

#### MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous) (ISO/IEC - 27001 - 2005 Certified)

### **SUMMER – 15 EXAMINATIONS**

Subject Code: 17311

Model Answer- Mechanics of Structure

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### Important Instruction to Examiners:-

- 1) The answers should be examined by key words & not as word to word as given in the model answers scheme.
- 2) The model answers & answers written by the candidate may vary but the examiner may try to access the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more importance.
- 4) While assessing figures, examiners, may give credit for principle components indicated in the figure.
- 5) The figures drawn by candidate & model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credit may be given step wise for numerical problems. In some cases, the assumed contact values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding.
- 7) For programming language papers, credit may be given to any other programme based on equivalent concept.

### Important notes to examiner

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**Model Answer** 

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| Q .NO       | SOLUTION                               | MARKS |
|-------------|--|-------|
| 1. A        |  |       |
| ه           | Persendicular Axis theorem             |       |
| 1           | Statement - i'f Ixx and Ivy are the    |       |
| -           | moment's of inertia of a Plane section |       |
|             | about the two mutually Perfendiwlers   |       |
|             | axes, meeting at 'o' then the moment   |       |
|             | of inextia, Izz about the third assis  |       |
|             | ZZ Les to Plane and Passing through    |       |
| 7           | the intersection of X-X con8 Y-Y is    |       |
| of Security | given by                               | OIM   |
|             | V IZZ = Ixx + Iyy                      |       |
|             |  |       |
| 1           |  |       |
|             | ( * X                                  |       |
|             | the third coxis ZZ is                  |       |
| 1           | Z & couled ces Polor Axis.             |       |
|             | i.e. Izz = Ip                          |       |
|             | Ip= Ixx + Iyy                          | olm   |
|             | where Ip = policer moment of Inertia   |       |
|             | Choic IP = folder, thorners of the the |       |
|             |  |       |
| Ы           | consider a triangular section ABC of   |       |
|             | base b & hightin' as shown in fig.     |       |
|             |  |       |

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| Q.NO   | SOLUTION   | MARKS |
|--------|--|-------|
| 9.1) A |  |       |
| 6      |  |       |
|        | ounti the centre of Gravity of triangle will be cet a distance of h/g from | 3     |
|        | the base AB.   |       |
|        | The base Ap  |       |
|        | P  |       |
|        | / \ h  |       |
|        | X X X  |       |
|        | h/3  |       |
| 5      | A B  |       |
| -      | K - P - N  |       |
|        | m. I. of, triumgle about the horizonal                                     |       |
|        | Axis PQ Passing through it's cafex 'c'                                     |       |
|        | is given by  |       |
|        | 3  |       |
|        | 7 = b.h  | M50   |
| 1      | 7  |       |
| - 1    |  |       |
| c)     | * Ductility: - it is the Property of                                       |       |
| /-     | material to undergo a considerable   |       |
|        | deformation under tension without  | OIM   |
|        | m 01-100 m   |       |
| ×      | it is the property of material due to which it can be drawn into           | D     |
|        | maileability: - it is the Property of a                                    |       |
| ×      | matereal by virtue of which it get's                                       | OIM   |
|        | Permanently deformed by compression.                                       |       |
|        | without roptose or   |       |
| I      | it is the property of a material due to which it can be drawn into         | )     |

\* it is the property of a material due to which it can be drawn into

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|--------------|---|---------------------------|-------|
| 0.1 A)       |   | a a                       |       |
| 9)           | nomina Breaking stre                    | SS Actual Breaking 5tress |       |
| •            | ) it is the ratio of Youd               | Dift is the ratio of      |       |
| 19           |   | local cet Breceking Pt.   | olM   |
|              | 11.10                                   | to the reduced            |       |
| 1 I E        | section, Area.                          | cross sectionce, area.    |       |
| 45           | 11 - 12 - 12 - 12 - 12 - 12 - 12 - 12 - | at forecture.             |       |
| Υ.           |   |                           |       |
|              | nominal breaking stress                 | @ Actual brocking         | ı     |
| 915          | is less than ultimate                   | stress is higher          | 01 M  |
| of beautiful | stress.                                 | theen ultimate. stress    | ۶.    |
|              |   |                           |       |
|              |   |                           |       |
| @            | end conditions of                       | column.                   |       |
|              |   | <u> </u>                  | 12M   |
|              | ) Both end hinged                       | 124                       | FOT   |
| 1            | 2) Both end fixed                       | $L=\frac{L}{2}$           | each  |
|              | 3> one end fixed                        | and other end hinged      | 1=/2  |
|              | 1) one end fixed o                      | and other end free        | 4=24  |
| 1.74.4       |   |                           |       |
|              |   |                           |       |
| f)           | (i) if 4=0, but 27 =1                   |                           |       |
|              | 1,156                                   |                           | (3)   |
|              | then column end,                        | s. himqee.                | OIM   |
| (            | i) if 4 = 0, 24 = 0                     | Et la mariation of a      |       |
|              | 0 ~                                     |                           |       |
|              | then column end                         | is free.                  | OIM   |

