

## 成功大學材料系 93 學年度碩士班研究生入學考試試題

C 卷：工程數學(10 題[1-10],每題 3 分)、材料科學(30 題[11-40],每題 1 分)、材料力學(15 題[41-55],每題 2 分)。滿分 90 分。倒扣至零分為止。

科目名稱：工程數學

每題為 4 選 1，每一題答對得 3 分，答錯倒扣 0.75 分。

1. The solution of the equation:  $y' - Ay = -By^2$  is

- Ⓐ  $1/[(A/B) + ce^{-Ax}]$ ,    Ⓑ  $1/[A + ce^{-Ax}]$ ,  
 Ⓒ  $A/[(A/B) + ce^{-Ax}]$ ,    Ⓓ  $1/[(B/A) + ce^{-Ax}]$ .

2. The equation of spring is  $y'' + (c/m)y' + (k/m)y = 0$ , for  $c = 0$ ,  $k = 2$ ,  $m = 5$ , the result is

- Ⓐ underdamping    Ⓑ critical damping  
 Ⓒ overdamping    Ⓓ no damping.

3. The Laplace transform of the function  $f(t)$  is  $1/[s^2 + \omega^2]$ , the function  $f(t)$  is

- Ⓐ  $(1/\omega)(1 - \cos\omega t)$ ,    Ⓑ  $(1/\omega^2)(1 - \cos\omega t)$ ,  
 Ⓒ  $(1/\omega^2)(1 - \sin\omega t)$ ,    Ⓓ  $(1/\omega^2)(1 + \cos\omega t)$ .

4. The Fourier series of the function  $f(x) = x$ ,  $(-\pi < x < \pi)$  is

- Ⓐ  $2(\sin x + \frac{1}{2}\sin 2x + \frac{1}{3}\sin 3x + \frac{1}{4}\sin 4x + \dots)$   
 Ⓑ  $2(\sin x + \sin 2x + \sin 3x + \sin 4x + \dots)$   
 Ⓒ  $2(\sin x - \frac{1}{2}\sin 2x + \frac{1}{3}\sin 3x - \frac{1}{4}\sin 4x + \dots)$   
 Ⓓ  $2(\sin x - \frac{1}{2}\cos 2x + \frac{1}{3}\sin 2x - \frac{1}{4}\cos 4x + \dots)$

(背面仍有題目,請繼續作答)

5. The general solution of the equation;  $x^2y' + xy = -y^{3/2}$  is

(A)  $\frac{2}{5}x^{3/2}y^{5/2} + \frac{2}{3}x^{3/2} = C$ ,      (B)  $\frac{2}{3}x^{3/2}y^{5/2} + \frac{2}{3}x^{3/2} = C$ ,

(C)  $\frac{2}{5}x^{5/2}y^{5/2} + \frac{2}{3}x^{3/2} = C$ ,      (D)  $\frac{2}{3}x^{3/2}y^{5/2} + \frac{2}{3}x^{3/2} = C$ .

6.  $y' = e^x$ , then  $y =$  (A)  $e^x$     (B)  $e^x + c$     (C)  $\ln x$     (D)  $\ln x + c$

7.  $y' = -\frac{y}{x}$ , and  $y(1) = 1$ , then  $y(3) =$  (A)  $\frac{1}{6}$     (B) 6    (C) 3    (D)  $\frac{1}{3}$

8.  $\frac{dv_z}{dx} = -\frac{\rho g \sin \beta}{\eta} x$ , and  $v_z(\delta) = 0$ , then  $v_z =$

(A)  $\frac{\rho g \delta^2 \sin \beta}{2\eta} \left[ 1 - \left(\frac{x}{\delta}\right) \right]$       (B)  $\frac{\rho g \delta^2 \sin \beta}{\eta} \left[ 1 - \left(\frac{x}{\delta}\right) \right]$

(C)  $\frac{\rho g \delta^2 \sin \beta}{2\eta} \left[ 1 - \left(\frac{x}{\delta}\right)^2 \right]$       (D)  $\frac{\rho g \delta^2 \sin \beta}{\eta} \left[ 1 - \left(\frac{x}{\delta}\right)^2 \right]$

9.  $\frac{d^2T}{dx^2} = 0$ , and  $T(0) = T_1$ ,  $T(L) = T_2$ , then which one is true?

