※ 考生請注意：本試題 ☑可 □不可 使用計算機

C 卷：材料科學導論(30 題選擇題[1-30], 每題 1 分)、材料力學(15 題選擇題[31-45], 每題 2 分)、工程數學(6 題非選擇題[46-51], 每題 5 分)。滿分 90 分。倒扣至零分為止。

一、 選擇題（請以 2B 鉛筆劃卡作答）

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。

1. A Ⓐ unit cell Ⓑ crystal structure Ⓒ crystal system Ⓓ crystallinity of a space lattice represents a repeating unit of atomic spatial positions.

2. A FCC crystal structure has a coordination number of Ⓐ four Ⓑ six Ⓒ eight Ⓓ twelve.

3. A family or form of a cubic crystallographic plane is indicated using the notation Ⓐ {hkl} Ⓑ [hkl] Ⓒ (hkl) Ⓓ <hkl>

4. Copper shows the largest modulus of elasticity values at Ⓐ [100] Ⓑ [110] Ⓒ [111] Ⓓ [121].

5. The surface energy of a single crystal Ⓐ increases Ⓑ decreases Ⓒ does not change Ⓓ none of the above with an increase in planar density.

6. Rank the magnitudes of the diffusion coefficients from greatest to least for the following systems: (a) C in Fe at 700°C, (b) C in Fe at 900°C, (c) Cr in Fe at 700°C, and (d) Cr in Fe at 900°C. Ⓐ (b)(d)(c)(a) Ⓑ (d)(c)(b)(a) Ⓒ (d) (b)(c)(a) Ⓓ (b)(a)(d)(c)

7. Ⓐ Elastic deformation Ⓑ Plastic deformation Ⓒ Anelastic deformation Ⓓ all of the above is time-independent and nonpermanent.

8. Metals such as Ⓐ lead Ⓑ tin Ⓒ zinc Ⓓ aluminum do strain harden when deformed at room temperature.

9. Ⓐ {100}<111> Ⓑ {110}<110> Ⓒ {111}<110> Ⓓ {110}<111> is the slip system for the FCC crystal structure.

(背面仍有題目,請繼續作答)

※ 考生請注意：本試題 ☑可　□不可　使用計算機

10. Ⓐ Ductility Ⓑ Toughness Ⓒ Hardness Ⓓ Elasticity　is a measure of the resistance of a metal to permanent deformation.

11. Which one of the following is Gibbs phase rule? P: Phase, F: Freedom degree, C: Composition, N: Number of noncompositional variables. Ⓐ P+C = F+N Ⓑ P-N = C+F Ⓒ P+F = C+N Ⓓ P-F = C+N

12. Which one of the following materials has a lamellae microstructure? Ⓐ Austenite Ⓑ Pearlite Ⓒ Matensite Ⓓ Bainite

13. Which one of the following phases is formed by diffusionless transformation? Ⓐ Pearlite Ⓑ Martensite Ⓒ Bainite Ⓓ Austenite

14. In comparison with the thermoset and thermoplastic polymers, which one is the advantage of thermoplastic? Ⓐ easier process Ⓑ better solvent resistance Ⓒ better heat resistance Ⓓ better cool process

15. Which one of the following materials has the highest specific heat? Ⓐ Zirconium Ⓑ Graphite Ⓒ Diamond Ⓓ Phenolic

16. What is the material most commonly used for optical fiber? Ⓐ Silica Ⓑ Carbon Ⓒ As Ⓓ Ge

17. Which one of the following polymers characteristic has linear and branched structure; they soften when heated and harden when cooled? Ⓐ thermoplastic Ⓑ thermosetting Ⓒ random copolymer Ⓓ graft copolymer

18. Which one of the following materials has a chain structure? Ⓐ Ceramic Ⓑ Glass Ⓒ Polymer Ⓓ Metal

19. When type of defect found in AX materials is a cation vacancy-anion vacancy pair, which type is it? Ⓐ Frenkel defect Ⓑ Schottky defect Ⓒ Vacancy Ⓓ Dislocation