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| Q .NO      | SOLUTION   | MARKS |
|------------|--|-------|
| 91A)       |  |       |
| (9)        | Proof resilience. (U max)  |       |
|            |  |       |
|            | the maximom amount of strain   |       |
|            | energy which can be stored by a  |       |
|            | member or a body without exceeding   | OIM   |
|            | the elestic limit. is colled as. proof   | - 4   |
|            | resilience.  | A     |
|            | 2  | 4     |
| 1/1        | U max = 6 .V   | MIO   |
| of Persons | 2E   |       |
|            | where 6= stress. Produced cet  |       |
|            | elcestic limit   |       |
|            | E = modulus of elesticity  |       |
|            | V = Volume of body.  |       |
|            | in the state of th |       |
| (h)        | Graduel 1000 Sodden 1000   |       |
|            | 6 salve (out   |       |
| (1)        | Stress Boduced is Ostress Boduced is $6 = \frac{1}{A}$   | oim   |
|            | $6 = \frac{P}{A}$ $6 = \frac{2P}{A}$   |       |
| (2)        | Stress due to goodel @ stress due to sode  | ŋ     |
|            | load is lesser load is higher  | OIM   |
|            | then sudden load then the goodua   |       |
|            | . (000).   |       |
|            |  |       |

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SOLUTION MARKS O.NO a-1(B)a) Assumption in bending Theory is The elastic limit is not exceeded. ii) The beam intially shaight and unshressed. FOX iii) each longitudinal fiber is true to expand or contract MAN independently from every other layer. Four in The resultant force accoust transverse section of the beam is zero. The deformation of the section due to shear force is neglected. vi) the material of the beam is homogene -ous cond isotopic. vii) Toconsverse section of the beam which is plane before bending will remain's picene after the bending viii) the beam is stressed well up to Propostional limit such that, it must obeys. Hooke's law, ix) the value of young's modulus (E) is same in tension and in combression Bending egg M - 6b = E I Y R MIG where Pt = Bend. moment = Mr I = m. I. of sect about the N.A. Passing through the centroid of section. I = INA = IXX OIM 6b = Bending strest in layer ata. distiy' from N-A.

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| Q .NO     | count SOLUTION  | MARKS |
|-----------|---|-------|
| 1 (B) (ii | y= Distance of the layer from the N-A   | -     |
|           | of the beam cross-section   |       |
|           | E = modolus of, elesticity, of beam majorio   | al l  |
|           | R= Radius of, concertise of bent of   |       |
|           | bean,   |       |
|           | 9mox =1:59ev  |       |
| (b)       | h/2 gman  |       |
|           | Meubiel Axis.   | 02M   |
| -         | b + 1 1.33 9 ov   | }     |
|           |   |       |
| 1         | consider a triangular section of base   |       |
|           | board hight hos shown in fig the  |       |
| 94.001    | N.A. Posses. through the cembroid 6' act ce   |       |
| 7         | dist. h/3 from the bose,  |       |
|           | $\frac{Q_{\text{cov}} = S - S}{A + \frac{1}{2}bh}$  | hM    |
| Éliten    | 9NA = 4 900V  | 12M   |
|           | the max. shear stress. occur. cet ce distance   | 1     |
|           | h/2 from the boere.   |       |
|           | 9max = 1.59cov  | IM    |
|           |   |       |
|           |   |       |
|           | A CONTRACT OF THE STATE OF THE |       |

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| Q.NO  | SOLUTION  | MARKS |
|-------|---|-------|
| Q-1-B | is short column                                   |       |
| (cc)  | when the ratio of effective length to the least   | 02M   |
|       | latural dimensions of the column is less than 12, |       |
|       | then it is called a short. Column.                |       |
|       | C)  |       |
|       | when the ratio of effective length to the least   |       |
|       | radius of gyration is less than 45, then it is    |       |
|       | called short column.                              |       |
|       |   |       |
|       | ii> long column.                                  |       |
|       | when the ratio of effective length to the         | 02M   |
| 794   | least radius of gyration is greater than 45       |       |
|       | then it is called a long column                   |       |
|       |   |       |
| 1     |   |       |
|       |   |       |
|       |   |       |
| 1     |   |       |
|       |   |       |
|       |   |       |
| 123   |   |       |
|       |   |       |
|       |   |       |
|       | 1 3 16 19   |       |
|       |   |       |
|       |   |       |
| 2     |   |       |

Page No: 09/30 N Subject Code: Model Answer SOLUTION MARKS Q.NO Q-2(a) Somm 7 = 66.77 mm somm 25 BG 2 7=73-23 mm 70mm i) Area calculation A1 = 30x00 = 100000002 Az = 130x20 = 2600 mm2 Azz 70x30 = 2100 mm M ii) Distance of commis from the base AA 41= 70+20+50/2 = 115 mm 42 = 70+ 20/2 = 70+10=80mm 43 = 70/2 - 35 mm Y= 1500 × 115 + 2600 × 80 + 200 × 35 1500 + 2600 + 200 Y= 73.23mm 01.W KXI brit ot (iii IGI = 30×503 = 312.5 × 13 mm4 12M h1=66-79 = 41-77 h=41-77 mm 1/2M 1xx1= 161+ D1h1 = 3125 × 103 + 1500 × (41:99) 1xx1 = 2.929 × 106 mm

