

系所組別：材料科學及工程學系

考試科目：C科目

考試日期：0307，節次：3

※ 考生請注意：本試題 可 不可 使用計算機

C 卷：工程數學(10 題[1-10]，每題 3 分)、材料力學(10 題[11-20]，每題 3 分)、材料科學導論(30 題[21-50]，每題 1 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 position of a moving particle is given by  $r(t) = 2 \cos t \bar{i} + 2 \sin t \bar{j} + 3t \bar{k}$ . The binormal is

(A)  $B = -\frac{3}{\sqrt{13}} \sin t \bar{i} + \frac{3}{\sqrt{13}} \cos t \bar{j} - \frac{2}{\sqrt{13}} \bar{k}$

(B)  $B = \frac{3}{\sqrt{13}} \sin t \bar{i} - \frac{3}{\sqrt{13}} \cos t \bar{j} + \frac{2}{\sqrt{13}} \bar{k}$

(C)  $B = \frac{2}{\sqrt{13}} \sin t \bar{i} - \frac{3}{\sqrt{13}} \cos t \bar{j} + \frac{3}{\sqrt{13}} \bar{k}$

(D)  $B = -\frac{2}{\sqrt{13}} \sin t \bar{i} + \frac{3}{\sqrt{13}} \cos t \bar{j} - \frac{3}{\sqrt{13}} \bar{k}$

2. The equation of tangent plane to the graph of  $z = \frac{1}{2}x^2 + \frac{1}{2}y^2 + 4$  at  $(1, -1, 5)$  is

(A)  $x + y + z = 7$

(B)  $x - y + z = 7$

(C)  $x + y - z = 7$

(D)  $-x + y + z = 7$

3. The inverse Laplace transform of  $\frac{-2s+6}{s^2+4}$  is

(A)  $2 \cos 2t - 3 \sin 2t$

(B)  $-2 \cos 2t + 3 \sin 2t$

(C)  $-3 \cos 2t + 2 \sin 2t$

(D)  $3 \cos 2t - 2 \sin 2t$

4. The cosine integral of the function  $f(x) = \begin{cases} 1, & \dots |x| < a \\ 0, & \dots |x| > a \end{cases}$  is

(A)  $f(x) = \frac{1}{2\pi} \int_0^{\infty} \frac{\sin \alpha x \cos \alpha x}{\alpha} d\alpha$

(B)  $f(x) = \frac{1}{\pi} \int_0^{\infty} \frac{\sin \alpha x \cos \alpha x}{\alpha} d\alpha$

(C)  $f(x) = \frac{2}{\pi} \int_0^{\infty} \frac{\sin \alpha x \cos \alpha x}{\alpha} d\alpha$

(D)  $f(x) = -\frac{1}{\pi} \int_0^{\infty} \frac{\sin \alpha x \cos \alpha x}{\alpha} d\alpha$

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5.  $\sum_{i=1}^{\infty} \left( \frac{1}{2^i} - \frac{3^i}{5^i} \right) =$

- (A) -0.5                      (B) 0.5                      (C) 1.5                      (D) 2.5

6. Heat equation is usually expressed as  $\frac{\partial U}{\partial t} = c^2 \nabla^2 U$ , where  $\nabla^2 U$  is

(A)  $\nabla^2 U = \frac{d^2 U}{dx^2} + \frac{d^2 U}{dy^2} + \frac{d^2 U}{dz^2}$

(B)  $\nabla^2 U = \frac{\partial^2 U}{\partial x^2} + \frac{\partial^2 U}{\partial y^2} + \frac{\partial^2 U}{\partial z^2}$

(C)  $\nabla^2 U = \frac{\partial U}{\partial x} \times \frac{\partial U}{\partial y} + \frac{\partial U}{\partial y} \times \frac{\partial U}{\partial z} + \frac{\partial U}{\partial x} \times \frac{\partial U}{\partial z}$

(D)  $\nabla^2 U = \frac{\partial^2 U}{\partial x \partial y} + \frac{\partial^2 U}{\partial y \partial z} + \frac{\partial^2 U}{\partial z \partial x}$