20. Which one of the following can form the carbon nanotubes structure? Ⓐ heptagon carbon + hexagon carbon Ⓑ hexagon carbon Ⓒ pentagon carbon + heptagon carbon Ⓓ pentagon carbon + hexagon carbon

系所組別： 材料科學及工程學系

考試科目： C科目　　　　　　　　　　　　　　　　考試日期：0219，節次：3

※ 考生請注意：本試題 ☑可 □不可 使用計算機

21. Metals rarely elongate plastically to more than 100 %, but some elastic polymers may experience elongations to as much as 1000 % like Ⓐ polyethylene Ⓑ polystyrene Ⓒ polymethyl methacrylate Ⓓ polyester.

22. In the process of deformation for a semicrystalline polymer, at the upper yield point, the chains become Ⓐ random Ⓑ grain refining Ⓒ entangled Ⓓ oriented, which leads to strengthening.

23. Some polymers respond with an instantaneous elastic strain as stressed, then followed by a time-dependent strain. The behavior is a form of Ⓐ elastic Ⓑ viscous Ⓒ anelastic Ⓓ plastic, deformation.

24. At point of Ⓐ Tm Ⓑ Tg Ⓒ Tc Ⓓ Tv, the polymer behaves like soft leathery, that is, deformation will be time dependent and not totally recoverable on release of an applied load.

25. As a general rule, the mode of fracture in thermosetting polymers is Ⓐ tough Ⓑbrittle Ⓒ ductile Ⓓ soft.

26. For silicon rubbers, the backbone carbon chain is replaced by a chain that alternates silicon and Ⓐ oxygen Ⓑ nitrogen Ⓒ sulfur Ⓓ hydrogen

27. For a large particle composite, its modulus of elasticity is usually Ⓐ higher Ⓑ equal Ⓒ lower Ⓓ better comparing to the values calculated from rule of mixture.

28. Automobile tires contain on the order of 15 to 30 vol% of carbon black with diameters of Ⓐ 30 μm Ⓑ 3μm Ⓒ 30 nm Ⓓ 30 Å.

29. The concrete is reinforced with Ⓐ carbon steel Ⓑ stainless steel Ⓒ alloy steel Ⓓ carbon fiber to increase the tensile strength and avoid corrosion during probably 40 years application.

30. A continuous and aligned glass fiber-reinforced composite consists of 40 vol% of glass fibers having a modulus of elasticity of 69 GPa and 60 vol% of a polyester resin that, when hardened, displays a modulus of 3.4 GPa, then the modulus of elasticity of this composite in the longitudinal direction is Ⓐ 69 GPa Ⓑ 3.4 GPa Ⓒ 30 GPa Ⓓ 60 GPa.

(背面仍有題目,請繼續作答)

系所組別： 材料科學及工程學系

考試科目： C科目　　　　　　　　　　　　　　　　　考試日期：0219，節次：3
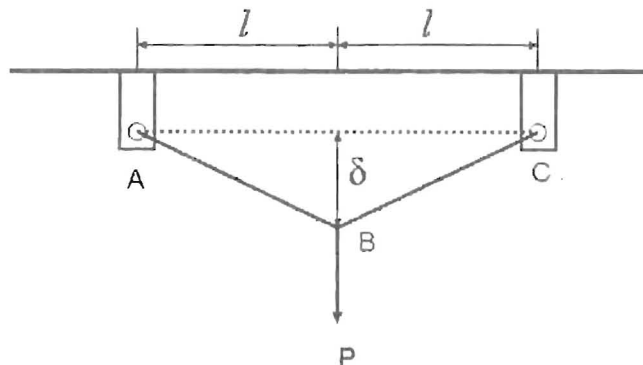
※ 考生請注意：本試題 ☑可　□不可 使用計算機

