficiency of a square threaded screw is maximum if the helix angle is equal to (Where φ = Angle of friction)
    a) 90° - φ   **c) 45° - φ/2**
    b) 45° - φ   d) 45° + φ/2

50. The process extensively used for making bolts and nuts is

a) Hot piercing

b) Extrusion

c) Cold peening

d) Cold heading

51. A double strap butt joint (with equal straps) is

a) Always in single shear

b) Always in double shear

c) Either in single shear or double shear

d) Any one of these

52. Which of the following screw thread is adopted for power transmission in either direction?

a) Acme threads

b) Square threads

c) Buttress threads

d) Multiple threads

53. Depending upon the holding arrangement, power screws operate in how many different arrangements.

a) 2

b) 3

c) 4

d) 5

54. Which type of joints is better when the product is subjected to large vibrations: welded or threaded?

a) Welded

b) Threaded

c) Both have same results

d) Depends on the magnitude of the vibrational force

55. If a fastener is threaded into a tapped hole, then the fastener is likely to be called as

a) Screw

b) Bolt

c) Washer

d) Screw or bolt

56. Which of the following requires more space for the rotation of spanner?

a) Square Head

b) Hexagonal Head

c) Both require equal space of rotation

d) Cannot be stated

57. Find the torque required to raise the load of 15kN and mean diameter of triple threaded screw being 46mm. Also given pitch=8mm and coefficient of friction is 0.15.

a) 11831.06N-mm

b) 11813.06N-mm

c) 12811.06N-mm

d) None of the listed

58. For a double threaded screw, what will be the tangent of helix angle if nominal diameter and pitch are 100mm and 12mm respectively?

   a) 0.045   c) 0.094

   b) 0.081   d) 0.023

59. If for a trapezoidal thread, angle of thread is 15' then what will be the replacement of the coefficient of friction which is 0.15.

   a) 0.1553   c) 0.1667

   b) 0.1335   d) 0.1776

60. What will be efficiency of the screw in case of raising the load when coefficient of friction is 0.1553 and tangent of helix angle is 0.0813?

   a) 34%   c) 54%

   b) 45%   d) 43%

61. A machine vice whose length of the handle is 150mm and the coefficient of friction for thread and collar are 0.15 and 0.17 respectively has a force applied at handle of 125N. Also the outer and inner diameters of collar are 55mm and 45mm respectively. Find the screw torque in terms of clamping force W if nominal diameter=22mm and pitch=5mm.

   a) 3.567W N-mm   c) 3.564W N-mm

   b) 2.286W N-mm   d) None of the mentioned

62. How many types of jacks are there which can be used in a screw jack?

   a) 2   c) 4

   b) 3   d) 5

63. Which of the following does not form the important part of the screw jack?

   a) Frame   c) Cup

   b) Nut   **d) Coupling**

64. The transverse shear stress at the root of the threads in the nut can be given by? (symbols have their usual meaning, z=number of threads in nut)

   a) $4W/\pi dz^2$ c) $4W/\pi td^2$

   b) $W/\pi dtz$ d) None of the mentioned

65. What type of friction in cup design is recommended for the set screw?

   a) Sliding   c) Static

   b) Rolling   d) None of the mentioned

66. What is the output from differential screws when pitch of the two screws is 12mm and 8mm? Also the nut is rotated by applying a force of 120N at a radius of 300mm and the two screws remain stationary. The torque of raising and lowering for the two

screws is 5k N-mm and 2.5k N-mm where k is the effective axial weight on the screw.

a) 13200 N-mm
**c) 19200 N-mm**
b) 15200 N-mm
d) 17200 N-mm

67. What is the efficiency of differential screws when pitch of the two screws is 12mm and 8mm? The nut is rotated by applying a force of 120N at a radius of 300mm and the two screws remain stationary. The torque of raising and lowering for the two screws is 5k N-mm and 2.5k N-mm where k is the effective axial weight on the screw.