(A)  $\frac{T_1 - T}{T_2 - T_1} = \frac{x}{L}$     (B)  $\frac{T_1 - T}{T_2 - T_1} = \frac{L}{x}$     (C)  $\frac{T - T_1}{T_2 - T_1} = \frac{L}{x}$     (D)  $\frac{T - T_1}{T_2 - T_1} = \frac{x}{L}$

10.  $\frac{1}{r} \frac{d}{dr} \left[ r \frac{dV_z}{dr} \right] = -a$ , and  $\frac{dV_z}{dr}(r_2) = 0$ ,  $V_z(r_1) = 0$ , then  $V_z =$

(A)  $\frac{a}{2} \left[ r_2^2 \ln\left(\frac{r}{r_2}\right) - \frac{1}{2}(r^2 - r_1^2) \right]$       (B)  $\frac{a}{2} \left[ r_2^2 \ln\left(\frac{r}{r_1}\right) - \frac{1}{2}(r^2 - r_1^2) \right]$

(C)  $\frac{a}{2} \left[ r_2^2 \ln\left(\frac{r}{r_2}\right) - \frac{1}{2}(r^2 - r_2^2) \right]$       (D)  $\frac{a}{2} \left[ r_2^2 \ln\left(\frac{r}{r_1}\right) - \frac{1}{2}(r^2 - r_2^2) \right]$

科目名稱：材料科學

每題為4選1，每一題答對得1分，答錯倒扣0.25分。

11. Cubic ferrite has the inverse spinel structure, in which
- Ⓐ  $O^{2-}$  ions are located in the cubic lattice
  - Ⓑ all  $Fe^{3+}$  ions are situated in octahedral position
  - Ⓒ  $Fe^{2+}$  ions are located in octahedral sites
  - Ⓓ  $1/2 Fe^{3+}$  ions in octahedral  $1/2 Fe^{3+}$  in tetrahedral sites. Which one is not correct in above descriptions.
12. Alnico is a Ⓐ hard Ⓑ soft Ⓒ medium Ⓓ para-magnetic material.
13. Superconductor  $YBa_2Cu_3O_7$  has a critical temperature of about
- Ⓐ  $25^\circ C$  Ⓑ 25K Ⓒ  $90^\circ C$  Ⓓ 90K
- below which the resistivity becomes almost zero.
14. The wavelength of visible light lies in
- Ⓐ 0.4-0.7m Ⓑ 0.4-0.7cm Ⓒ 0.4-0.7  $\mu m$  Ⓓ 0.4-0.7nm
15. A single crystal of  $Al_2O_3$  doped with 0.5-2%  $Cr_2O_3$  has a brilliant red color, as called ruby, because the absorption peaks occur in
- Ⓐ regions of blue and green Ⓑ yellow and orange
  - Ⓒ orange and red Ⓓ ultraviolet.
16. Optical fibers for communications are made by
- Ⓐ ruby Ⓑ sapphire Ⓒ silica glass Ⓓ kaolinite.
17. Nd-YAG laser can be used for Ⓐ recording Ⓑ distance measurement
- Ⓒ welding Ⓓ CD and video disks
18. Which of the following materials has the lowest thermal expansion coefficient  $\alpha_t$
- Ⓐ Al Ⓑ W Ⓒ stainless steel Ⓓ Invar

(背面仍有題目,請繼續作答)

19. Which of the following materials has the highest thermal conductivity?  
Ⓐ Cu    Ⓑ diamond    Ⓒ Fe    Ⓓ Al
20. As the Sb is doped to the Si, the donor state in the electron energy band locates within the energy gap and  
Ⓐ just below the bottom of the conduction band  
Ⓑ just above the top of the valence band  
Ⓒ in the middle of the energy gap  
Ⓓ just below the top of the valence band.
21. What is the magnitude of the maximum stress that exists at the tip of an internal crack having a radius of curvature of  $2.5 \times 10^{-4}$  mm ( $10^{-5}$  in.) and a crack length of  $2.5 \times 10^{-2}$  mm ( $10^{-3}$  in.) when a tensile stress of 170 MPa (25,000 psi) is applied?  
Ⓐ 24 MPa    Ⓑ 4200 MPa    Ⓒ 2404 MPa    Ⓓ 420 Mpa
22.  $\text{Fe}_3\text{C}$  is also called  
Ⓐ cementite    Ⓑ pearlite    Ⓒ austenite    Ⓓ peritectoid
23. Which one is NOT one of the major sources for causing internal residual stresses in metal components  
Ⓐ mixing    Ⓑ plastic deformation    Ⓒ non uniform cooling    Ⓓ phase transformation
24. The driving force for sintering is the reduction in total particle  
Ⓐ surface area    Ⓑ micro pores    Ⓒ phases    Ⓓ components
25. Usually for a specimen of a ceramic material, the magnitude of the stress at the most severe flaw is (E is the modulus of elasticity)  
Ⓐ greater than  $E/10$     Ⓑ smaller than  $E/10$     Ⓒ greater than  $E/100$   
Ⓓ smaller than  $E/100$