7. Solve  $y'' - 4y' + 4y = (x+1)e^{2x}$

(A)  $y = \left( C_1 + C_2 x + \frac{1}{2} x^2 + \frac{1}{6} x^3 \right) e^{2x}$

(B)  $y = \left( C_1 + C_2 x + \frac{1}{6} x^2 + \frac{1}{2} x^3 \right) e^{2x}$

(C)  $y = C_1 e^{2x} + C_2 x + \frac{1}{2} x^3 e^{2x}$

(D)  $y = C_1 e^{2x} + C_2 x + \frac{1}{6} x^3 e^{2x}$

8. A pressure distribution is as follows.

$$P_f \Big|_{r=R} = -\frac{3}{2} \frac{\mu v_{\infty}}{R} \cos \theta$$

It is known that  $F_{n,f} = \int_0^{\pi} \int_0^{2\pi} (-P_f \Big|_{r=R} \cos \theta) R^2 \sin \theta d\theta d\phi$

$F_{n,f} =$

- (A)  $3\pi\mu R v_{\infty}$                       (B)  $2\pi\mu R v_{\infty}$                       (C)  $\pi\mu R^2 v_{\infty}$                       (D)  $3\pi\mu R^2 v_{\infty}$

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Ⓐ 25

Ⓑ 20

Ⓒ 15

Ⓓ 5

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

Ⓐ  $\frac{T_1 - T}{T_2 - T_1} = \frac{x}{L}$

Ⓑ  $\frac{T_1 - T}{T_2 - T_1} = \frac{L}{x}$

Ⓒ  $\frac{T - T_1}{T_2 - T_1} = \frac{x}{L}$

Ⓓ  $\frac{T - T_1}{T_2 - T_1} = \frac{L}{x}$

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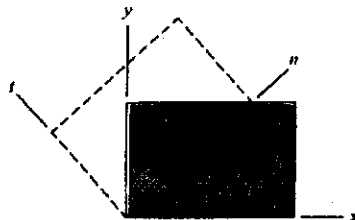
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科目名稱： 材料力學

每題為 4 選 1，每一題答對得 3 分，答錯倒扣 0.75 分。

11. Stress concentration is not significant in the case of static loading of a ductile material because the material will
  - (A) fracture
  - (B) crack
  - (C) yield
  - (D) deform inelastically in the region of high stress.
  
12. From the feature of a stress-strain curve, the area under the entire stress-strain curve from zero to rupture gives the property known as
  - (A) modulus of toughness
  - (B) modulus of resilience
  - (C) modulus of plasticity
  - (D) modulus of rigidity
  
13. Cantilever beams and simple beams have only
  - (A) one
  - (B) two
  - (C) three
  - (D) four reactions, and these reactions can be obtained from a free body diagram of the beam by applying the equations of equilibrium. Such beams are said to be statically determinate.
  
14. In an equilateral triangle ABC with a side length of 2m, the resultant moment at A, B, and C points are 10 kNm, -10 kNm and 0, respectively. This state can be simplified as the resultant force which acts on the points of the triangle ABC. At which point act the force?
  - (A) Point A
  - (B) Point B
  - (C) Point C
  - (D) no force
  
15. The strain components of  $\epsilon_{xx}$ ,  $\epsilon_{yy}$ , and  $\gamma_{xy}$  at a point in a body subjected plan strain are -800, 640 and -960  $\mu$  in./in., respectively. Determine the  $\epsilon_n$  when the nt-axes are at  $\theta=42^\circ$  counterclockwise from the xy-axes shown in the figure below.
  - (A) 473
  - (B) 1322
  - (C) 732
  - (D) -633



16. The solid 100-mm-diameter shaft is subjected to an axial compressive force  $P=200$  kN and a torque  $T=30$  kNm. For a point A on the outside surface of the shaft, determine the maximal shear stress.

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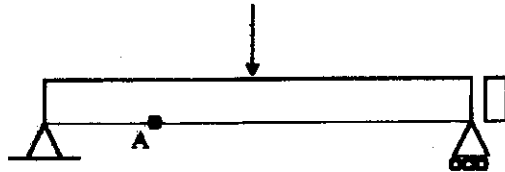
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- Ⓐ 25.5 MPa      Ⓑ 152.8 MPa      Ⓒ 153.3MPa      Ⓓ 140.6 MPa

17. Determine the stress state at the point A in a simple beam of rectangle cross section shown in the figure below.

- Ⓐ plane stress      Ⓑ compressive stress  
Ⓒ tensile stress      Ⓓ shear stress



18. A cube is deformed by stretching 20% in the  $x$ -direction and reducing 20% in the  $y$ -direction. Which of the following statements regarding the volume of the cube is correct?

- Ⓐ The deformation does not change the volume.  
Ⓑ The deformation increases the volume 10%.  
Ⓒ The deformation reduces the volume 10%.  
Ⓓ The deformation reduces the volume 4%.