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 0.5 分。

31. The uniform wire ABC, of unstretched length $2l$ is applied with a vertical load P at the midpoint B. The cross-sectional area of the wire is denoted by A and the modulus of elasticity by E. Assuming $\delta \ll l$, the ratio of δ/l at the midpoint B is Ⓐ $\sqrt[3]{\dfrac{AE}{P}}$　Ⓑ $\sqrt{\dfrac{P}{AE}}$　Ⓒ

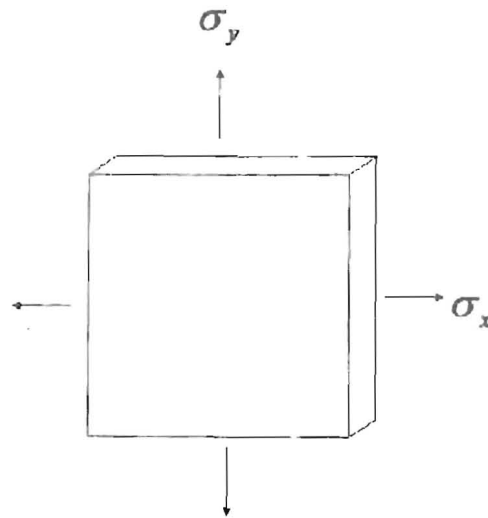$\sqrt{\dfrac{AE}{P}}$　Ⓓ $\sqrt[3]{\dfrac{P}{AE}}$.

32. In the case of the thin plate, if the strains and are experimentally given, determine the stress and strain states in the thin plate. Ⓐ $\sigma_y = E\dfrac{\varepsilon_x + v\varepsilon_y}{1-v^2}$　Ⓑ $\varepsilon_z = -\dfrac{v}{1-v}\left(\varepsilon_x - \varepsilon_y\right)$　Ⓒ

$\sigma_x = E\dfrac{\varepsilon_y + v\varepsilon_x}{1-v^2}$　Ⓓ $\sigma_z = E\dfrac{\varepsilon_z + v\varepsilon_y}{1-v^2}$.

系所組別： 材料科學及工程學系

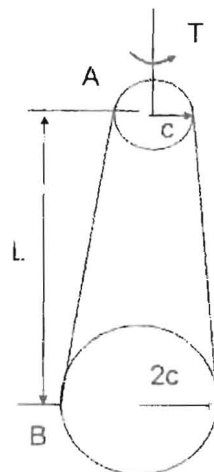考試科目： C科目　　　　　　　　　　　　　　　　　　　　考試日期：0219，節次：3

※ 考生請注意：本試題 ☑可　□不可 使用計算機

33. A pipe with 200 mm outside diameter is made by bending a plate of 10 mm thickness and then butt welding the plate along a helix forming an angle of 45° with the longitudinal axis. Knowing that the allowable tensile stress in the weld is 85 MPa, determine the largest torque applied to the pipe. Ⓐ 34.7 kNm　Ⓑ 45.9 kNm Ⓒ 58.3 kNm Ⓓ 61.6 kNm.

34. A torque T is applied to a solid tapered shaft AB. Determine the angle of twist at A　Ⓐ

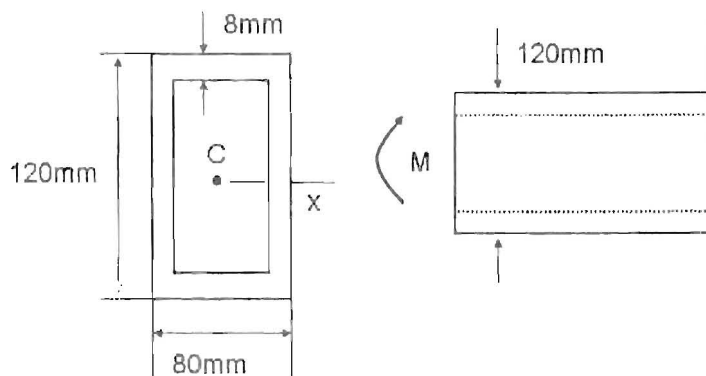$$\phi_A = \frac{7TL}{12\pi Gc^4} \quad \text{Ⓑ} \quad \phi_A = \frac{7TL^2}{12\pi Gc^4} \quad \text{Ⓒ} \quad \phi_A = \frac{12TL}{7\pi Gc^4} \quad \text{Ⓓ} \ \phi_A = \frac{12TL^2}{7\pi Gc^4}.$$