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| SOLUTION   | MARKS  |
|--|--|
| $I_{G2} = \frac{130 \times 20^3}{12} = 86.67 \times 10^3 \text{ mm}^4$ | 12M  |
| $h_2 = 66.77 - \left(50 + \frac{20}{2}\right)$                         |  |
| hz= 6.77 mm  | 1/2M   |
| = 86.67×103 + 2600× (6.73)   |  |
| 1xx2 = 205.84 x103 mm4   | 01M  |
| IG3 = 30×303 = 875.5×103 mm4   | 12m  |
| h3 = 73.23-30/ = 38.23 mm  | 1277   |
| Ixx3 = I6+A3h3= 875.3 x 103 + 400 x (38.28)                            |  |
| 1xx3 = 3.9447 x10 mm9  | 01 M   |
| Now<br>Ixx=Ixx,+Ixx2+Ixx3  |  |
| = 2.929×106+86.67×103+3-9447×106                                       | 1/M  |
|  | 12)  |
|  |  |
|  |  |
|  |  |
|  |  |
|  | $I_{G2} = 130 \times 10^{3} = 86.67 \times 10^{3} \text{ mm}^{4}$ $h_{1} = 66.37 - \left(50 + \frac{10}{2}\right)$ $h_{2} = 6.77 \text{ mm}$ $I_{2} = 16.77 \text{ mm}$ $I_{2} = 16.67 \times 10^{3} + 1600 \times (6.73)^{2}$ $I_{2} = 12 \times 10^{3} \times 10^{3} \times 10^{3} \times 10^{3} \times 10^{3} \times 10^{3}$ $I_{3} = 16 \times 10^{3} \times 10^{$ |

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| Q .NO  | SOLUTION   | MARKS |
|--------|--|-------|
| Q-2(b) | K GOOMM K  |       |
|        |  |       |
|        |  |       |
|        | 0 /  |       |
| e      | 600mm  |       |
|        |  |       |
|        |  |       |
|        | 1 600mm  |       |
|        |  |       |
|        | ·· i> Area calculation   |       |
|        | A1 = 600 × 600 = 18000 amm <sup>2</sup>  |       |
|        | 2  |       |
|        | Az= 180000 mm²   | 1/2M  |
|        | $n_1 = \frac{2}{3} \times 600 = 400 \text{ mm}$ $y = \frac{600}{3} = 200 \text{ mm}$ | 12M   |
| `      | N2 = 600+ 600 - 800mm 42 - 3 x600 = 400 mm   | 1/2 M |
|        | 7 - AM+ ALM2 - 180000 X 400 + 180000 X 800   | -y -  |
| )      | 7 - A1 M1+ A2M2 - 180000 X 400 + 180000 X 800  A1+A2 180000 + 180000                 | - T   |
|        | N= 600mm   | 1,m   |
|        | Y= AIYI+AZYL AI+AZ   | 12 M  |
|        | AI+AZ  | 12)   |
|        | 7 = 180000 × 200 + 180000 × 400  | 1     |
|        | 180000 + 180000  |       |
|        | 7 = 300 mm   | 12M   |
|        | iis MI @ x-x anis  |       |
|        | h_= 4-4, = 300 - 200 = 100mm   | 1, M  |
|        | hz= 42-4 = 400-300 = 100mm   | LM    |
|        |  | 12    |

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| Q .NO     | SOLUTION                                       | MARKS |
|-----------|--|-------|
| Q-2(b)    | Ixx=[161+A1hi]+[162+A2h2]                      |       |
| cont.     | 1XX= [261T HINIST LJG2T HZh2]                  |       |
|           | -[600×6003 + 180000 × 1002.]+                  | 01 M  |
| 9         | 600×6003<br>12 + 180000×100 <sup>2</sup> ]     |       |
|           | Ixx = 2.52 × 10 mm4                            | olm   |
|           | iii) M.I @ 4-4 - anis                          |       |
|           | Iyy = M.I of briangle (1) @ base +             |       |
|           | M.I of Triangle @ w base                       |       |
| of Second | $\frac{144 - \frac{6}{12} + \frac{6}{12}}{12}$ | 011   |
|           | $144 = \frac{600 \times 600^3}{6}$             |       |
| 1         | Luy = 600×6003                                 |       |
|           | 6  |       |
| )         | 144 = 216 × 10° mm <sup>7</sup>                | 0112  |
|           |  |       |
|           |  |       |
|           |  |       |
|           |  |       |
|           |  |       |
|           |  |       |
|           |  |       |
|           |  |       |