a) 6.48%
c) 23.1%
b) 8.48%
d) 42.8%

68. If core diameter of bolt is 13.8cm the it's nominal diameter is given by?

a) 17.27mm
c) 14.67mm
b) 15.34mm
d) 16.34mm

69. Refer to fig 1.Two plates are fastened by means of two bolts. The yield strength of bolt is 400N/mm² and factor of safety is 4. Determine the permissible shear stress in the bolts.
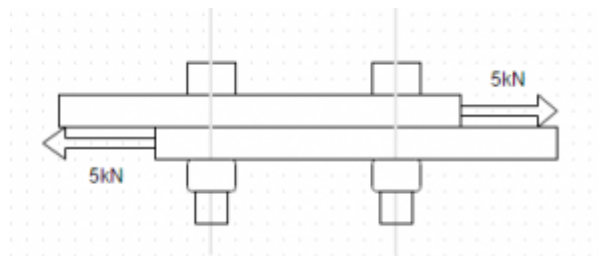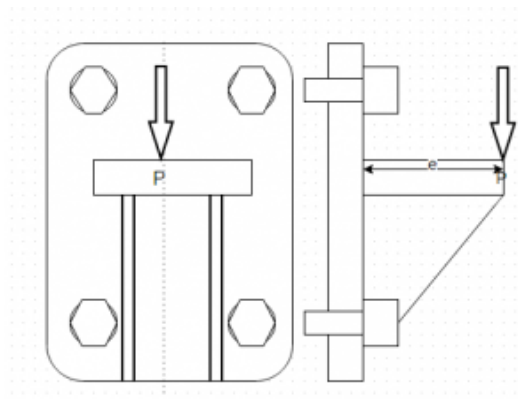

a) 100N/mm²
c) 25N/mm²
b) 50N/mm²
d) 75N/mm²

For questions 70-77.

The following data is given for bracket
P=20kN, e=100mm, S(yt)=400N/mm², FS=3

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70. Find the direct shear stress in bolts if diameter =18mm
    a) 16.9N/mm²
    c) 78.6 N/mm²
    b) 19.6 N/mm²
    d) 76.8 N/mm²

71. If distance between the bolts from the axis of tilting is 125mm and 25mm, then find the effective tensile force acting on the bolts lying at 125mm from tilting axis.
    a) 6765.2N
    c) 7692.3N
    b) 8798.2N
    d) 7962.11N

72. If distance between the bolts from the axis of tilting is 125mm and 25mm, then find the effective tensile force acting on the bolts lying at 25mm from tilting axis.
    a) None of the listed
    c) 2345.2N
    b) 7692.3N
    d) 1538.46N

73. Which bolt can be used as criteria for designing?
    a) Left top bolt
    c) Left bottom bolt
    b) Both top bolts
    d) Both bottom bolt

74. Find the principal shear stress in the top bolts in terms of area A?
    a) None of the listed
    c) 6308.2/A
    b) 5309.2/A
    d) 6980.4/A

75. Find the size of the bolt using maximum shear stress theory.
    a) 11mm
    c) 13mm
    b) 12mm
    d) 14mm

76. Find the size of the bolt using maximum principal stress theory.
    a) None of the listed
    c) 15.3mm
    b) 19.2mm
    d) 21.2mm

77. All welding processes require pressure along with heat.
    a) Yes
    c) Can't be stated
    b) No, fusion doesn't require
    d) None of the listed

78. If force act in a direction parallel to the direction of weld, then fillet weld is called as?
    a) Transverse
    c) Parallel
    b) Longitudinal
    d) Longitudinal or Parallel

79. Relation between throat and leg for a parallel fillet weld is
    a) t =h Cos (45')
    c) h= t
    b) h =t Cos (45')
    d) None of the listed

80. Referring to figure 1, determine the required length of the weld joining two steel plates which are 10mm wide and 10mm thick. The permissible shear stress in the weld is 80N/mm²

a) **18mm**   c) 16mm

b) 15mm   d) 14mm

81. Find the total length of weld required to with stand the load of 100kN. Permissible shear stress in weld is 70kN/mm².

a) None of the listed   **c) 202.06mm**

b) 101.03mm   d) 30309mm

82. If a circular shaft is welded to the plate by means of circumferential fillet, then the shaft is subjected to torsional moment M. If throat of weld is t, then torsional shear stress is given by

a) **M/2πtr²**   c) M/4πtr²

b) M/πtr²   d) None of the listed

83. A rivet is specified as a 20mm rivet. What does it mean?

a) None of the mentioned   c) Head dia 20mm

b) Shank dia 20mm   d) Both head and shank dia 20mm

84. Calculate the diameter of the rivets by shear considerations if permissible shear stress in rivets is 60N/mm² and P=15kN.

a) 6mm   **c) 9mm**

b) 7mm   d) 8mm

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5. Design of Spring

Position in Question Paper   **Total Marks-12**

Q.1. f) 2-Marks.
Q.3. c) 4-Marks.
Q.6. b) 6-Marks.