26. Which of the following is called a Gibbs phase rule? P is the number of phases present, F is the number of degrees of freedom, C is the number of components, N is the number of non compositional variables ( e.g. temperature and pressure )  
Ⓐ  $P + C = F + N$  Ⓑ  $P + F = C + N$  Ⓒ  $P - C = F + N$  Ⓓ  $C + F = P + N$
27. The strength and hardness of some metal alloys may be enhanced by the formation of extremely small uniformly dispersed particles of a second phase within the original phase matrix ; this can be accomplished by appropriate heat treatments. This process is called  
Ⓐ work hardening Ⓑ annealing Ⓒ calcinations Ⓓ precipitation hardening
28. Generally, a class of ferrous alloys with carbon contents above 2.14 wt% is called  
Ⓐ low carbon steel Ⓑ medium carbon steel  
Ⓒ high carbon steel Ⓓ cast iron
29. Which one of the following material could be used at very high temperature  
Ⓐ copper Ⓑ plastics Ⓒ MgO Ⓓ Graphite
30. Which one of the following material has very strong covalent bond?  
Ⓐ Al  
Ⓑ diamond Ⓒ SiO<sub>2</sub> Ⓓ Si<sub>3</sub>N<sub>4</sub>
31. The relationship between the weight gain per unit area and the time determines the oxidation behavior of a metal. If the oxide that forms is nonporous and adheres to the metal surface then a  
Ⓐ linear Ⓑ cubic Ⓒ exponential Ⓓ parabolic relationship exists.
32. For the most advanced carbon-composite, it has a lot of desirable properties, but it has a major drawback of  
Ⓐ low resistance to creep  
Ⓑ high oxidation rate  
Ⓒ low fracture toughness  
Ⓓ low thermal shock resistance as used at high temperatures.

(背面仍有題目,請繼續作答)

33. Among the following polymers, which one has a better fatigue strength  
Ⓐ PE Ⓑ PP Ⓒ PMMA Ⓓ PET
34. In vulcanization Ⓐ Sulfur Ⓑ Carbon Ⓒ Nitrogen Ⓓ Boron compounds are added to heated elastomer.
35. Ni-based superalloy may be reinforced by dispersion strengthening with  
Ⓐ  $\text{TiO}_2$  Ⓑ  $\text{ThO}_2$  Ⓒ  $\text{SiO}_2$  Ⓓ SiC
36. Whisker is Ⓐ single crystal Ⓑ polycrystal Ⓒ amorphous Ⓓ polymer
37. What is the coordination number for the atoms in the BCC crystal structure?  
Ⓐ 2 Ⓑ 4 Ⓒ 8 Ⓓ 12
38. How many atoms per unit cell are there in the FCC crystal structure?  
Ⓐ 2 Ⓑ 4 Ⓒ 8 Ⓓ 12 atoms.
39. What is the coordination number for the atoms in the FCC crystal structure?  
Ⓐ 2 Ⓑ 4 Ⓒ 8 Ⓓ 12
40. The electron configuration of the yttrium element ( $Z = 39$ ) by using *spdf* notion: Ⓐ [Kr]  
 $4d^3$  Ⓑ [Kr]  $4d^2 5s^1$  Ⓒ [Kr]  $4d^1 5s^2$  Ⓓ non of the above