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| ON. Q      | SOLUTION   | MARKS     |
|------------|--|-----------|
| Q-2<br>Cc) | is y by y c  |           |
| (cc)       | Di T   |           |
|            | 0 0/2  |           |
|            | × ig × i,  |           |
|            | 1 10/2   |           |
|            | Base   |           |
|            | A 6/2 / 6/24   |           |
|            | 1 79 1   |           |
|            | late to the NO   |           |
|            |  |           |
| \$2\$A     | Az bxd   |           |
|            | $h = \frac{d}{2}$  | - 100     |
|            |  | 1,00      |
| -          | 1) let las= lose= lot Hn   | 20)       |
|            | i) let $LAB = LBase = LG + AB^2$ $= \frac{bd^3}{12} + bxdx(\frac{d}{2})^2$   | 1/21      |
|            | ·  |           |
| ,          | $= bd^3 + bdd^2$   |           |
|            |  |           |
|            | $= bd^{3} \times bd^{3}$   | -/-(-}-)- |
|            | 12 4   |           |
|            | $= bd^3, 3bd^3$  | 9.5       |
|            | 12 12  |           |
| 7-         | $= \frac{4 \text{ bd}3}{12}$   | 1         |
|            |  | - M       |
|            | Igase = bd3  | o I.M     |
| 2          |  |           |
|            | ii) Moment of inertia from side AB   | w         |
|            | let IAD= Tside= I&+ Ab   | 1/2 M     |
|            | let IAD = Tside = $\frac{16t \text{ Ab}^2}{12}$ $= \frac{db^3}{12} + b \times d \times \left(\frac{b}{2}\right)^2$ | 1/2 M     |
|            |  | 018       |
|            | $1AD = \frac{db^3}{3}$   | 012       |

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| Q<br>.NO      | SOLUTION  | MARK |
|---------------|---|------|
| Q-2-<br>c-ii) | Draw stress-strain curve for mild steel unoer tensile loading showing Important points on it.   | 04 M |
|               | Ultimate stress Yield stress  A D diagram or nominal stress-strain A D diagram or nominal stress-strain (it is the stress at failure)  Linear range | 04 M |
|               |   |      |
|               |   |      |

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| Q .NO   | SOLUTION  | MARKS |
|---------|---|-------|
| a-3(a)  | 48 48   |       |
|         | 20 20   |       |
|         |   |       |
|         | 1 m y 1.5 m y lm  |       |
|         | 2p Sted 2p 2p Sted 2p   |       |
|         | 4P-2P= Aluminium 4P-2P 2P 2P  | 0119  |
| 1       | 20 20   | -0111 |
| -       | givendata   |       |
| A 40000 | i> Asted = 75 mm <sup>2</sup> ii> AAI = 300mm <sup>2</sup>                    |       |
|         | SL= 2mm   |       |
|         | Sh = Sh, + Sh2 + Sh3  | 01 M  |
|         | SL= (P.L)<br>A·E) Still (P.L)<br>A·E) AI + (P.L)<br>A·E Still                 | OIM   |
|         | 2 2P X 1000 , 2P X 1500 _ 2P X 1000   | OIM   |
| )       | 75 X 20 X 104 300 X 7 X 104 75 X 20 X 104                                     |       |
|         | 2 2000P, 3000P 2000P  | OIM   |
| LIK T   | $2 = -1.3333 \times 10^{4} + 1.4286 \times 10^{4} - 1.3333 \times 10^{54}$    | 0110  |
|         | 2 = -1.238 × 104 P  |       |
|         | P 2   | OM    |
|         | 1.238 × 10-4  | 1,1,  |
| ±-      | P= -16.15 X103 N (-ve sign indicate P is<br>P= 16.15 KN compressive in nature | 01 M  |

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| Q .NO   | SOLUTION  | MARKS            |
|---------|---|------------------|
| Q-3 (b) | steu bar given                                    |                  |
| 20.00   | 20 mm d p=500 KM                                  |                  |
|         | 3 Es - 12:23                                      |                  |
|         | 400mm Es - 13.33                                  |                  |
|         | F ·   |                  |
| ANS     | i> Total area = 400×400 = 160000mm2               | 1 <sub>2</sub> M |
| 7       | ii) Area of stey = 4 x II x 202 = 1256.63 mm2     | 12 /2 M          |
|         | iii> Area of concrete = Total area - Area of sted |                  |
|         | = 160000 -1256.63                                 |                  |
|         | = 158.74 × 103 mm                                 | 次M               |
| p brand | iv) 6s - Es =m                                    |                  |
| 1       | 65 = 13.33 [65 = 13.33 6c]                        | ½M               |
|         | v) P= Ps+Pc                                       |                  |
|         | = 65 As + 60 Ac                                   | oIM              |
| /       | = 13.33 6 × 1256.63 + 6 × 158.74 × 103            | alm              |
|         | = 16.75087 × 103 6c + 158.74 × 103 6c             |                  |
|         | 500×103 = 175.49 ×103 6c                          | 010              |
|         | $6c = \frac{500 \times 10^3}{175.49 \times 10^3}$ | OIM              |
|         | 175.49 × 103                                      |                  |
|         | 6c = 2.849 N/mm <sup>2</sup>                      | 01 M             |
|         | 6s = 13.33 × 2.849                                |                  |
|         | 65 = 37.979 N/mm <sup>2</sup>                     | 011              |
|         |   |                  |

