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 system of $y' = \begin{bmatrix} 0 & 1 \\ -4 & 0 \end{bmatrix} y$ has a

Ⓐ proper node Ⓑ improper node Ⓒ saddle point Ⓓ center.

2. The solution of $y' - y = e^{2x}$ is

Ⓐ $y = e^{-2x} + ce^{x}$ Ⓑ $y = e^{2x} + ce^{-x}$

Ⓒ $y = e^{2x} + ce^{x}$ Ⓓ $y = e^{2x} - ce^{x}$

3. The Bessel function of $J_{3/2}(x)$ is equal to

Ⓐ $\sqrt{\frac{2}{\pi x}}(\frac{\sin x}{x} + \cos x)$ Ⓑ $\sqrt{\frac{2}{\pi x}}(\frac{\cos x}{x} - \sin x)$

Ⓒ $\sqrt{\frac{2}{\pi x}}(\frac{\cos x}{x} + \sin x)$ Ⓓ $\sqrt{\frac{2}{\pi x}}(\frac{\sin x}{x} - \cos x)$

4. What is the definition of Ordinary Differential Equation (ODE)?

Ⓐ an equation containing no derivatives of dependent variable(s).

Ⓑ an equation contains only ordinary derivatives of dependent variable(s) with respect to a single independent variable.

Ⓒ an equation involving partial derivatives of dependent variable(s) of two or more independent variables

Ⓓ an equation involving ordinary derivatives of dependent variable(s) of two or more independent variables

5. Which of the following Laplace transform is <u>INCORRECT</u>:

Ⓐ $L\{t\} = \frac{1}{s^2}$ Ⓑ $L\{e^{at}\} = \frac{1}{s-a}$

Ⓒ $L\{\cos\omega t\} = \frac{s}{s^2+\omega^2}$ Ⓓ $L\{e^{at}\sin\omega t\} = \frac{s-a}{(s-a)^2+\omega^2}$

（背面仍有題目,請繼續作答）

6. Say $M=\begin{pmatrix}5 & 8\\ 1 & 0\\ 2 & 7\end{pmatrix}$ and $N=\begin{pmatrix}-4 & -3\\ 2 & 0\end{pmatrix}$. Please find out $MN=$

Ⓐ $\begin{pmatrix}-36 & -15\\ -4 & -3\\ -22 & -6\end{pmatrix}$ Ⓑ $\begin{pmatrix}-20 & 1\\ -4 & -3\\ -8 & 8\end{pmatrix}$

Ⓒ $\begin{pmatrix}-4 & -15\\ -4 & -3\\ 6 & -6\end{pmatrix}$ Ⓓ $\begin{pmatrix}-20 & -31\\ -4 & -3\\ -8 & -22\end{pmatrix}$

7. A damped oscillation system can be expressed by a differential equation $my''+cy'+ky=0$.

If the system under goes a underdamping condition, the differential equation must satisfy :

Ⓐ $\frac{c^2}{4m}=k$ Ⓑ $\frac{c^2}{4m}\neq k$ Ⓒ $c^2>4mk$ Ⓓ $c^2<4mk$

8. $\tau_{xz}^{I}=(\frac{p_o-P_L}{L})x+C_1^{I}$; $\tau_{xz}^{II}=(\frac{p_o-P_L}{L})x+C_1^{II}$

It is known that $\tau_{xz}^{I}=-\mu^{I}\frac{\partial v_z^{I}}{\partial x}$, $\tau_{xz}^{II}=-\mu^{II}\frac{\partial v_z^{II}}{\partial x}$ and the boundary conditions are as follows.

B.C. 1: x=0, $\tau_{xz}^{I}=\tau_{xz}^{II}$

B.C. 2: x=0, $v_z^{I}=v_z^{II}$

B.C. 3: x=-b, $v_z^{I}=0$

B.C. 4: x=+b, $v_z^{II}=0$

Then $v_z^{I}=$

Ⓐ $\frac{(P_0-P_L)b^2}{2\mu^{I}L}\left[(\frac{2\mu^{I}}{\mu^{I}+\mu^{II}})+(\frac{\mu^{I}-\mu^{II}}{\mu^{I}+\mu^{II}})(\frac{x}{b})-(\frac{x}{b})^2\right]$

Ⓑ $\frac{(P_0-P_L)b^2}{\mu' L}\left[\left(\frac{2\mu'}{\mu'+\mu''}\right)+\left(\frac{\mu'-\mu''}{\mu'+\mu''}\right)\left(\frac{x}{b}\right)-\left(\frac{x}{b}\right)^2\right]$