※ 考生請注意：本試題 ☑可　□不可　使用計算機

35. The rectangular tube is extruded from an aluminum alloy for which $\sigma_Y = 150$ MPa, $\sigma_U = 300$ MPa and $E = 70$ GPa. What is correct using the factor of safety = 3.0? Ⓐ Moment of inertia $I = 3.21 \times 10^{-5}$ m^4 Ⓑ allowable stress $\sigma_{all} = 50$ MPa Ⓒ bending moment $M = 9.2$ kN.m Ⓓ the radius of curvature of the tube $\rho = 38$ m.

36. The beam having a rectangular cross section. is supported two loads at both ends. What is not correct? Ⓐ Point A is supported to pure bending. Ⓑ Point B is supported to pure bending. Ⓒ The moment at point A is not equal to zero. Ⓓ The vertical force at point B is equal to zero.
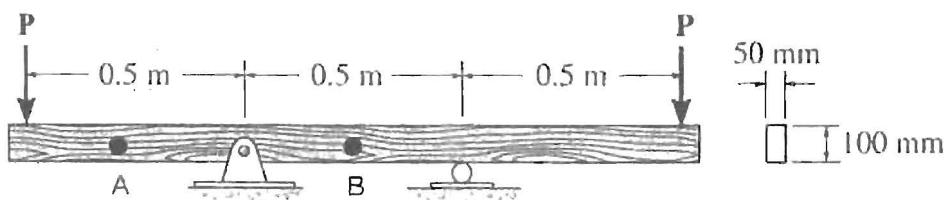
37. A point on the surface of a cylindrical pressure vessel is subjected to the state of plane stress with $\sigma_1 = 64$ MPa and $\sigma_2 = 32$ MPa. Determine the absolute maximum shear stress σ_{max} at this point. Ⓐ 64MPa Ⓑ 32MPa Ⓒ 16MPa Ⓓ 8MPa.

38. A thin-walled spherical pressure vessel having an inner radius r and thickness t is subjected to an internal pressure p. Determine the increase in the volume within the vessel ΔV. Ⓐ $\dfrac{p\pi r^4}{Et(1-v)}$ Ⓑ $\dfrac{2p\pi r^4}{Et(1-v)}$ Ⓒ $\dfrac{2E\pi r^4}{pt(1-v)}$ Ⓓ $\dfrac{E\pi r^4}{pt(1-v)}$.