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| Q .NO   | + 64=20 HIMMOLUTION  | MARKS |
|---------|--|-------|
|         |  |       |
| 1-3 (c) |  |       |
|         | > so N/mm2   |       |
|         | 62=  |       |
|         | a = side of cube = 150 mm  |       |
|         | 62 6x = 6y = 6z = SON mm2  |       |
| -       | The state of the s |       |
|         | V= 150×150×150 = 3.375×10 mm3<br>E=2×105 N/mm2 & U=0.33  | 17    |
|         |  | olW   |
|         | SV - 6x+6y+62 (1-211)  | 0111  |
|         | 8V - SO+50+50 (1-3×0.33)   | OIM   |
|         | N = 2x102 (1-5x0.33)   |       |
| -       | δν - 150 x (0.34)  | OIM   |
|         | V 2x105  |       |
| -       | $\frac{\delta v}{v} = 2.55 \times 10^{-4}$   | OIM   |
|         | δν= (2.55×104) x (3.375 ×106)  |       |
| ž       | δν = 860.625 mm <sup>3</sup>   | 01 M  |
| 7       | $E = 3K(1 - 2\mu)$   | olm   |
|         | E = 3K(1 - 2L)<br>$2 \times 10^{5} = 3K(1 - 2 \times 0.33)$  | OIM   |
|         | K= 196.078 ×103 H/mm2  | 010   |
| 16      |  |       |
|         |  |       |
|         | $K = \frac{6}{8v} = \frac{50}{860.628}$  | ,     |
|         | $(100)^3$  |       |
|         | K= 196-078×103 N/mm2   |       |

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| Q .NO     | SOLUTION   | MARKS   |
|-----------|--|---------|
| 0-40      | e) given data  |         |
| ~ 10      | L=1m=1000 mm   |         |
|           | 78 100 Sept. 200 |         |
|           | P= 9 KN  |         |
|           | t= 20° c<br>d= 12mm E=200 KN/mm2 x= 16 x 106 1° c  |         |
|           | d= 12mm E=200 KN/mm = x=16 x 10 / C  |         |
|           | i> stress due to enturnal load (61)  |         |
| _         |  | 01M     |
|           | 6-P-9×103-79.579 N/mm2   | formula |
|           | $61 - P - 9 \times 10^{3} = 79.579 \text{ N/mm}^{2}$   | ol M)   |
|           |  | 01 M    |
| of Secure | ii) stress due to Temperature  | UN 2    |
|           |  |         |
|           | 62 = Ext   | OIM     |
|           | = 200×10 <sup>3</sup> × 16×10 <sup>6</sup> × 20  | 01M     |
|           | $= 64 \text{ N/mm}^2$  | oim     |
| 2         | iii) Total stressés (resultant stresses)   |         |
|           | residual stress = 79.579 + 64  |         |
|           | $6 = 143.579  \text{N/mm}^2$   | 02M)    |
| C Was all |  |         |
|           |  |         |
|           |  |         |
|           | 175.87   | >       |
|           |  |         |
|           |  |         |
|           |  |         |

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|--------|--|-------------|
| Q.NO   | SOLUTION   | MARKS       |
| Q-4(b) | a = cill of Cillo                                |             |
|        | To a = side of Cube - 200 mm                     |             |
|        | Sv = S200 mm <sup>3</sup>                        |             |
|        | 13 250 mm, U- 1- 0.25                            |             |
|        | 18)  |             |
|        | $6x - 6y - 6z - 3.8 \times 10^{6}$               | 2           |
|        | 6x=6y=6z-3.8×106 - 60.8 N/m                      | mtolm       |
|        | δv - 6x+6y+6z (1-2U)                             |             |
|        | V E  | OIM         |
|        | 67=64=62=6                                       |             |
|        | SV - 36 (1-24)                                   | - 1 00      |
|        | VEC  | OIM)        |
|        | 5200 - 3×60.8 (1-2×0.25)                         |             |
|        | $(250)^3$ E $(1-2\times0.25)$                    | 0/14/       |
|        | 3.320 × 1=4 = 182.4 ( -)                         |             |
|        | 3.328 x 104 - 182.4 x (0.5)                      |             |
|        | 3.378 ×104 - 91.2                                |             |
| 1      | E  |             |
|        | F- 91.2  |             |
| 1      | 3.328 × 10-4                                     | OJM         |
|        | F = 274,020 11/2002                              |             |
|        | $E = \frac{274.038 \text{ H/mm}^2}{\times 10^3}$ | OIM         |
|        |  |             |
|        | E= 3K (1-2L)                                     | OIM         |
|        | K= E = 274.038 × 103                             |             |
|        | 3(1-2U) 3(1-2×0·25)                              |             |
|        | K- 182.692 Nlmm2                                 | 3.1.54      |
|        | K= 182.692 N/mm2                                 | OIM         |
|        |  |             |
|        |  |             |

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**Model Answer** 

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| Q.NO | SOLUTION                    | MARKS |
|------|-----------------------------|-------|
|      | Step-III > B.M calculation. |       |
| W.   | i> Ma=0                     |       |
|      | ii) MB-0                    |       |
|      | 111) Mcz 62x2 - (20X1X /2)  |       |
|      | Mc= 114 KN/M                | alw   |
|      | iv) MO = 62XI = 62KN/M      |       |
|      | Step-IV) S.FD & B.M.D       |       |
|      | SO KN/W EOKN                |       |
| 7    | 20 KM 50 KM                 |       |
|      | A C D A B                   |       |
| -    | RA RB                       |       |
|      | 1 3m Im Im                  |       |
|      | 68KM                        |       |
| 2    |                             |       |
|      | +VC 8KM S.F.D               | 02M   |
|      | 42KM 62KM                   |       |
|      | 62KM                        | 4     |
|      | 1144/17                     |       |
|      | B.W.D                       |       |
|      | OKN/m +VC OKN/m             | 02 M  |
| 6    | B (Vi) 11)                  |       |

