國立中山大學101學年度碩士暨碩士專班招生考試試題

科目：材料力學【機電系碩士班乙組】

題號：4094

一、**選擇題**（單選題）（下列20題選擇題，每題2.5分，共計50分）

（請於答案紙上作答，僅在試題上作答部份將不與計分）

1. （　　）在平面應力(Plane Stress)假設下，若一機件上某點之應力值，已知為 $\sigma_{xx}=10$ MPa，$\sigma_{yy}=2$ MPa，且 $\tau_{xy}=4$ MPa，下列結果何者為誤？
   (A) 最大主應力值為 11.7 MPa　(B) 最小主應力值為零
   (C) 最大剪應力值為 4 MPa　(D) 最大主應力值一定在 XY 平面上
   (E) 以上皆非

2. （　　）下列那一個公式係用於計算兩接觸曲面間之表面接觸應力？
   (A) Hertz Equation　(B) Sodeberg's Equation
   (C) Modified Goodman's Equation　(D) Miner's Rule
   (E) 以上皆非

3. （　　）下列那一個公式係用於計算工件承受疲勞負載時之殘留壽命？
   (A) Hertz Equation　(B) Sodeberg's Equation
   (C) Modified Goodman's Equation　(D) Miner's Rule
   (E) 以上皆非

（I）Following strains are derived from three strain gages which are located on the free surface of a loaded body.

$$\varepsilon_{xx}=0.005;\ \varepsilon_{yy}=0.01 \text{ and } \gamma_{xy}=0$$

Consider the Young's modulus and the Poisson's ration of this body are $E=207\,GPa$ and $\nu=0.3$ respectively.

4. (　) The principal stress $\sigma_1,\sigma_2,\sigma_3$ at this measured point are
   (A) $\sigma_1=2.616;\ \sigma_2=1.820$ and $\sigma_3=0$ GPa
   (B) $\sigma_1=12.36;\ \sigma_2=0$ and $\sigma_3=-32.36$ GPa
   (C) $\sigma_1=2.616;\ \sigma_2=-2.30$ and $\sigma_3=-32.36$ GPa
   (D) $\sigma_1=32.36;\ \sigma_2=1.820$ and $\sigma_3=0$ GPa
   (E) None

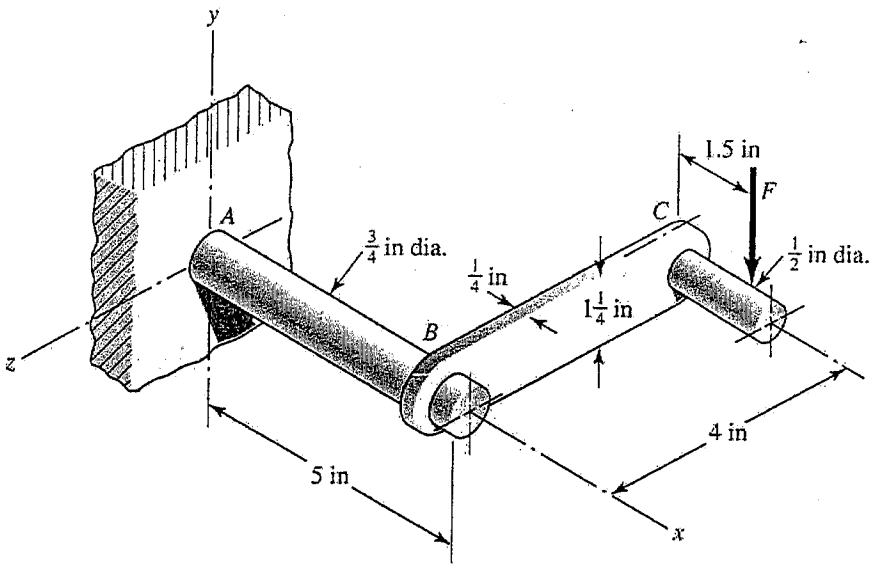
5. (　) The maximum shear stress τ_{max} at this point.
   (A) $\tau_{max}=1.308$ GPa　(B) $\tau_{max}=22.36$ GPa
   (C) $\tau_{max}=17.488$ GPa　(D) $\tau_{max}=0$ GPa
   (E) None

國立中山大學 101 學年度碩士暨碩士專班招生考試試題

科目：材料力學【機電系碩士班乙組】

題號：4094

（II）A crank is loaded by a force *F=300 lbf* that causes twisting and bending of a 3/4 inch diameter shaft fixed to a support at the origin of the reference system.



6. ( ) The bending stress at a stress element A is
   (A) $\sigma_x = 19400\ psi$ (B) $\sigma_x = 47100\ psi$
   (C) $\sigma_x = 68900\ psi$ (D) $\sigma_x = 94700\ psi$ (E) None

7. ( ) The torsional stress at a stress element A is
   (A) $\tau_{xz} = -14500\ psi$ (B) $\tau_{xz} = -44500\ psi$
   (C) $\tau_{xz} = 14500\ psi$ (D) $\tau_{xz} = 44500\ psi$ (E) None

8. ( ) Point A is in a state of
   (A) Plane strain state in the xz plane
   (B) Plane stress state in the xz plane
   (C) Plane strain state in the xy plane
   (D) Plane stress state in the xy plane (E) None

9. ( ) The maximum principal stress at the point A is
   (A) $\sigma_1 = 3.82\ kpsi$ (B) $\sigma_1 = 47.1\ kpsi$
   (C) $\sigma_1 = 51.2\ kpsi$ (D) $\sigma_1 = 93.87\ kpsi$ (E) None

10. ( ) The maximum shear stress at the point A is
   (A) $\tau_{max} = 2.56\ kpsi$ (B) $\tau_{max} = 4.76\ kpsi$
   (C) $\tau_{max} = 11.2\ kpsi$ (D) $\tau_{max} = 27.7\ kpsi$ (E) None

（III）A hot-rolled steel has a yield strength of $S_{yt} = S_{yc} = 400\ MPa$. Estimate the factor of safety for the principal stress states of $\sigma_1 = 100\ MPa$, $\sigma_2 = 0\ MPa$, and $\sigma_3 = -100\ MPa$.