科目名稱：材料力學

每題為 4 選 1，每一題答對得 2 分，答錯倒扣 0.50 分。

41.  $\sigma_1$ ,  $\sigma_2$  and  $\sigma_3$  are the three principal stresses acting on a solid. Which of the following stress conditions gives rise to the largest shear stress?
- (A)  $\sigma_1 = \sigma_2 = \sigma_3 = 10$  MPa.  
 (B)  $\sigma_1 = \sigma_2 = 10$  MPa,  $\sigma_3 = 0$  MPa.  
 (C)  $\sigma_1 = \sigma_2 = 10$  MPa,  $\sigma_3 = -5$  MPa.  
 (D)  $\sigma_1 = 10$  MPa,  $\sigma_2 = -5$  MPa,  $\sigma_3 = -10$  MPa.
42. A round wire of initial diameter 2 mm and length 300 mm yielded at a tensile load of 286 N. The maximum load was 380 N when the length was 400 mm. After necking, the wire fractured at a load of 314 N. What is the true tensile stress in the region of the specimen away from the neck at the instance fracture occurs in the neck?
- (A) 143 MPa,  
 (B) 190 MPa,  
 (C) 133 MPa,  
 (D) 157 MPa.
43. The elastic constants of copper and tungsten are listed in the following table.

Material	Young's Modulus (GPa)	Poisson's Ratio
Copper	110	0.33
Tungsten	400	0.27

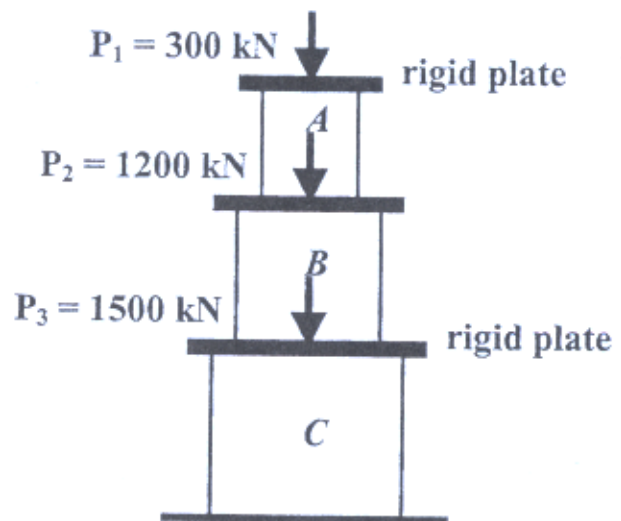
Which of the following statements is correct?

- (A) Tungsten is less ductile than copper since its Young's modulus is larger.  
 (B) Owing to its smaller Young's modulus, copper has lower strength and hardness than tungsten.  
 (C) Copper possesses larger Poisson's ratio than tungsten. Thus when deformed elastically to the same longitudinal strain under uniaxial tension, the volume change of copper is smaller than tungsten.  
 (D) None of the above statements is correct.

(背面仍有題目,請繼續作答)



44. A 2.00-m length metal rod is subjected to a nonuniform heating that produces an extensional (axial) strain that is proportional to the square of the distance from the unheated end ( $\epsilon(x) = kx^2$ ). If the strain at the mid-point of the rod is  $1200 \mu\text{m}/\text{m}$ , determine the change in length of the rod.
- (A)  $1200 \mu\text{m}$ ;  
 (B)  $2400 \mu\text{m}$ ;  
 (C)  $3200 \mu\text{m}$ ;  
 (D)  $4800 \mu\text{m}$ .
45. In a plane strain deformation, the two normal strains  $\epsilon_x$  and  $\epsilon_y$  in certain  $x$ - $y$  Cartesian coordinate system are  $500\mu$  and  $-700\mu$ , respectively. Knowing one principal strain as  $1000\mu$ , what is the other?
- (A)  $-900\mu$ ;  
 (B)  $-1000\mu$ ;  
 (C)  $-1100\mu$ ;  
 (D)  $-1200\mu$ .