19. A prismatic rod is fixed at its two ends. The rod remains straight when it is subjected to a temperature rise. To cope with the thermal strain, the axial stress of the rod is

- Ⓐ tensile      Ⓑ compressive      Ⓒ zero      Ⓓ indefinite.

20. In terms of principal stresses, maximum-distortion-energy theory (von Mises yield criterion) predicts yielding of a specimen when  $(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2 = 2\sigma_y^2$ , where  $\sigma_y$  is the tensile (and compressive) yield stress. A material with  $\sigma_y = 250$  MPa is subjected to  $\sigma_1 = \sigma_2 = 200$  MPa and  $\sigma_3 = 0$ . The factor of safety with respect to failure by yielding according to maximum-distortion-energy theory is

- Ⓐ 2.0      Ⓑ 1.5      Ⓒ 1.25      Ⓓ 1.2

(背面仍有題目,請繼續作答)

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科目名稱： 材料科學導論

每題為 4 選 1，每一題答對得 1 分，答錯倒扣 0.25 分。

21. What is the intensity of light transporting in a material at depth  $L$ ? (The intensity of incident light is  $I_0$  and absorption coefficient of material is  $\beta$ .)  
 (A)  $I_0 \text{ Exp}(-\beta L)$       (B)  $I_0 \text{ Exp}(\beta L)$       (C)  $I_0 \text{ Exp}(-2\beta L)$       (D)  $I_0 \text{ Exp}(-\beta/L)$
22. Which one of the following doped in silicon will cause p-type conductivity?  
 (A) P      (B) As      (C) Sb      (D) B
23. Luminescence is classified as fluorescence or phosphorescence by:  
 (A) Emitting wavelength      (B) Delay time  
 (C) Material      (D) Energy gap
24. Conductivity of metal is influenced by  
 (A) Temperature      (B) Purity      (C) Deformation      (D) All above
25. In the inverse spinel structure, magnetic moment are contributed by:  
 (A) Trivalent transition metal ion at octahedral site  
 (B) Trivalent transition metal ion at tetrahedral site  
 (C) Divalent transition metal ion at octahedral site  
 (D) Net magnetic moment of all above
26. Which one of the following doesn't show ferromagnetism?  
 (A) BCC phase iron      (B) FCC phase iron      (C) Cobalt      (D) Nickel
27. For intrinsic gallium arsenide, the room-temperature electrical conductivity is  $10^{-6} (\Omega\text{-m})^{-1}$ ; the electron and hole mobilities are 0.85 and  $0.04 \text{ m}^2/\text{V-s}$ , respectively. Compute the intrinsic carrier concentration  $n_i$  at room temperature  
 (A)  $7.0 \times 10^{10} \text{ m}^{-3}$       (B)  $7.0 \times 10^{11} \text{ m}^{-3}$   
 (C)  $7.0 \times 10^{12} \text{ m}^{-3}$       (D)  $7.0 \times 10^{13} \text{ m}^{-3}$
28. Assume  $V_H$  is Hall voltage,  $d$  is specimen thickness,  $R_H$  is Hall coefficient,  $I_X$  is the current of the electron or hole move in the X direction,  $B_Z$  is a magnetic field impose in the positive Z direction. The magnitude among  $V_H$ ,  $d$ ,  $R_H$ ,  $I_X$ ,  $B_Z$  can be expressed as

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Ⓐ  $V_H = d / (R_H I_x B_z)$

Ⓑ  $V_H = (I_x B_z) / (d R_H)$

Ⓒ  $V_H = d R_H I_x B_z$

Ⓓ  $V_H = (R_H I_x B_z) / d$

29. For a ferromagnetic or ferrimagnetic material, the magnitude of residual flux density that remains when a magnetic field is removed is called

Ⓐ Saturation magnetization

Ⓑ Paramagnetism

Ⓒ Magnetization

Ⓓ Remanence

30. Which of the following materials has the highest specific heat?

Ⓐ Zirconium

Ⓑ Phenolic

Ⓒ Diamond

Ⓓ Graphite

31. The applied magnetic field necessary to reduce to zero the magnetic flux density of a magnetized ferromagnetic or ferrimagnetic material is called

Ⓐ Magnetic susceptibility

Ⓑ Diamagnetism

Ⓒ Coercivity

Ⓓ Antiferromagnetism

32. Bending of a light beam upon pass from one medium into another; the velocity of light differs in the two media is called

Ⓐ Refraction

Ⓑ Reflection

Ⓒ Transmission

Ⓓ Transparent

33. Which of the following is wrong for metal and semiconductor?

Ⓐ Conductivity increases with temperature increasing for both of them.