11. ( ) The factor of safety based on the maximum shear stress theory is
(A) $SF = 4.0$ (B) $SF = 2.30$ (C) $SF = 2.0$
(D) $SF = \infty$ (E) None

12. ( ) The factor of safety based on the maximum distortion energy theory is
((A) $SF = 4.0$ (B) $SF = 2.30$ (C) $SF = 2.0$
(D) $SF = \infty$ (E) None

13. ( ) The factor of safety based on the maximum normal stress theory is
(A) $SF = 4.0$ (B) $SF = 2.30$ (C) $SF = 2.0$
(D) $SF = \infty$ (E) None

（III）Assume the stress tensor at a point is

$$\left[\sigma_{ij}\right] = \begin{bmatrix} -2 & 4 & 0 \\ 4 & -8 & 0 \\ 0 & 0 & 0 \end{bmatrix} \text{ (MPa)}$$

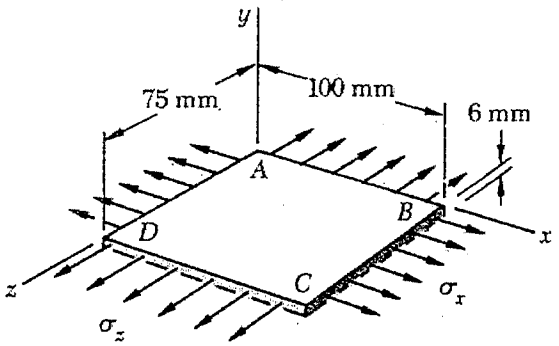
14. ( ) The principal stresses at this point is
(A) $\sigma_1 = 0; \sigma_2 = 0$ and $\sigma_3 = -10$ MPa
(B) $\sigma_1 = 12.36; \sigma_2 = 0$ and $\sigma_3 = -32.36$ MPa
(C) $\sigma_1 = 0; \sigma_2 = -23.0$ and $\sigma_3 = -32.36$ MPa
(D) $\sigma_1 = 0; \sigma_2 = 0$ and $\sigma_3 = -32.36$ MPa
(E) None

15. ( ) The maximum shear stress at this point is
(A) $\tau_{max} = 5.0$ MPa (B) $\tau_{max} = 22.36$ MPa (C) $\tau_{max} = 16.18$ MPa
(D) $\tau_{max} = 32.36$ MPa (E) None

16. ( ) The stress state at this point is
(A) a pure bending stress state (B) a pure torsion stress state
(C) a pure transverse shear stress state (D) a plane stress state (E) None

17. ( ) The von-Mises stress at this point is
(A) $\tau_{max} = 5.0$ MPa (B) $\tau_{max} = 22.36$ MPa (C) $\tau_{max} = 16.18$ MPa
(D) $\tau_{max} = 32.36$ MPa (E) None

(IV) A homogeneous plate ABCD is subjected to a biaxial loading which results in the normal stress $\sigma_x = 150\ MPa$ and $\sigma_z = 100\ MPa$. Knowing that the plate is made of steel which $E = 200\ GPa$ and Poison's ratio $\nu = 0.30$.



18. ( ) The change in length of edge AB is
(A) $+7.5\mu m$ (B) $+10.8\ \mu m$ (C) $+60.0\mu m$
(D) $+120\mu m$ (E) None

19. ( ) The change in length of edge BC is
(A) $+7.5\mu m$ (B) $+8.8\ \mu m$ (C) $+10.4\mu m$
(D) $+20.6\mu m$ (E) None

20. ( ) The change in length of diagonal AC is
(A) $+47.5\mu m$ (B) $+60.4\ \mu m$ (C) $+101.4\mu m$
(D) $+205.6\mu m$ (E) None

國立中山大學101學年度碩士暨碩士專班招生考試試題

科目：材料力學【機電系碩士班乙組】

題號：4094

二、 **問答分析及計算題**（下列共四題，共計 50 分）

1. Please plot the stress-strain diagrams (not to scale) and denote three specified points (if necessary) for (a) brittle materials, (b) ductile materials, such as mild steel, and (c) nonlinearly elastic materials. (15%)

2. What two conditions must be valid if the principle of superposition is to be applied? (10%)

3. A solid shaft of radius c is subjected to a torque T. Please determine the fraction of T that is resisted by the material contained within the outer region of the shaft as a tube, which has (a) an inner radius of $c/2$ and outer radius c, and (b) an inner radius $3c/4$ and outer radius c. (10%)

4. In plane stress condition the normal stresses are -20 MPa and 90 MPa in x and y axes, and shear stress 60 MPa, respectively. Please find the principal strains and maximum shear strain with Young's modulus 10 GPa and Poisson's ratio 0.3. (15%)