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Subject Code

- Any -

Chapter Name

- Any -

Apply

Examination: 2017 SUMMER

Que.No	Marks	
Q 4a)(ii)	4	Question: **Define following terms with respect to springs : 1) Free length 2) Solid height 3) Spring rate 4) Spring index** Answer: Definition of 1) Free length-it is a length of spring in unloaded condition 2) Solid height-it is a length of spring in fully loaded condition 3) Spring rate-load per unit deflection 4) Spring index- ratio of mean diameter of coil to diameter of wire --
Q 5b)(i)	8	Question: **(i) The extension springs are in considerably less use than compression springs. Why?** Answer: (i) it is easier to overextend the extension spring. Compression springs will bottom out before the overextend. Also it seems like the tensile strength will be weaker at the attachment point for the extension spring, making it generally larger and more cumbersome to correct the deficiency --

Que.No	Marks	
Q 6 b)	4	Question: **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. Take Wahle's factor 4 4 4 1 . , C C C 0 615 = - - + 'C' being the spring index** Answer: given load W= 135N Deflection δ =7.5mm Spring index c=10 Permissible shear stress Ʈ=480 MPa Modulus of rigidity G =80 KN/mm2 Wahl's factor K =4C-1/4C-4 +0.615/C=4X10-1/4X10-4 +0.615/10=1.14 (1)Mean dia. Of the spring coil (1 mark) Maximum shear stress, Ʈ = Kx 8WC/π d 2 480 = 1.14x 8x135x10/3.142xd2 d = 2.857mm from table we shall take a standard wire of size SWG 3 having diameters (d) =2.946mm mean dia. Of the spring coil D= CXd =10x2.946=29.46 mm outer dia. Of the spring coil Do =D+d=29.46+2.946=32.406mm (2) number of turns of the spring coil (n) (1 mark) Deflection δ= 8WC3 n/Gd 7.5 =8x135X103x n/ 80000xd n =1.64 say 2 For square and ground end n' =n+2=2+2=4 (3) free length of spring (1 mark) =Lf =n'd+ δ + 0.15 x δ=4x2.496+7.5+0.15xx7.5=18.609mm (4) pitch of the coil (1 mark) p= free length/n'-1=18.609/4-1=6.203mm --

Examination: 2017 WINTER

Que.No	Marks	
Q 4 b)	8	Question: **A helical compeersion imperssion speraing** Answer: **Design of spring** Given Data:LOAD W= 500N , $\delta = 25\ mm$ C= 8 τ =350 MPa = 350 N/m G= 85 x 10^3 N/mm^2 $Kw = \frac{4C-1}{4C-4} + \frac{0.615}{C}$ $Kw = \frac{4x8-1}{4x\,8-4} + \frac{0.615}{8}$ = 1.184 $\tau = Kw\ \frac{8\ W\ C}{\pi\ d^2}$ $350 = 1.184\ \frac{8\ X500X8}{\pi\ d^2}$ $d\ = 5.87\ mm$ say 6 mm $\delta = \frac{8\ W\ C^3\ n}{G\ d}$ $25 = \frac{8\,x\,500\ 8^3\ n}{85\ X\ 10^3\ X6}$ n =6.15 say 7 $Number\ of\ active\ turns\ of\ spring = 7$ --

Que.No	Marks	
Q 6c)(i)	4	Question: **State any four area of Application of spring:** Answer: 1) To cushion, absorb or control energy to external load : Car springs, Railway buffers 2) To store Energy : Watches Toys 3) To Measure forces : Spring Balances, Gauges ,Engines 4) To provide clamping force in Jigs & fixtures. 5) To apply forces as in brakes, clutches & spring loaded valve. --

Examination: 2016 SUMMER

Que.No	Marks	
Q 4a)(iii)	4	Question: **State any four applications of spring.** Answer: 1) To cushion, absorb or control energy to external load : Car springs, Railway buffers 2) To store Energy : Watches Toys 3) To Measure forces : Spring Balances, Gauges ,Engines 4) To provide clamping force in Jigs & fixtures. 5) To apply forces as in brakes, clutches & spring loaded valve. --

<table>
<tr><th>Que.No</th><th>Marks</th><th></th></tr>
<tr><td>Q 5 b)</td><td>8</td><td>
Question:
A railway wagon having 1500 kg mass and moving at 1 m/s velocity dashes against a bumper consisting of two helical springs of spring index 6. The springs, which get compressed by 150 mm while resisting a dash made of spring steel having allowable shear stress of 360 N/mm2 and modulus of rigidity 8.4 104 N/mm2 . Design the helical coil spring with circular crosssection of spring wire.