| Q.NO   | SOLUTION                                     | MARKS |
|--------|--|-------|
| 95a>   | 20KN   |       |
|        | Levim  |       |
|        | c Conn'')                                    |       |
|        | $A \leftarrow 3m \rightarrow 8$              |       |
|        | 3.6KH 3.6KH                                  |       |
|        |  |       |
|        |  |       |
|        |  | 2.M   |
| 1.11   | S.FD (KN·m) (-)                              |       |
|        | 10-4KN 10-4KH                                |       |
|        | 28-8 HN·M                                    |       |
|        | 20-8 KN-YO                                   | 7.    |
|        |  |       |
|        | ( <del>+</del> )                             |       |
| f=b    |  | 2m    |
|        | B.M.D (KH.M)                                 |       |
|        | > Support reulions                           |       |
| 7 :- 1 | > Support remisors  a> ZFy=0; RA+RB = 20 KN. |       |
|        | by ZM@A=0; (20x3)-8-RBX5=0                   |       |
|        | 52 = 5RB                                     |       |
| 75     | - RB = 10-4 KN                               | im    |
|        | : RA = 9.6 KN                                | :11   |
|        |  |       |
| 2      | 7 S.F. Calculation                           |       |
|        | 7.S.F. at just left of A = 0                 |       |
| 0      | TISE of West right of A = RA = 9.6 KM        |       |
| 95     | is Fat just left of G = 9.6 KN               |       |

| O Jeet C | ode: 17311 SUMMER - 15 EXAMINATION  Model Answer Page No: 2                    | 1/30  |
|----------|--|-------|
| ON. 9    | SOLUTION   | MARKS |
| ond,     | VSF at : 1st Sapt of a = 9.6-20 =-10.4 KN                                      |       |
| 14000    | VSF at just right of C = 9.6-20 =-10.4 KN<br>PS.F at just left of B = -10.4 KN | 2M    |
|          | is Feet just right of B = -10-4+RB = 0 KoV.                                    |       |
|          | 7 29 7 2   |       |
|          | 3> B.m. Calculation.   | -     |
|          | FIBMat A = B.mat B = 0 KN·m S.S. end   |       |
| j        | B. mat just left of C  | 1 3   |
|          | MC1 = RAX3 = 9.6X3 = 28.8 KN.M   | IM    |
|          | iii> B.mat just sight of C   |       |
|          | Mcg = RAX3-8 = 9.6X3-8 = 20.8 KN·M   |       |
|          |  |       |
| 356>     |  |       |
| 1911     | 20 KH/M  |       |
| 3.0      | A 4m D 4m B 2m2  |       |
| 1-1      |  |       |
|          | 17 Support sentions  |       |
|          | a) ZFy=0; RA+RB = 20×10 = 200KN.   |       |
|          | b) =m@A=0; (20x10x5)-8 RB=0  |       |
|          | :. RB = 125 KN.  | Im    |
| F.B.     | : RA = 75 HN   |       |
| 8        |  |       |
|          | 27 B.M. Calculation  | 1.7.  |
|          | MA = MC = 0  |       |
|          | mo = RAX4 - 20X4X2 = 75X4 - 20X4X2 = 140KN                                     | カゴア   |
|          | MB = RAX8- 20X8X4 = 75X8-20X8X4 = -40 KN·M                                     |       |
|          |  |       |
| 10       |  |       |

| Q.NO     | SOLUTION                                  |                |
|----------|---|----------------|
| 70017    |   |                |
|          | 140 KN-M)                                 |                |
| ontoo    |   | =              |
|          | E B.m.n                                   |                |
|          | B·m·D                                     |                |
|          | 40MN·M)                                   |                |
|          | 40N.17                                    |                |
|          | 3> To locate agent of Combrattering (E).  |                |
| TEX      | 3> To Locate point of Contraffexure (E).  | 9              |
|          | Let se be the distance of E from A.       | 1m             |
|          | EME-0                                     |                |
|          | : Mx = RA:x - 20xx.zc = 75xe-10x2         | <del> </del> - |
|          | Equating mx to the zero we have.          |                |
|          | 2 - 2                                     |                |
|          | $752e - 102c^2 = 0$                       |                |
|          | 75-1020 =0                                | 100            |
|          | ze = 7.5m. (0<2<8) point E                | IM             |
|          | lies between AdB.                         |                |
|          |   |                |
| 95bii    | leki)                                     |                |
| 80011    | <b>A</b>                                  |                |
| )        | A JOKN.M                                  |                |
|          | 2m.                                       |                |
|          |   |                |
|          | D   | 17             |
|          | 0   | IM             |
| 11 18s 1 | (-)                                       |                |
|          |   |                |
|          | 8·m·D(KH·m) SOKN·M                        | 1011           |
| · ·      |   |                |
|          | 10  |                |
|          | 17 Support rention<br>ZFy=0; RA+10=0      |                |
|          | ZFY=0; RA+10=0<br>RA=-10KN :: RA=10KN (*) | 1m             |