46. Three steel pipes are loaded and supported as shown in the figure. If the normal stress in each pipe must not exceed  $150 \text{ MPa}$ , determine the cross-sectional areas required for each of the sections.
- (A)  $A_A = 2,000 \text{ mm}^2$ ,  $A_B = 10,000 \text{ mm}^2$ ,  $A_C = 20,000 \text{ mm}^2$ ;  
 (B)  $A_A = 3,000 \text{ mm}^2$ ,  $A_B = 12,000 \text{ mm}^2$ ,  $A_C = 15,000 \text{ mm}^2$ ;  
 (C)  $A_A = 4,000 \text{ mm}^2$ ,  $A_B = 20,000 \text{ mm}^2$ ,  $A_C = 40,000 \text{ mm}^2$ ;  
 (D)  $A_A = 5,000 \text{ mm}^2$ ,  $A_B = 24,000 \text{ mm}^2$ ,  $A_C = 60,000 \text{ mm}^2$ .
47. At a point in a structural member subjected to plane stress, the state of stress is given by  $\sigma_x = 5000 \text{ psi}$ ,  $\sigma_y = -1000 \text{ psi}$  and  $\tau_{xy} = 4000 \text{ psi}$ . Determine the principal stresses.
- (A)  $\sigma_1 = 7200 \text{ psi}$ ,  $\sigma_2 = 0$  and  $\sigma_3 = -1800 \text{ psi}$ ;  
 (B)  $\sigma_1 = 8000 \text{ psi}$ ,  $\sigma_2 = 0$  and  $\sigma_3 = -2000 \text{ psi}$ ;  
 (C)  $\sigma_1 = 7500 \text{ psi}$ ,  $\sigma_2 = 0$  and  $\sigma_3 = -2500 \text{ psi}$ ;  
 (D)  $\sigma_1 = 7000 \text{ psi}$ ,  $\sigma_2 = 0$  and  $\sigma_3 = -3000 \text{ psi}$ .



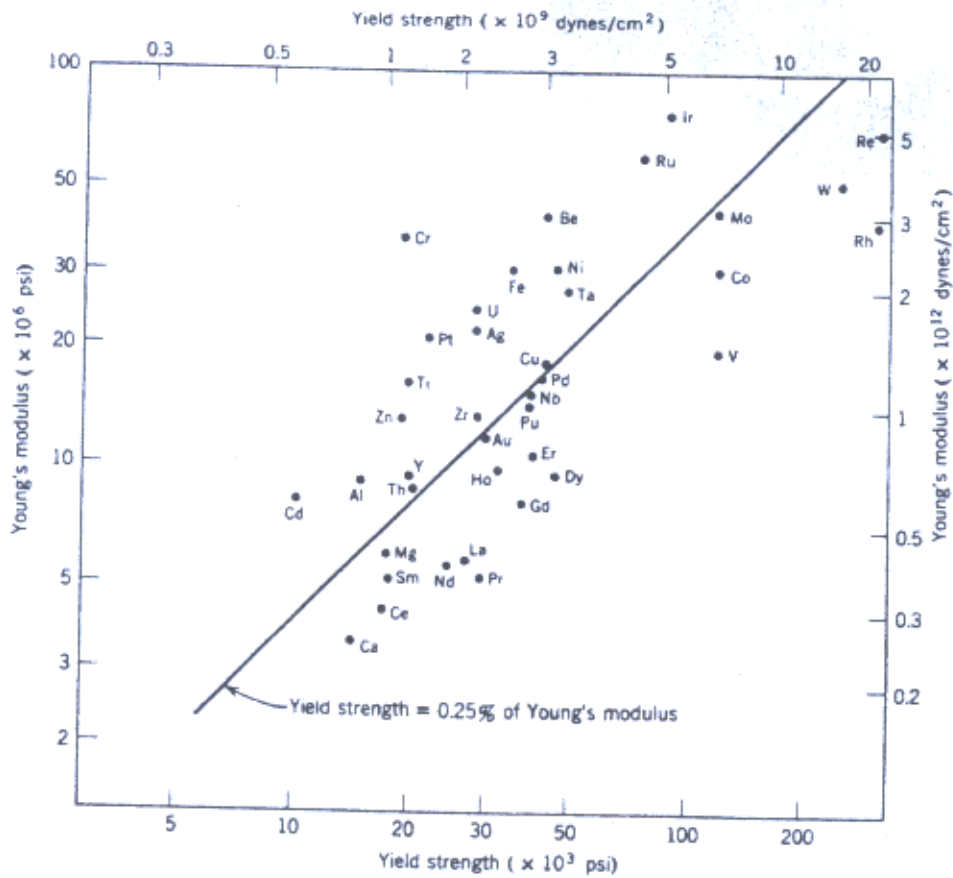
48. The von Mises yield criterion can be expressed as  $[(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2 + 6(\tau_{xy}^2 + \tau_{yz}^2 + \tau_{zx}^2)] / 2 = \sigma_0^2$ , where  $\sigma_0$  is the yield stress in simple tension. Consider the case of a thin-walled cylinder with the  $x$ -direction taken along the axis of the cylinder. Which of the followings is the correct reduced form of the yield criterion when the cylinder is subjected to both tension and torsion?
- (A)  $[\sigma_x^2 + 3\tau_{xy}^2]^{1/2} = \sigma_0$ ;  
 (B)  $[\sigma_x^2 + 4\tau_{xy}^2]^{1/2} = \sigma_0$ ;  
 (C)  $[\sigma_x^2 + 3\tau_{yz}^2]^{1/2} = \sigma_0$ ;  
 (D)  $[\sigma_x^2 + 4\tau_{yz}^2]^{1/2} = \sigma_0$ .
49. Consider simple tension and pure torsion, both having the same maximum tensile stress. Which of the following statements is not correct?
- (A) The maximum shear stress in torsion is twice that in tension.  
 (B) The hydrostatic stress in tension is equal to one third of the tensile stress.  
 (C) Torsion gives rise to no hydrostatic stress.  
 (D) Materials that are brittle in tension always crack rather than yield in torsion.
50. An isotropic elastic solid of Poisson's ratio  $\nu = 1/3$  is subjected to a plane strain deformation with normal strain  $\epsilon_z = 0$  along  $z$ -direction. The two normal stresses  $\sigma_x$  and  $\sigma_y$  are 4500 psi and 6000 psi, respectively. Determine the third normal stress,  $\sigma_z$ .
- (A) 0 psi;  
 (B) 3000 psi;  
 (C) 3500 psi;  
 (D) 4000 psi.
51. Which of the following descriptions regarding the broken specimen shown in the photo is definitely not correct?