Descriptive Question

1. Define following terms with respect to springs:
   a) Free length   c) Spring rate
   b) Solid height   d) Spring index

2. A helical valve spring is to be designed for an operating load range of approximately 135 N. The deflection of the spring for the load range is 7.5 mm. Assume spring index of 10. Permissible shear stress for the material of the spring = 480 MPa and its modulus of rigidity = 80 KN/mm2.Design the spring.

3. Take Wahle's factor = (4C-1/4C-4)+(0.615/C) 'C' being the spring index. (4)

4. A helical spring is made from a wire of 8 mm diameter and has outside diameter 90 mm; if the permissible shear stress is 350 N/mm2 and modulus of rigidity 84 kN/mm2, find the axial load which the spring can carry and the deflection per active turn. i) Neglecting the effect of curvature. ii) Considering the effect of curvature.(8)

5. A closed coil helical spring is used for front suspension of an automobile. The spring has stiffness 90 N/mm with square and ground ends. The load on the spring causes a total deflection of 8.5 mm. By taking permissible shear stress of material as 450 MPa. Find : i) Spring wire diameter ii)Length of spring

6. Write the equation with Wahl's factor, used for design of helical coil spring. State the SI units of each term in the equation. (4)

7. A helical compression spring carries a load of 500 N with a deflection of 25 mm. The spring index may be taken as 8. Assume permissible shear stress = 350 MPa. Modulus of rigidity N = 84 kN/mm2, Wahl's factor as (4C-1/4C-4)+(0.615/C) where C is spring index. Find the no. of active turns of spring.

8. Design a close coiled helical compression spring for service load ranging from2250 N to 2750 N, the axial deflection of the spring of the load range is 6 mm. Assume

a spring index of 5. The permissible shear stress intensity is 420 N/mm2 and modulus of rigidity, G = 84 kN/mm2. Take design stress 25% of permissible stress for severe condition and intermittent operation. (8)

9. List the desirable properties of spring Material

10. A closed coil helical spring is used for front suspension of an automobile. The spring has stiffness 90 N/mm with square and ground ends. The load on the spring causes a total deflection of 8.5 mm. By taking permissible shear stress of material as 450 MPa. Find i) Spring wire diameter ii) Length of spring. Assume spring index = 6 and G = 80 × 103 N/mm2

11. Classify springs.

12. State any four applications of spring.

13. Design helical compression spring for - maximum load of 1000N for deflection of 25 mm using value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm²

Take Wahl's factor, $K = \frac{4c-1}{4c-4} + \frac{0.615}{c}$, Where c = spring index.

MCQ Question

(Total number of Question=Marks*3=12*3=36)

Note: Correct answer is marked with **bold**

1. Which of the following function can the spring perform?
   a) Store energy
   b) Absorb shock
   c) Measure force
   d) All of the mentioned

2. The helix angle is very small about 2º. The spring is open coiled spring.
   a) Yes
   b) It is closed coiled spring
   c) That small angle isn't possible
   d) None of the listed

3. The longest leaf in a leaf spring is called centre leaf.
   a) It is called middle leaf
   b) It is called master leaf
   c) Yes
   d) None of the listed

4. If spring index=2.5, what can be concluded about stresses in the wire?
   a) They are high
   b) They are negligible
   c) They are moderate
   d) Cannot be determined

5. If the spring is compressed completely and the adjacent coils touch each other, the length of spring is called as?
   a) Solid length
   b) Compressed length

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    c) Free length   d) None of the mentioned