※ 考生請注意：本試題 ☑可 □不可 使用計算機

39. A 3.6m long beam AC has a 2.4 m span AB. Assuming the width of the beam is given by 90mm and a 12 MPa stress is allowed, what is correct for the following values? Ⓐ V_A vertical force at point A = -17.2 kN Ⓑ V_B vertical force at point B = -2.8 kN Ⓒ the absolute maximum bending moment M_{max} = 24kN.m Ⓓ the minimum required depth of the beam is 254mm.
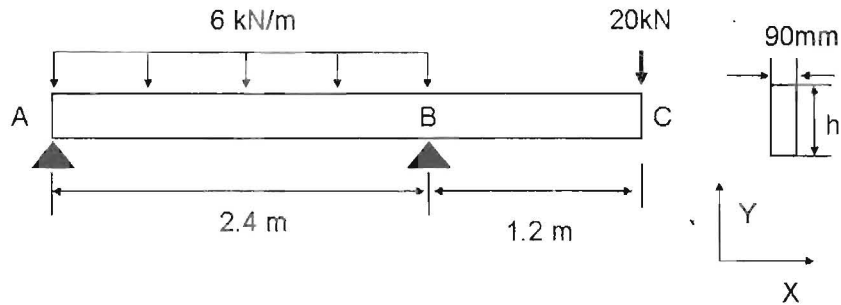
40. A point on a thin plate is subjected to two successive states of stress. Determine the resulting state of stress in terms of reference at the bottom. Ⓐ $\sigma_{x'}$ =130MPa Ⓑ $\sigma_{y'}$ = 40MPa Ⓒ $\sigma_{x'} + \sigma_{y'} = 170$MPa Ⓓ $\tau_{x'y'} = 30$MPa.
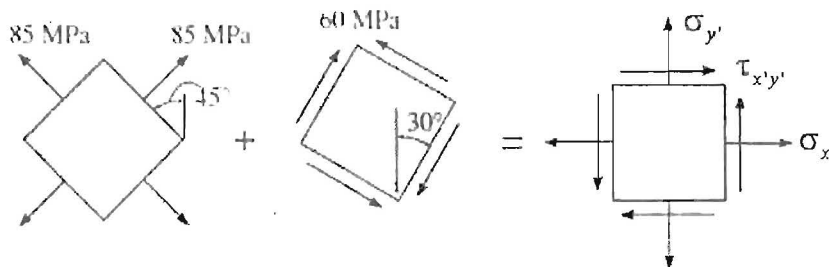
41. From the feature of a stress-strain curve, the area under the entire stress-strain curve from zero to rupture gives the property known as Ⓐ modulus of toughness Ⓑ modulus of resilience Ⓒ modulus of plasticity Ⓓ modulus of rigidity.

42. The stresses in a cylindrical vessel subjected to uniform internal pressure commonly indicated that the stress on a longitudinal plane is Ⓐ equal Ⓑ twice Ⓒ three times Ⓓ four times the stress on a transverse plane.

43. Stress concentration is not significant in the case of static loading of a ductile material because the material will Ⓐ fracture Ⓑ crack Ⓒ yield Ⓓ deform inelastically in the region of high stress.

※ 考生請注意：本試題 ☑可 □不可 使用計算機

44. A typical thin-walled spherical pressure vessel used for gas storage, if the weights of the gas and vessel are negligible, symmetry of loading and geometry requires that stresses on sections that pass through the center of the sphere is Ⓐ zero Ⓑ equal Ⓒ larger Ⓓ smaller

45. A graphical representation is useful because it enables you to visualize the relationships between the normal and shear stresses acting on various inclined planes, that the plane stress can be represented by a plot known as Ⓐ stress-strain diagram Ⓑ shear force diagram Ⓒ bending-moment diagram Ⓓ Mohr's circle.

二、非選擇題（請以原子筆在非選擇題答案紙上標明題號作答）

科目名稱：工程數學 （每題 5 分）

46. Find the general solutions of a Second Order Homogeneous Linear ODE with constant coefficient, $y'' + ay' + by = 0$

47. The Laplacian of u in polar coordinates is

$$\nabla^2 u = \frac{\partial^2 u}{\partial r^2} + \frac{1}{r}\frac{\partial u}{\partial r} + \frac{1}{r^2}\frac{\partial^2 u}{\partial r\theta^2}$$

Show that an alternative form is

$$\nabla^2 u = \frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial u}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 u}{\partial r\theta^2}$$

48. It is known that $y' = y$, and $y(0) = 1$, please calculate the value of y(2).

49. It is known that $\frac{d^2 v_z}{dy^2} = a$, and $\frac{d v_z}{dy}(L) = 0$, $v_z(0) = 0$, please calculate for the expression of v_z.

50. Expand $e^{i\theta}$ as a function of $\sin\theta$ and $\cos\theta$, where $i = \sqrt{-1}$ and $-\infty < \theta < \infty$. Show the details of your derivation.

51. Fit a straight line to the given points of $(x, y) = (0, 1.1)$ and $(2, 2.9)$ by the method of least squares.