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|---------------------|---|-------|
| Q.NO                | SOLUTION  | MARKS |
|                     |   |       |
| gsbri) zmeA = c     |   |       |
| MA + 10X            | 2-20 =0   |       |
| MA = 0              |   | -     |
| 7.77                |   |       |
| 0>0 - 0             | 1 12-0  |       |
| 27 B.M. Car         |   |       |
|                     | A = MA = 0 KN·m.                                |       |
| ii> Bm at 1         | eft of B  | 2M    |
| MB1 =               | -MA*-RAX2 = -10x2 = -20 KN·m                    | 21    |
| 122 Om 1            | out to B.                                       |       |
| [11/ B:10) at 3     | eight of B.<br>-ma-RAX2+20 = 0 KN·m.            |       |
| INBR =              | = -MA-KHXZ+20 - C14-11                          |       |
|                     | 6bc   |       |
| 25c) K 1807         | $\eta \eta - \eta$                              |       |
| 2                   | 20mm  |       |
|                     | J= 48.64  |       |
| NA -                | I   |       |
|                     |   |       |
| 150mm               | dt 121.36/                                      |       |
| (I                  |   | -     |
|                     | 1/  |       |
| W.                  | on Obt  |       |
| Comes moddie        | on is mensioned about the type of begy          | 7     |
| 5,1100 1700101      | beam as simply supported beam.                  |       |
| Assume the          | BOKHIM (  |       |
| ~                   | mmmm  | -     |
|                     | 8m  |       |
| (Super              |   |       |
| 17 Maximum          | 0 8:00  |       |
|                     | 017 200 02 (10 Valve)                           | 2M    |
| 11/max              | = 1012 - 80x 82 - 640 KN·M                      | 1-11  |
|                     | No co   |       |

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|-------|---|---------|
| Q.NO  | SOLUTION  | MARKS   |
| 350>  | 2× m = 0 10   |         |
| ont   | 2> m. I. of section .   |         |
| - X   | i) Position of N.A.   | AW      |
|       | $\frac{y_{t} = 9N_{1} + 92N_{2} - (50\times20\times75) + (180\times20\times160)}{91 + 92} $ $(150\times20) + (180\times20)$ | +       |
|       |   | 1.      |
|       | $\underline{y_t} = 121.36  \text{mm}.$  | 1 m     |
|       | Te = 170-121.36 = 48.64 mm.   |         |
|       |   |         |
|       | $T_{xx} = \frac{20 \times 150^{3}}{12} + \frac{150 \times 20 (121.36 - 75)^{2}}{12} + \frac{1}{12}$                         | MF      |
|       |   |         |
| _     | 180×293+ 180×20(121·36-160)2  | ^       |
|       | 12  |         |
|       | Ixx = 12.07 x106 + 5.49 x106  |         |
|       | Ixx = 17.56 x106 mm4  | 1m      |
|       | IXX = 11.30 No 1  |         |
|       | 2> mail and long others   | 1       |
|       | 3> Maximum Benching stress  |         |
|       | Now using Bearling stress equation  | ٠,٠٠٠   |
| 1 0   | M - 64  | IM      |
|       |   |         |
|       | ·   |         |
|       | •   | 1 11 11 |
|       |   | 1       |
|       |   |         |
| The A | : 6bt = M. Xt   |         |
| 1     | I I I I I I I I I I I I I I I I I I I   |         |
| 11.11 | 68t. = 640×106 × 121.36 = 4423.14 H/mm  | mt = 50 |
|       | 17.56×106 × 121.36 = 4423.14 H/mm   |         |
| · 1   | 1 VIJSITE/  | HILL    |

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|----------|---|-------|
| Q.NO     | SOLUTION  | MARKS |
| 36a>     |   |       |
| <b>→</b> | Given, h = 230mm, S = 120KN, Tmay = 3-13 Nhmm                           |       |
|          | 1) Average shear stress (Tang)  |       |
|          | Tiener - S - 120×10 - 501.74  | 1m    |
|          | Teng = S - 120×103 = 521.74 9/s Area 230×d d                            |       |
|          | 27 For recturgular section,   |       |
|          | 27 For recturgular Section,  Tmax = 3 Ting                              | 1M    |
|          | 3.131 = 3 × 521.74  |       |
| 19       | i. d = 3 x 521.74 - 250.03 mm.  | 2 M   |
|          | 37 Minimum radius of gyration Thin                                      |       |
|          | Trip = Inin.  | 土M    |
|          | $I_{xx} = bd^3 - 230 \times 250.03^3 - 299.58 \times 10^6 \text{ pm}^4$ | IM    |
| e da la  | $I_{yy} - db^3 = 250.03 \times 230^3 = 253.50 \times 10^6 \text{ mm}^4$ | TM    |
|          | :. Imin = Igy = 253.50×106mm4   |       |
|          | : bmin = 252.50×106 - 66.395 mm.  | 1m    |