6. If number of coils are 8 and wire diameter of spring 3mm, then solid length is given by?

    a) None of the listed   **c) 24mm**

    b) 27mm   d) 21mm

7. Pitch of coil is defined as axial distance in compressed state of the coil.

    a) Yes

    b) It is measured in uncompressed state

    c) It is same in uncompressed or compressed state

    d) None of the listed

8. If uncompressed length of spring is 40mm and number of coils 10mm, then pitch of coil is?

    a) 4   c) 40/11

    b) 40/9   d) None of the mentioned

9. Active and inactive, both types of coils support the load although both don't participate in spring action.

    a) Active coils don't support the load

    b) Inactive coils don't support the load

    c) Both active and inactive don't support the load

    d) Both active and inactive support the load

10. If a spring has plain ends then number of inactive coils is?

    a) 1   c) 3

    b) 2   **d) 0**

11. The angle of twist for the equivalent bar to a spring is given by? (Symbols have their usual meaning)

    a) $8PD^2N/Gd^4$ c) $16PDN/Gd^3$

    b) $16PD^2N/Gd^4$ d) $8PDN/Gd^3$

12. The axial deflection of spring for the small angle of θ is given by?

    a) $328PD^3N/Gd^4$ c) $16PD^3N/Gd^4$

    b) $8PD^3N/Gd^4$ d) $8PD^2N/Gd^3$

13. Find the Wahl's factor if spring index is 6.

    a) 1.2020   **c) 1.2525**

    b) 1.2424   d) 1.5252

14. Find the shear stress in the spring wire used to design a helical compression sprig if a load of 1200N is applied on the spring. Spring index is 6, and wire diameter 7mm.

a) 452.2N/mm²   c) 512.2N/mm²

b) 468.6N/mm²   d) None of the listed

15. Find the mean coil diameter of a helical compression sprig if a load of 1200N is applied on the spring. Spring index is 6, and wire diameter 7mm.

   a) 7/6mm   c) 1200×6/7 mm

   b) 42mm   d) None of the listed

16. Find total number coils in a spring having square and ground ends. Deflection in the spring is 6mm when load of 1100N is applied. Modulus of rigidity is 81370N/mm². Wire diameter and pitch circle diameter are 10mm and 50mm respectively.

   a) 7   c) 5

   b) 6   d) 4

17. Railway wagon moving with a speed of 1.5m/s is brought to rest by bumper consisting of two springs. Mass of wagon is 100kg. The springs are compressed by 125mm. Calculate the maximum force acting on each spring.

   a) 1200N   **c) 1800N**

   b) 1500N   d) 2000N

18. If the spring have same solid length and number of coils in the two springs are 8 and 10, then find the diameter of the spring with 8 coils. It is given diameter of spring with 10 coils is 12mm.

   a) 9.6mm   c) 12mm

   b) 9mm   d) 15mm

19. Two spring having stiffness constants of 22N/mm and 25N/mm are connected in parallel. They are to be replaced by a single spring to have same effect. The stiffness of that spring will be?

   a) None of the mentioned.   **c) 47N/mm**

   b) 3N/mm   d) 11.7N/mm

20. What will happen if stresses induced due to surge in the spring exceeds the endurance limit stress of the spring.

   a) Fatigue Failure   c) None of the listed

   b) Fracture   d) Nipping

21. For a helical torsion sprig, the stress concentration factor at inner fibre is? Give spring index=5.

   a) 1.005   c) 1.223

   b) 1.175   d) 1.545

22. For a helical torsion sprig, the stress concentration factor at outer fibre is? Give spring index=5.
   a. 0.78
   b) 0.87
   c) 1.87
   d) 0.69

23. Spiral spring is quite rigid.
   a) Yes
   b) No it is flexible
   c) It is of moderate rigidity
   d) Rigidity can't be determined

24. Calculate the bending stress induced in the strip of the helical spring. The spring is subjected to a moment of 1250N-mm with breadth and thickens of the strip being 11mm and 1.5mmm respectively.
   a) 508.8N/mm²
   b) 612.2N/mm²
   c) 606.1N/mm²
   d) 564.3N/mm²

25. A leaf spring consists of 3 extra full length leaves and 14 graduated length leaves. The maximum force that can act on the spring is 70kN and the distance between eyes of the spring is 1.2m. Width and thickness of the leaves are 100mm and 12mm respectively. If modulus of elasticity is 207000N/mm², calculate the initial nip.
   a) 26.8mm
   b) 24.9mm
   c) 22.5mm
   d) 23.1mm