- (A) The specimen is made of certain brittle solid.  
 (B) The specimen was failed by torsional loading.  
 (C) Tensile stress caused the specimen to fail in tension.  
 (D) The fracture surface, which is  $45^\circ$  to the longitudinal axis, was the plane of maximum shear stress.

(背面仍有題目,請繼續作答)

52. The figure shows that Mo, Co and V are about equal in yield strength but different in Young's Modulus ( $E_{Mo} > E_{Co} > E_V$ ). Which of the following statements regarding these three metals is definitely not correct?



- (A) V possesses the smallest modulus of resilience (i.e., the lowest resilience).
  - (B) Mo is the most rigid.
  - (C) Judging from the Young's modulus data, V possesses the smallest shear modulus.
  - (D) Judging from the yield strength data, the three metals should have similar hardness.
53. Which of the following stresses was the major cause of the failure of the pressure vessel shown in the photo?
- (A) the hoop stress (circumferential stress);
  - (B) the axial stress (longitudinal stress);
  - (C) the maximum out-of-plane shear stress;
  - (D) the maximum in-plane shear stress.



54. Tresca yield criterion predicts yielding of a specimen when the maximum shear stress at any point in the specimen reaches half the tensile (and compressive) yield stress  $\sigma_0$  of the same material. Consider a material with  $\sigma_0 = 36$  ksi. In terms of principal stresses, the material is subjected to  $\sigma_1 = 18$  ksi,  $\sigma_2 = 10$  ksi and  $\sigma_3 = 0$  ksi. What is the factor of safety with respect to failure by yielding according to Tresca criterion?
- (A) 1.8;  
 (B) 2.0;  
 (C) 2.1;  
 (D) 2.4.
55. An isotropic linear elastic material of Poisson's ratio  $\nu = 1/3$  is subjected to a compressive stress  $\sigma_z$ . The deformation is permitted in the  $x$ -direction but is confined in the  $y$ -direction. Determine  $\sigma_y$ , the normal stress in the  $y$ -direction.
- (A)  $\sigma_y = 0$ ;  
 (B)  $\sigma_y = \sigma_z$ ;  
 (C)  $\sigma_y = \sigma_z/3$ ;  
 (D)  $\sigma_y = 2\sigma_z/3$ .