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|------------|---|----------|
| Q.NO       | SOLUTION  | MARKS    |
| 366>       |   |          |
| <b>→</b>   | Given, D = 200 mm, d = 150mm, L = 5m  |          |
|            | $f_c = 550 \text{ N/mm}^2$ , $a = (1/100)$ .                                  |          |
|            | TC = 550 NIMM, 4 (1800).  |          |
|            | i) Runkines crippling load  |          |
|            | Theresand Corpport  |          |
|            | PR = fc. Ac   | IM       |
|            | $P_{R} = \frac{f_{c} \cdot A_{c}}{1 + a \left(\frac{Le}{3min}\right)^{2}}$    |          |
|            |   |          |
| 9          | Area of column Ac = T (02-d2)   |          |
|            | - TI (2002-1502)  | T V      |
|            | Area of column $Ac = T (D^2 - d^2)$ $- T (200^2 - 150^2)$ $A - 13744.46 mm^2$ |          |
|            |   |          |
| 24000      | Minimum seclius of gyschion   |          |
|            | , , ,   |          |
|            | Vmin = Imin - (2004-1504) - 62.5mm  | IM       |
|            | VA / 13744-46   |          |
|            | o R   |          |
|            |   |          |
|            | 16 1 16   |          |
|            | case-I - Both ends are fixed.   | <u> </u> |
|            | Effective length Le = 1 - 5 = 2.5m.   | 麦M       |
|            | 22  |          |
|            | ·. PR = 550× 13744.46   |          |
|            | $1 + \frac{1}{1600} \left( \frac{2500}{62.5} \right)^2$                       |          |
|            | PR - 3779.72 KN.  | 上M       |
|            |   |          |

|         | ode: 17311 SUMMER - 15 EXAMINATION  Model Answer Page No: 29   |       |
|---------|--|-------|
| Q.NO    | SOLUTION   | MARKS |
| 3697    | 1 2 1 1 1 2 1 1 2 2  |       |
| iontion | Case-II one end is fixed dother free<br>Effective length Le = 2L = 2x5 = 10 m.   | 去M    |
|         | Effective length Le = 2L = 2x5 = 10m.  | 211   |
|         |  |       |
|         | : Po - CSDX 13744-46 - 7559.45XIO  |       |
| -       | $P_{R} = \frac{550 \times 13744 - 46}{1 + \frac{1}{1800} \left(\frac{10000}{62.5}\right)^{2}} = \frac{7559.45 \times 10^{3}}{17}$  |       |
|         | PR - 444.67 KN   | IM    |
|         | - 444.67 7174  | 100   |
|         | a - a li mond of otheric hingred   |       |
|         | Case-III- One and is fixed a cine of the   | 专M    |
|         | Case-III- One end is fixed of other is hinged Exfective length $Le = L = 5 = 3.535m$ .   | 2.1   |
|         |  |       |
|         | :. PR = 550×13744.46   |       |
|         | $PR = \frac{550 \times 13744.46}{1 + \frac{1}{1600} \left(\frac{3535}{62.5}\right)^2}$   |       |
|         |  |       |
|         | 02 - 2-22 00 VI  | IM    |
|         | PR = 2520.32 KN  | 1     |
|         | a T and and hinged   |       |
|         | Case - N - Book entre de la la   | 歩か    |
|         | Case - IV - Both ends are hinged<br>Effective length, Le - L = 5m.   | 1     |
|         |  |       |
|         | $PR = \frac{550 \times 13744.46}{1 + \frac{1}{1600} \left(\frac{5000}{62.5}\right)^2}$   |       |
|         | 1 + 1600 (62.5)  |       |
| -       |  |       |
|         | PR = 1511.89 KN  | IM    |
|         | TR - EU-S  | 1     |
|         | A Page of the control |       |
|         |  | 1 20  |
|         |  |       |
|         |  |       |

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|-----------------|---|-------------------|--|
| Q.NO            | SOLUTION  | MARKS             |  |
| 360>            | •   |                   |  |
| -> Gi           | ven, D= 25mm, L-1500mm, P= 30KN   |                   |  |
|                 | E = 2-1×105 N/mm2   |                   |  |
|                 |   |                   |  |
| 17              | Area of rod A = I 02 = II (25)2   |                   |  |
|                 | A = 490.87 mm <sup>2</sup>  | 专M                |  |
|                 |   |                   |  |
| 27              | Volume of sod V = AXL = 490.87X1500   | 麦m                |  |
|                 | $V = 736305 mm^3$<br>$V = .736.305 \times 10^{-6} m^3$                                | <u>y , r</u>      |  |
| 37              | street los sombers and red load   |                   |  |
|                 | Stress for Suddenly applied load.  6 = 2P - 2×30×10, = 122.23 N/mm²  A 490.87         | 1 m               |  |
|                 |   |                   |  |
| 47.             | Strain energy stored $U = 6^{2} / V - 122-23 \times 736305$ $2E 2x2-1x10^{5}$         | 1m                |  |
| 7               | $U = \frac{6200}{2E} - \frac{122-23}{2\times 2-1\times 10^5} \times \frac{736305}{2}$ |                   |  |
|                 | U= 26191.72 N.mm = 26.19 N.m or Jowle   | IM                |  |
| 57              | modulus of resilience - U - 26.19.  | 1m                |  |
|                 | , 00 0 - N 0  | λ                 |  |
|                 | = 35569.5 Joule/m3  | 1m                |  |
| 67              | change in Length (St)   |                   |  |
| - 7             | Change in Length (81)  81 = 61 = 122-23×1500  E 2.1×105                               | 1m                |  |
|                 | 8L = 0.873  mm  | 1m                |  |