Ⓒ $\frac{(P_0-P_L)b^2}{2\mu' L}\left[\left(\frac{\mu'}{\mu'+\mu''}\right)+\left(\frac{\mu'-\mu''}{\mu'+\mu''}\right)\left(\frac{x}{b}\right)-\left(\frac{x}{b}\right)^2\right]$

Ⓓ $\frac{(P_0-P_L)b^2}{\mu' L}\left[\left(\frac{\mu'}{\mu'+\mu''}\right)+\left(\frac{\mu'-\mu''}{\mu'+\mu''}\right)\left(\frac{x}{b}\right)-\left(\frac{x}{b}\right)^2\right]$

9. A pressure distribution is as follows. $P_b\big|_{r=R}=P_0-\rho g R\cos\theta$

It is known that $F_{n,b}=\int_0^{2\pi}\int_0^{\pi}(-P_b\big|_{r=R}\cos\theta)R^2\sin\theta d\theta d\phi$. Then $F_{n,b}=$

Ⓐ $\frac{4}{3}\pi R^3\rho g$ Ⓑ $\frac{2}{3}\pi R^3\rho g$

Ⓒ $\frac{2}{3}\pi R^2\rho g$ Ⓓ $\frac{4}{3}\pi R^2\rho g$

10. A friction drag can be calculated in the following way $F_t=\int_0^{2\pi}\int_0^{\pi}\left(\tau_{r\theta}\big|_{r=R}\sin\theta\right)R^2\sin\theta d\theta d\phi$,

where $\tau_{r\theta}\Big|_{r=R}=\frac{3}{2}\frac{\eta v_\infty}{R}\sin\theta$.

It is also known from the Table of Integrals that $\int\sin^3 x dx=-\frac{1}{3}\cos x(\sin^2 x+2)$.

Then $F_t=$

Ⓐ $3\eta v_\infty R^2$ Ⓑ $2\eta v_\infty R^2$

Ⓒ $3\eta v_\infty R$ Ⓓ $4\eta v_\infty R$

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. Materials that exhibit considerable ductility beyond the proportional limit generally offer much greater resistance to impact loads than do brittle materials. Also, bars with grooves, holes, and other forms of stress concentration that against impact are very.
Ⓐ weak Ⓑ ductile Ⓒ strong Ⓓ hard

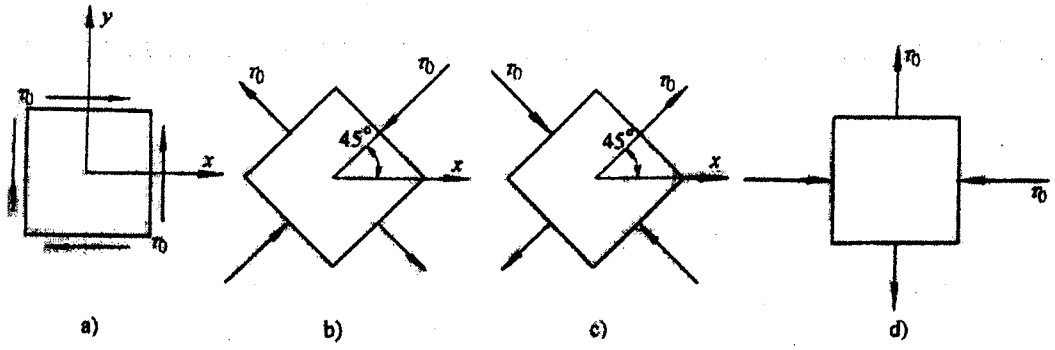
12. The magnitude of the load causing a fatigue failure is
Ⓐ more Ⓑ less Ⓒ equal Ⓓ without influence
than load that can be sustained statically.

13. Beams with holes, notches, or other abrupt changes in dimensions, whenever such discontinuities exist, the factor can be extremely important when a member is made of brittle material or is subjected to dynamic loads is
Ⓐ shear Ⓑ bending
Ⓒ torsion Ⓓ stress concentrations.

14. A rectangular element with a length side of a, when a pure shear is applied, the elongation of the diagonal line is a/2000. Determine the shear stress τ, assuming the shear modulus G = 80GPa.
Ⓐ 10.5 MPa Ⓑ 22.56 MPa Ⓒ 56.6 MPa Ⓓ 82.6 MPa.

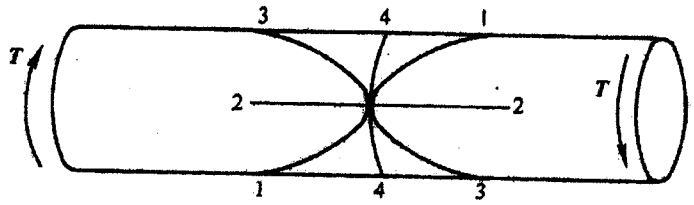
15. The normal flexural stress on a transverse plane is given as $\sigma = \frac{My}{I}$ for a beam which is subjected to bending. The second moment of area "I" is with respect to an axis. The axis is called as
Ⓐ the central axis Ⓑ the neural axis
Ⓒ the symmetrical axis Ⓓ the center of gravity.