Answer:
Given Data: m=1500 kg , V= 1 M/s , $\delta = 150\ mm$,
τ =360 N/m , G= 8.4 x 10^4 N/mm^2 , C= 6
K.E=$\frac{1}{2}\ M\ V^2$ = $\frac{1}{2}$ $1500x1^2$ =750 N.m = 750 x 10^3 N.mm
Energy stored in spring = $\frac{1}{2}\ W\ \ \delta\ \ X\ \ 2$ (2 Buffer spring)
750 x 10^3 = W x 150 , W= 5 X 10^3 N ....
Torque transmitted by spring
T=W X Dm/2 = 5 X 10^3 x (C x d)/2 = 5 X 10^3 x (6 x d)/2 =15x 10^3 d
T= π /16 x τ x d^3 =(16x15x10^3) / (π x 360)
d= 14.56 mm =15 mm ....
C= Dm/d = 6= Dm/15 , Dm = 90 mm
$\delta = \frac{8\ W\ \ D^3\ n}{G\ d^4}$,150 = $\frac{8\ X\ 5\ X\ \ 10^3\ \ x\ 90^3\ n}{8.4\ x\ 10^4 x\ 15^4}$ n= 21.87i.e 22 turns ....
Assuming squared & grounded ends ,total number of truns is given by
n' = n +2 = 22+2 =24
Solid Length = Ls= n' x d = 24 x 6 = 144 mm
Free Length = Fs = n' x d + $\delta max + 0.15\ \delta max$
Fs = 22 x 6 + 150 + 0.15 x 150 = 304.5 mm

Pitch of coil = P=$\frac{free\ length}{n'-1}$ = $\frac{304.5}{24-1}$ = 13.24 mm

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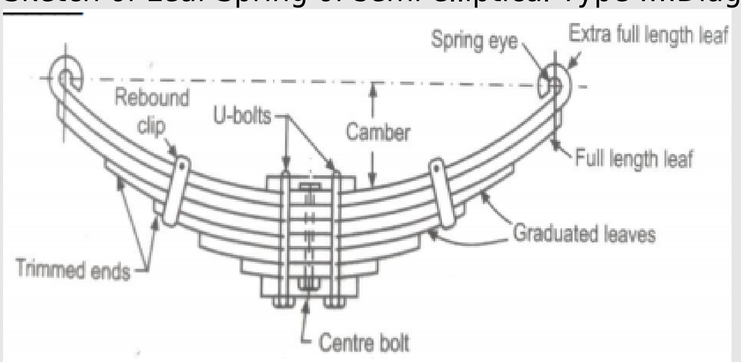
<tr><td>Q 6)</td><td>4</td><td>
Question:
Draw a neat sketch of leaf spring of semi-elliptical type and name its parts.

Answer:
Sketch of Leaf Spring of semi elliptical Type ....Diagram+ Names :


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Examination: 2016 WINTER

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<tr><td>Q 4a)(ii)</td><td>4</td><td>
Question:
Write the equation with Wahl's factor, used for design of helical coil spring. State the SI unit of each term in the equation

Answer:
Wahl's Factor Equation:
$K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$
S.I unit of Each Term:
C: Spring Index Unit: it is constant unit less term

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<tr><td>Q 5 b)</td><td>8</td><td>
Question:
Design a helical compression spring with ground ends. The spring index is 12. Maximum load on the spring is 100N and deflection under maximum load is 15 mm. Allowable shear stress of the material is 100 MPa and modulus of rigidity is 4 MPa. Find wire and spring diameters, number of coils and stiffness of spring.

