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| **Scheme of Valuation/Answer Key**  (Scheme of evaluation (marks in brackets) and answers of problems/key) | | | | | |
| **APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY**  FOURTH SEMESTER B.TECH DEGREE EXAMINATION, APRIL 2019 | | | | | |
| **Course Code: ME202** | | | | | |
| **Course Name: ADVANCED MECHANICS OF SOLIDS (ME)** | | | | | |
| Max. Marks: 100 | | |  | Duration: 3 Hours | |
| **PART A** | | | | | |
|  |  | ***Answer any three full questions, each carries 10marks.*** | | | Marks |
| 1 | a) | Explanation-Totality of the stress it includes normal and shear stress at a point. Also mention the stress matrix.  Suppose students answer is state of stress at a point, consider it also to give the marks | | | (4) |
|  | b) | Cubical equation σ3-3σ2-20σ +43=0, I1=3, I2= - 20, I3= - 43(1 marks each). σ1=5.25 kPa, σ2= - 4.2 kPa, σ3= 1.95 kPa (1 mark each) | | | (6 ) |
| 2 | a) | Sketch the rectangular element and mark all stresses (4 marks)  Balance the forces in X direction and final result-(3 marks)  Balance the forces in Y direction and final result -(3 marks)  Suppose the derivation starts by taking the three dimensional element consider this to give marks. But in final answer they should reduce it to 2 Dimension | | | (10) |
| 3 | a) | By Airy stress function method bending stress and shear stress can be found out. It is given by σx= My/I.(2 marks) Where M –Moment,y –distance from neutral axis , M=100x4=400 kNm(1 mark).I-Moment of inertia ,I =2x153/12=562.5 cm4(1 mark).Maximum bending stress is obtained by putting y=7.5 cm, σx max=533.33 kN/cm2( 2 marks)  τxy= (P/2I)(h2-y2)-(2 marks).Where P=100 kN .In this put y=0 and h=7.5 cm we get  τxy max=5 kN/cm2(2 marks) | | | (10) |
| 4 | a) | Explanation with example (6 marks) | | | (6) |
|  | b) | Explanation (4 marks) | | | (4) |
| **PART B** | | | | | |
| ***Answer any three full questions, each carries 10marks.*** | | | | | |
| 5 | a) | Sketch-(2 marks), Marking stresses-(2 marks) | | | (4 ) |
|  | b) | Equilibrium equation in ‘r’ direction- 3maks  Equilibrium equation in ‘ϴ’ direction- 3 marks | | | (6 ) |
| 6 |  | Take the given load as say ‘F’.Then find the reactions at A and B ,RA=0.75F kN RB=0.25F kN (0.5 mark each),Finding forces in the members.FAB=0.433 F k N FBC= 0.5 F k N FAC= 0.866 F k N ( 0.5 mark each).Find strain energy in each member and add all these strain energy this will give Utotal=1/2AE[0.8662 F2x 2.5+0.52 F2 x4.33+0.4332 F2 x5](4 marks).Displacement ‘**𝛿’** obtained by differentiate above expression with respect ‘F’ OR by equating Utotal with F**𝛿/2**. Then get displacement=3.8947 F /AE-(2 marks).Put the values of F=1000x1000 N A=2x10 -4 m 2 and E=200 x 10 9 Pa. Displacement=0.097 m=9.7 cm -(1.5 marks).  The strain energy method is used here to find the displacement. If any other method is used to find the displacement it should be considered to give the marks | | | (10) |
| 7 |  | Airy stress function ϕ=A ln r+Br2 ln r+C r2 +D(2 marks)  σ r = 1/r(dϕ/dr)= A/r2 +B(1+2 ln r)+2C (1 mark)  σ ϴ =d2 ϕ/dr2= -A/r2 +B(3+2 ln r)+2C (1 mark)  But constant B=0 then  σ r= A/r2+2C (1 mark)  σ ϴ =-A/r2+2C(1 mark)  Apply the boundary condition and find the constants ‘A’  And ‘2C’ ie σ r= -pa at r=a and σ r =0 at r=b ( 1 mark)  σ r= pa a2/b2-a2 [1-b2/r2] (1.5 marks)  σ ϴ= pa a2/b2-a2 [1+b2/r2] (1.5 marks) | | | (10) |
| 8 |  | Expression for strain in terms of angle and radial distances (2 marks)  General stress equation by combining strain and ‘E’ (1mark)  Two Boundary conditions (2 marks)  Expression for neutral axis location ie say ‘R’( 2marks)  Final expression for bending stress (3 marks) | | | (10) |
| **PART C** | | | | | |
| ***Answer any four full questions, each carries 10marks.*** | | | | | |
| 9 |  | Statement –(2 marks) Proof (3 marks) for each theorem | | | (10) |
| 10 |  | Strain energy U= (1 mark) Where M=[Px+wx2/2] (2 mark)  Final expression of U –(5marks) ie U=1/2EI[(P2 L3 /3) +(w2 L5/20)+(P w L4/4)]  Displacement obtained by partial differentiation of ‘U’.Then displacement=1/EI[PL3/3+wL4/8] (2 marks) | | | (10) |
| 11 | a) | Shear flow q=τ x t=35x106x6x10 -3= 210000 N/m( 1 mark)  A=0.056 x 0.1 =5.6x 10 -3 m2(1 mark)  Torque ‘T’ =Twisting moment=2qA=2352 Nm( 2 mark)  Angle of twist=(T/4 A2 G) -(2 marks)  ds/t =(100+56+100+56)/6=52 (2 marks)  Angle of twist = 0.034 rad/ unit length ( 2 marks)  Note that -While consider the sides of the rectangular section thickness is negligible | | | (10) |
| 12 | a) | Statement –(2 marks) Explanation –(3 marks) | | | (5) |
|  | b) | The stresses induced in the shaft  are τzy=2Tx/π a3 b (1.5 marks)  τzx =2Ty/π a b3 (1.5 marks)  Among this **τzx** is maximum when putting y=b  τzx max =2T/ π a b2  (1mark)  τzx max =113.23 N/cm2  (1 mark) | | | (5) |
| 13 | a) | Statement -2 mark Explanation-3 marks | | | (5) |
|  | b) | Statement -2 mark Explanation-3 marks | | | (5) |
| 14 |  | Angle of twist per unit length - 5 marks  Torsional rigidity- 3 marks  Stresses - 2 marks | | | (10) |