16. Determine the following stress states which are equal. (see figure in the next page)
Ⓐ a = b = c = d Ⓑ a = b Ⓒ b = c Ⓓ a = c



17. A cast iron is subjected a torque T as shown below. Determine the fracture section in which direction.

Ⓐ 1-1　　Ⓑ 2-2　　Ⓒ 3-3　　Ⓓ 4-4.



18. Which of the following average values of elastic constants is apparently incorrect?

	Young's Modulus (Modulus of Elasticity)	Shear Modulus (Modulus of Rigidity)
Aluminum Alloys	72 GPa	28 GPa
Structural Steel	200 GPa	136 GPa

Ⓐ Young's modulus of aluminum alloys;
Ⓑ shear modulus of aluminum alloys;
Ⓒ Young's modulus of structural steel;
Ⓓ shear modulus of structural steel.

19. A prismatic bar, which has the Poisson's ratio equal to 0.28, is loaded by an axial force to deform elastically with axial strain ε_a. The dilatation of the prismatic bar is

Ⓐ 0.28 ε_a ;　　Ⓑ 0.44 ε_a ;　　Ⓒ 0.56 ε_a ;　　Ⓓ 0.

20. In a plane stress deformation, the two normal stresses σ_x and σ_y in certain x-y Cartesian coordinate system are 20 ksi and -30 ksi, respectively. Knowing one principal stress as 45 ksi, the other one is then

Ⓐ -55 ksi;　　Ⓑ -50 ksi;　　Ⓒ -65 ksi;　　Ⓓ -60 ksi.

（背面仍有題目,請繼續作答）

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。

21. Which one of the following is called for Fe_3C?
Ⓐ pearlite Ⓑ austenite Ⓒ ferrite Ⓓ cementite

22. Steels in which carbon is the prime alloying element are termed?
Ⓐ alloy steels Ⓑ pain carbon steel Ⓒ stainless steel Ⓓ cast iron

23. Assume ρ is the electrical resistivity, R is the electrical resistance of the material through which the current is passing, ℓ is the distance between the two points at which the voltage is measured, A is the cross-sectional area perpendicular to the current the correlation among ρ, R, ℓ, A, can be expressed as

Ⓐ $\rho = \ell RA$ Ⓑ $\rho = \frac{\ell}{RA}$ Ⓒ $\rho = R\frac{\ell}{A}$ Ⓓ $\rho = \frac{RA}{\ell}$

24. Assume μ_e is the electron mobility, σ is the conductivity of material, n is the number of free electron per unit volume, $|e|$ is the absolute magnitude of the electrical charge on an electron. The correlation among σ, n, μ_e, $|e|$ can be express as

Ⓐ $\sigma = n|e|\mu_e$ Ⓑ $\mu_e = n|e|\sigma$ Ⓒ $\sigma = \frac{1}{n|e|\mu_e}$ Ⓓ $\sigma = \frac{\mu_e}{n|e|}$

25. Assume p is the number of phases present, F is the number of degrees of freedom, C is the number of components in the system, N is the number of noncompositional variable, the Gibbs phase rule can be expressed as
Ⓐ P+C = F+N Ⓑ P+N = F+C Ⓒ P+F = C+N Ⓓ P = F+C+N-1

26. A maximum concentration of solute atoms that may dissolve to form a solid solution is called
Ⓐ Solvent limit Ⓑ Eutectic point Ⓒ Precipitation limit Ⓓ Solubility limit

27. The alignment of permanent or induced atomic or molecular dipole moments with an external electric field is called
Ⓐ Capacity Ⓑ Polarization Ⓒ Magnetic Ⓓ Dipole moment

28. The mechanical characteristics of a fiber-reinforced composite depend on

Ⓐ Fiber length Ⓑ Fiber orientation Ⓒ Fiber type Ⓓ All of above

29. Assume E is the modulus of elasticity. The theoretical cohesive strength of a brittle elastic solid is approximately

Ⓐ E/10 Ⓑ E×10 Ⓒ E×100 Ⓓ E×1000

30. Assume σ_m is the maximum stress at the crack tip, a is the half length of an internal crack, ρ_t is the radius of curvature of crack tip. The correlation among σ_m, ρ_t, a can be expressed as