26. A leaf spring consists of 3 extra full length leaves and 14 graduated length leaves. The maximum force that can act on the spring is 70kN and the distance between eyes of the spring is 1.2m. Width and thickness of the leaves are 100mm and 12mm respectively. Calculate the initial pre load required to close the nip.
   a) 4332.2N
   b) 4674.1N
   c) 4985.4N
   d) Can't be determined

27. Belleville spring can only produce linear load deflection characteristics.
   a) Only linear
   b) Linear as well as non linear
   c) Non-linear
   d) None of the mentioned

28. When two Belleville sprigs are arranged in series, half deflection is obtained for same force.
   a) One fourth deflection
   b) Double deflection
   c) Four time deflection
   d) None of the listed

29. When two Belleville springs are in parallel, half force is obtained for a given deflection.
   a) Half force
   b) Double force
   c) Same force
   d) Can't be determined

30. The strain energy stored in a spiral spring is given by?
   a) $12M^2L/Ebt^3$
   c) $8M^2L/Ebt^3$
   b) $6M^2L/Ebt^3$
   d) None of the listed

31. Free length for helical compression springs having square ends is given as _____.
   a) pn + 2d
   c) 2(p + d)
   b) pn + 3d
   d) pn + 4d

32. In which condition the axial distance between two adjacent coils is called as pitch?
   a) Compressed condition
   c) Both a. and b.
   b) Uncompressed condition
   d) None of the above

33. Solid length for helical compression springs having square and ground ends is given as _____.
   a) (n + 2)d
   c) (n + 1)d
   b) (n + 3)d
   d) None of the above

34. In spring balances, the spring is used
   a) To apply forces
   c) To store strain energy
   b) To absorb shocks
   d) To measure forces

35. The most important property for the spring material is
   a) High elastic limit
   c) Resistance to fatigue and shock
   b) High deflection value
   d) All of these

36. The springs in brakes and clutches are used
   a) To apply forces
   c) To absorb shocks
   b) To measure forces
   d) To absorb strain energy

37. In a watch, the spring is used to store energy. The energy is released
   a) To stop the watch
   c) To change the time
   b) To run the watch
   d) All of these

38. A spring used to absorb shocks and vibrations is
   a) Close-coil helical spring
   c) Spiral spring
   b) Open coiled helical spring
   d) Leaf spring

39. The spring used in mechanical toys is
   a) Leaf spring
   c) Helical spring
   b) Spiral spring
   d) All of these

40. The laminated springs are given initial curvature
   a) To have uniform strength
   b) To make it more economical

c) **So that plates may become flat, when subjected to design load**

d) None of these

41. When a close-coiled helical spring is subjected to an axial load, it is said to be under.

   a) Bending
   b) Shear
   c) **Torsion**
   d) Crushing

42. The close-coiled helical springs 'A' and 'B' are of same material, same coil dia., same wire diameter and subjected to same load. If thenumber of turns of spring 'A' is half that of spring 'B', the ratio of deflection of spring 'A' to spring 'B' is

   a) **1/2**
   b) 2
   c) 1
   d) 4

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6. Selection of Ant frictional bearing and gears

Position in Question Paper   **Total Marks-08**

Q.1. g) 2-Marks.
Q.5. c) 6-Marks.

Descriptive Question

1. What are rolling contact bearings? State their advantages over sliding contact bearings. (4)
2. i) Define following terms as applied to rolling contact bearings:
   a) Basic static load rating
   b) Basic dynamic load rating
   c) Limiting speed
   ii) List important physical characteristics of good bearing material. (8)
3. Differentiate between rolling contact and sliding contact bearing on the basis of:
   a) Size   c) Coefficient of friction
   b) Life   d) Resistance to shock (4)
4. Write Lewis equation for the strength of gear tooth. Give the meaning of each term. (4)
5. Explain the following modes of failure of gear tooth:
   a) Pitting   c) Abrasive wear (6)
   b) Scoring
6. Write down the procedure for selection of bearing from manufacturer's catalogue. (4)
7. Explain gear tooth failures (i) Scoring (ii) Pitting (4)
8. State any six design considerations while designing the spur gear. (4)
9. Explain the principle of working of hydrodynamic formal bearing with a neat sketch. (4)
10. Give classification of bearings. (4)
11. Write the design steps involved in selection of bearing from manufacturer's catalogue. (4)
12. Name any four manufacturers of Bearing
13. Write down the procedure for selection of bearing from manufacturer's catalogue with suitable example
14. Give four applications of gear drive