Answer:
Design of Helical Compression Spring:
Given Data: W=100 N , $\delta = 15\ mm$,
τ =100 N/mm^2 , G= 84 x 10^3 N/mm^2
(actually in question paper G= 4MPa is given , but it is not a correct value it could be printing mistake)
C= 12
C= D_m/d =12,
Ks=1 + $\frac{1}{2C}$ = 1 + $\frac{1}{2\ X\ 12}$ = 1.04(Neglecting curvature effect)

$\tau = Ks \frac{8\ WC}{\pi d^2}$, 100 =1.04 x $\frac{8\ X\ 100\ X\ 12}{\pi X d^2}$ d=5.6 mm Say 6mm
ii. Spring diameter : D= CX d = 12 X 6 = 72
iii. No of turns:
$\delta = \frac{8\ WD^3 n}{Gd^4}$
$15 = \frac{8\ X 100\ X\ 72^3 n}{84\ x 10^3 x\ 6^4}$ n= 5.47 i.e 6 turns
Assuming squared & grounded ends ,total number of truns is given by
n' = n +2 = 6+2 =8
iv. Stiffness of spring K= W/δ = 100/ 15 = 6.66
(Note: spring is designed by considering G= 84 X10^3 N/mm^2 instead of 4 Mpa)

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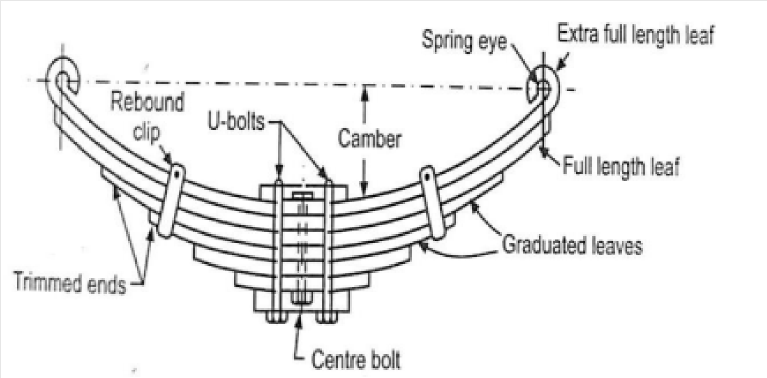
<tr><td>Q 6 b)</td><td>4</td><td>
Question:
State two applications of leaf spring. Draw neat sketch of leaf spring

Answer:
Application of Leaf spring Bus/truck/Car suspension springs, diving board, Sketch of Leaf Spring of semi elliptical Type


Given Data: D=250 mm , P=1.5 N/mm2 , n =12 Nos. ,σt = 30 Mpa

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Examination: 2015 WINTER

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<tr><td>Q 4a)(ii)</td><td>4</td><td>
Question:
: (1) Spring index (2) Spring stiffness (3) Free length of spring (4) Solid length of spring

Answer:
1) Spring Index:It is a ration of mean diameter of coil to the diameter of spring wire.
Mathematically $C = \frac{D}{d}$ ....
2) Spring stiffness: It is load required per unit deflection of the spring.
$spring\ Rate = \frac{W}{\delta}$.................
3) Free length of spring : Length of spring when spring is free or unloaded condition
Lf= n’ x d + δmax + 0.15 δmax...... ....
4) Solid Length of spring: it is the product of number of coils and diameter of wire
Or Length of spring when spring is fully loaded condition.
Ls= n’ x d ....

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Que.No	Marks	
Q 5 b)	8	Question: **A safety valve of 60 mm diameter is to blow off at a pressure of 1.2 N/mm2. It is held on its seat by a close coiled helical spring. The maximum lift of the valve is 10 mm. Design a suitable compression spring of spring index 5 with an initial compression of 35 mm. The shear stress for spring material is limited to 500 MPa. Take G = 80 kN/mm2.** Answer: (continued below)

Answer:

Given data, $D_v = 60mm$, $P = 1.2 N/mm^2$, $\tau = 500 N/mm^2$

$G = 80 \times 10^3 N/mm^2$, $C = 5$, Initial compression = 35 mm

maximum lift of valve = 10 mm.