Ⓐ $\sigma_m \propto (a\rho_t)^{1/2}$ Ⓑ $\sigma_m \propto (a/\rho_t)^{1/2}$ Ⓒ $\sigma_m \propto (\rho_t/a)^{1/2}$ Ⓓ $\sigma_m \propto (1/a\rho_t)^{1/2}$

31. Assume ℓ_c is the critical length on the fiber, d is the diameter of fiber, σ_f^* is the ultimate strength, τ_c is fiber-matrix bond strength. The critical length among $\ell_c, d, \sigma_f^*, \tau_c$ can be expressed as

Ⓐ $\ell_c = 2\sigma_f^* d\tau_c$ Ⓑ $\ell_c = \frac{2d\tau_c}{\sigma_f^*}$ Ⓒ $\ell_c = \frac{2\sigma_f^*\tau_c}{d}$ Ⓓ $\ell_c = \frac{\sigma_f^* d}{2\tau_c}$.

32. Optical fibers for communications are made by

Ⓐ silica glass Ⓑ graphite Ⓒ plastics Ⓓ sapphire.

33. Two edge dislocations which are side by side at the same slip plane with opposite Burgers factor will

Ⓐ Attract each other Ⓑ Release stress in grain
Ⓒ Disappear finally Ⓓ All of above

34. By vulcanization to strengthen polymer, what kind of bonding is required in the polymer chain?

Ⓐ C=C Ⓑ C-C Ⓒ C-H Ⓓ None of above.

35. FCC slip plane is

Ⓐ {111} Ⓑ {110} Ⓒ {211} Ⓓ {321}

36. Ductile fracture is seldom seen in

Ⓐ Metal Ⓑ Ceramics Ⓒ Polymer Ⓓ None of above.

37. In September 11, 2001(911), a terrible attack happened on the building World Trade Center

（背面仍有題目，請繼續作答）

in New York City which is composed **of steel truss**. The building was burning **under high temperature** and then crushed down under **gravity of earth**. Who did help the terrorist destroy the building?

Ⓐ Creep Ⓑ Fatigue
Ⓒ The building designer Ⓓ None of above.

38. Liquid phase alloy is cooled below eutectic point. What kind of phase will form?

Ⓐ Mixture of two solid phases Ⓑ Mixture of liquid and solid phases
Ⓒ Single solid phase Ⓓ None of above.

39. In binary phase diagram, what can not be observed?

Ⓐ Two lines cross together Ⓑ Three lines cross together
Ⓒ Five lines cross together Ⓓ Line parallel to the composition axis.

40. Cementite is a

Ⓐ Intermediate compound Ⓑ Alloy of carbon and iron
Ⓒ Mixture of iron and intermediate Ⓓ None of all

41. A ceramic composite material consists of 30 volume % SiC whiskers in an Al_2O_3 matrix. Estimate the theoretical density (TD) if SiC has a crystallographic density of 3.22 g/cm^3 and Al_2O_3 has a crystallographic density of 3.95 g/cm^3.

Ⓐ 2.937 Ⓑ 3.948 Ⓒ 3.731 Ⓓ 4.245

42. What is the typical microstructure of a quenched plain medium carbon steel?

Ⓐ fine pearlite Ⓑ coarse pearlite Ⓒ martensite Ⓓ austenite.

43. What are the densest-packed planes in the FCC structure?

Ⓐ [100] Ⓑ $[1\bar{1}0]$ Ⓒ [111] Ⓓ none of the above.

44. What are the closest-packed directions in the HCP structure?

Ⓐ $(11\bar{2}0)$ Ⓑ (0001) Ⓒ (1101) Ⓓ none of the above.

45. How many atoms per unit cell are there in the FCC crystal structure?

Ⓐ 4 Ⓑ 6 Ⓒ 8 Ⓓ 12

46. A high-molecular-weight polypropylene has an average molecular weight of 42000 g/mol. What is its average degree of polymerization?

Ⓐ 1750 Ⓑ 1500 Ⓒ 1000 Ⓓ 800 mers.

47. Which noble gas would be expected to have the strongest dipole bonding ?
Ⓐ Argon Ⓑ Krypton Ⓒ Xenon Ⓓ Neon.

48. What is the electron configuration of the Cu^{2+} ion? (atomic number of copper: 29)
Ⓐ $[Ar]3d^9 4s^2$ Ⓑ $[Ar]3d^9 4s^1$ Ⓒ $[Ar]3d^9$ Ⓓ $[Ar]3d^7 4s^2$

49. A
Ⓐ phonon Ⓑ photon Ⓒ permittivity Ⓓ permeability
is a discrete amount or quantum of energy in the form of electromagnetic radiation.

50. Which element is the most electronegative according to the electronegativity scale?
Ⓐ Oxygen Ⓑ Nitrogen Ⓒ Fluorine Ⓓ Chlorine