MCQ Question

(Total number of Question=Marks*3=08*3=24)

Note: Correct answer is marked with **bold**

1. Which of the following are functions of bearings?
   a) Ensure free rotation of shaft with minimum friction
   b) Holding shaft in a correct position
   c) Transmit the force of the shaft to the frame
   d) All of the listed

2. A_____ bearing supports the load acting along the axis of the shaft.
   a) Thrust   c) Longitudinal
   b) Radial   d) Transversal

3. In gear boxes and small size motors, rolling contact bearings are used.
   a) True   b) False

4. Deep groove ball bearings creates a lot of noise.
   a) Yes
   b) They create very less noise
   c) Depends on the application
   d) No reference frame for comparison is mentioned

5. There is problem of alignment in deep groove ball bearings.
   a) Yes
   b) No, it is self-aligning
   c) It aligns itself only in some particular cases
   d) Can't be determined

6. In angular contact bearings, ____ bearings are required to take thrust load in both directions.
   a) 1   **c) 2**
   b) 4   d) 3

7. The angular play bearing must be mounted without axial play.
   a) Yes   c) Little tolerance is necessary
   b) Little tolerance is adjusted   d) Can't be stated

8. Taper rolling supports
   a) Axial loads   b) Thrust loads

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    c) Both axial and thrust loads   d) None of the mentioned

9. Which of the following isn't the property of taper roller?
   a) High rigidity
   b) Easy dismantling
   c) Take low radial and heavy loads
   d) All are the properties of tapper roller

10. Which of the following cannot take radial load?
    a) Cylindrical Roller bearing   **c) Thrust ball bearing**
    b) Taper roller bearing   d) None of the listed

11. Which of the following cannot tolerate misalignment?
    a) Angular contact bearing   c) Thrust ball bearings
    b) Cylinder roller bearing   **d) All of the listed**

12. Deep groove ball bearing has immense rigidity.
    a) True
    b) No it has point contact and hence low rigidity
    c) It has surface contact
    d) It has line contact

13. When the bearing is subjected to large fluctuations of load and heavy impacts, the bearing characteristic number should be _____ the bearing modulus.
    a) 10 times   **c) 15 times**
    b) 5 times   d) 20 times

14. Which of the following can be used for power transmission in intersecting shafts.
    a) Spur Gear   **c) Bevel Gear**
    b) Helical Gear   d) None of the listed

15. Which of the following is not true about gears?
    a) Positive drive   c) Transmit large power
    b) Constant velocity ratio   **d) Bulky construction**

16. Bevel gears impose _____ loads on the shafts.
    a) Radial and thrust   c) Thrust
    b) Radial   d) Neither radial nor thrust

17. Spur gears used for machine tool gearboxes must have the contact ratio
    a) Equal to 1   **c) More than 1.4**
    b) Less than 1   d) Equal to 2

18. In case of spur gears, Lewis form factor depends upon
    a) Module   b) Number of teeth

c) Pressure angle   d) **Both (B) and (C)**

19. In Lewis equation, gear tooth is considered as

  a) Simply supported beam   c) Curved beam

  b) **Cantilever beam**   d) None of the above

20. Buckingham's equation of gear tooth is based on

  a) Maximum crushing stress in gear tooth

  b) Maximum bending stress in gear tooth

  c) Maximum shear stress in gear tooth

  d) **Maximum contact stress in gear tooth**

21. Maximum efficiency of a pair of spur gears is

  a) **99 %**   c) 50 %

  b) 80 %   d) 92 %

22. In case of spur gears, increasing pressure angle results in

  a) **Wider base & stronger teeth**   c) Bigger size of gear

  b) Weaker teeth   d) Higher pitch line velocity

23. If two springs are in parallel then their overall stiffness will be

  a) Half   c) **Double**

  b) Same   d) None of the above

24. Antifriction bearings are

  a) Sleeve bearings   c) Thin lubricated bearings

  b) Hydrodynamic bearings   d) **None of the above**

25. The rated life of a bearing varies

  a) Inversely as fourth power of load   c) Inversely as square of load

  b) **Inversely as cube of load**   d) Directly as load