Ⓑ Conductivity of metal is higher than semiconductor.

Ⓒ Free electrons contribute the conductivity of metal.

Ⓓ Conductivity can be promoted when valence band electron jump to conduction band for semiconductor.

34. The indices of the direction that results from the intersection of (110) and (111) planes is

Ⓐ [110]

Ⓑ  $[\bar{1}10]$

Ⓒ [111]

Ⓓ [101]

35. Ⓐ Rhombohedral Ⓑ Orthorhombic Ⓒ Monoclinic Ⓓ Triclinic  
crystal system shows  $a \neq b \neq c$ , and  $\alpha = \gamma = 90^\circ \neq \beta$ .

36. Ⓐ Self-diffusion Ⓑ Interdiffusion Ⓒ Frenkel diffusion Ⓓ Schottky diffusion  
may be monitored by using radioactive isotopes of the metal being studied.

(背面仍有題目,請繼續作答)

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- Ⓐ  $[\text{Ar}]3d^{10}4s^24p^6$     Ⓑ  $[\text{Ar}]3d^{10}4s^24p^4$     Ⓒ  $[\text{Ar}]3d^84s^24p^6$     Ⓓ  $[\text{Ar}]3d^{10}4s^2$

38. Copper has a crystal structure of closely packed atoms; each atom is surrounded by

- Ⓐ four                      Ⓑ six                      Ⓒ eight                      Ⓓ twelve  
others.

39. Convert the  $[110]$  direction into the four-index Miller-Bravais scheme for hexagonal unit cells. The direction is represented as  $[uv\bar{t}w] =$ 

- Ⓐ  $[1110]$                       Ⓑ  $[10\bar{1}0]$                       Ⓒ  $[\bar{1}\bar{1}23]$                       Ⓓ  $[11\bar{2}0]$

40. Ⓐ Interdiffusion    Ⓑ Substitutional    Ⓒ Nonsteady-state    Ⓓ Steady-state  
diffusion is the situation wherein the rate of diffusion into a given system is just equal to the rate of diffusion out.

41. The driving force for

- Ⓐ recrystallization    Ⓑ grain growth                      Ⓒ plastic deformation    Ⓓ slip deformation  
is the reduction in grain boundary energy as the total grain boundary area decreases.

42. 80 HRB represents a

- Ⓐ Knoop                                      Ⓑ Vickers  
Ⓒ Rockwell                                      Ⓓ Superficial Rockwell  
hardness.

43. Ⓐ  $[100]$                       Ⓑ  $[110]$                       Ⓒ  $[101]$                       Ⓓ  $[111]$   
orientation for iron shows the largest modulus of elasticity values.

44. For many materials, the

- Ⓐ yield strength    Ⓑ hardness                      Ⓒ toughness                      Ⓓ shear stress  
varies with grain size according to the Hall-Petch equation.

45. The soda-line glass used as container and window consists of  $\text{SiO}_2$ ,  $\text{Na}_2\text{O}$  and  $\text{CaO}$  to have the characteristics of

- Ⓐ low melting temperature                      Ⓑ low coefficient of expansion  
Ⓒ high thermal shock resistance                      Ⓓ high chemical resistance

46. Upon consideration of the  $\text{SiO}_2$ - $\text{Al}_2\text{O}_3$  phase diagram, which one would you judge to be a



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more desirable refractory,

Ⓐ 90w/o  $\text{SiO}_2$  + 10 w/o  $\text{Al}_2\text{O}_3$ Ⓑ 93 w/o  $\text{SiO}_2$  + 7 w/o  $\text{Al}_2\text{O}_3$ Ⓒ 95 w/o  $\text{SiO}_2$  + 5 w/o  $\text{Al}_2\text{O}_3$ Ⓓ 100w/o  $\text{SiO}_2$ 

47. Which one of the following polymers is thermoplastic

Ⓐ phenolics

Ⓑ melamine

Ⓒ polyvinyl chloride

Ⓓ epoxy

48. The mechanical behavior of thermosetting polymers is

Ⓐ weak

Ⓑ soft

Ⓒ brittle

Ⓓ tough

49. The crosslinking process of elastomers is achieved by adding compounds of

Ⓐ sulfur

Ⓑ carbon

Ⓒ phosphorous

Ⓓ calcium

50. The aramid fiber reinforced materials known as trade name of Kevlar could be used for

Ⓐ bottles

Ⓑ toys

Ⓒ boats

Ⓓ bullet-proof vests