→ Solution

① Diameter of spring wire (d)

• calculate load at which valve is blow off

$$W_1 = p \times \frac{\pi}{4} \times D_v^2 = 1.2 \times \frac{\pi}{4} \times (60)^2$$

$W_1 = 3392.92 N$

• maximum compression = Initial comp + Max. lift of valve

$$\delta_{max} = 35 + 10 = 45 mm$$

• at initial comp. of spring (35mm) ⟶ $W_1 = 3392.92 N$

Maximum comp. (45mm) ⟶ $W_2 = ?$

$$W_2 = \frac{3392.92 \times 45}{35} = 4362.32 N$$

• Wahl's stress concentration factor is,

$$K = \frac{4C-1}{4C-4} + \frac{0.615}{C} = \frac{(4\times5)-1}{(4\times5)-4} + \frac{0.615}{5} = 1.310$$

• The maximum shear stress is,

$$\tau = K \times \frac{8 W_2 C}{\pi d^2}, \quad d^2 = \frac{K \times 8 W_2 C}{\pi \tau}$$

$d = 12.06 mm$

• Then, mean diameter of spring wire = $D = C \times d$

$D = 5 \times 12.06 = 60.3 mm$

② Number of turns (n)

$$\delta_{max} = \frac{8 W_2 D^3 n}{G \times d^4} \quad \& \quad n = \frac{45 \times 80 \times 10^3 \times (12.06)^4}{8 \times 4362.32 \times (60.3)^3}$$

$n = 9.95 \simeq 10$ turns

Assuming square & grounded end, total no of turns

$n' = n + 2 = 10 + 2 = 12$ turns

③ Solid length (Ls)

$L_s = n' \times d = 12 \times 12.06 = 144.72 mm$

④ Free Length (Lf)

$$L_f = n' \times d + \delta_{max} + 0.15 \delta_{max}$$
$$= (12 \times 12.06) + 45 + (45 \times 0.15)$$

$L_f = 196.47 mm$

⑤ Pitch of coil (P)

$$P = \frac{\text{Free Length}}{n' - 1} = \frac{196.47}{12 - 1} = 17.86 mm$$

$P = 17.86 mm$

Que.No	Marks	
Q 6 b)	8	Question: **A semi-elliptical carriage spring of 1200 mm length withstands a load of 60 kN with maximum deflection of 90 mm. Assume breadth to thickness ratio as 8. Design the spring if bending stress of spring material is 540 MPa and E = 2 × 105 N/mm2.** Answer: **Given data:** Central load on each spring = 2W =60KN W= 30 KN =$30X10^3$ N, 2L= 1200, L= 600 mm, $\delta = 90\ mm$ σb =540Mpa, E= 2 x 10^5 N/mm^2 Here, b/t= 8 , thus b = 8t The stress in leaf spring is given by $\sigma b = \frac{6\ W\ L}{n\ b\ t^2}$ $n \times b \times t^2 = \frac{6\ W\ L}{\sigma b} = \frac{6\ X\ 30\ X\ 10^3\ X\ 600}{540} = 200\ X\ 10^3$……… I **…1 Marks** $\delta = \frac{6\ W\ L^3}{nE\ b\ t^3}$ $n \times b \times t^3 = \frac{(6\ W\ L^3)}{\delta\ X\ E}$ $n \times b \times t^3 = \frac{6\ X\ 30\ X\ 10^3\ X\ 600^3}{90\ X\ 2\ X\ 10^5} = 2.16\ X\ 10^3$…… Dividing equation II by equation I ,we get t= 10.8 mm b= 8t = 8 x 10.8 = 86.4 mm from equation I, $n \times b \times t^2 = 200\ X\ 10^3$ $n \times 86.4 \times 10.8^2 = 200\ X\ 10^3$ n = 19.84 ≅ 20 Total Number of leaves n= 20 Numbers --