國立中山大學102學年度轉學考招生考試試題

科目名稱：微積分【光電系二年級】　　題號：735001

※本科目依簡章規定「不可以」使用計算機　　

答題時，每題須寫下題號與詳細步驟。 請依題號順序作答，不會作答題目請寫下題號並留空白。

1. (20%) Evaluate the derivative at the indicated point.

   (a) $f(x) = \dfrac{1-\sec x}{\tan x}$ at $(\pi/3, -1/\sqrt{3})$.　　(b) $f(x) = 2^{x^2+x}$ at $(1,4)$.

   (c) $\arctan xy = \pi x/4$ at $(1,1)$.　　(d) $f(x) = \displaystyle\int_x^{x^2} t^3 e^{t^2}\, dt$ at $x = 2$.

2. (30%) Evaluate

   (a) $\displaystyle\int_1^2 \frac{2x}{\sqrt{x+1}}\, dx$.　　(b) $\displaystyle\int_{\pi/2}^{\pi} \sin 2x \cos 3x\, dx$.

   (c) $\displaystyle\int_2^{\infty} \frac{1}{x\sqrt{x^2-1}}\, dx$.　　(d) $\displaystyle\int_{-1}^{1} \frac{3x^3-5x^2-2x+5}{(x-2)^2(x^2+1)}\, dx$.

   (e) $\displaystyle\int_2^{\infty} \frac{\operatorname{arcsec} x}{x^2}\, dx$.　　(f) $\displaystyle\int_0^{\pi/4} \left[\left(\frac{\csc x}{\cot^2 x}\right)\mathbf{i} + \left(\tan^3 x \sec^4 x \mathbf{j}\right)\right] dx$.

3. (10%) Find a and b such that $f(x) = \begin{cases} x^2 \sin\left(\dfrac{1}{x}\right) + b, & x > 0 \\ (x+a)(x-2), & x \le 0 \end{cases}$ is differentiable on $\mathbb{R}$.

4. (10%) Find the volume of solid bounded below by the surface $z = \sqrt{x^2+y^2}$ and above by the surface $z = \sqrt{3-2x^2-2y^2}$.

5. **(a)** (10%) Determine the relative extrema of $f(x,y) = x^3 - y^2 - 3x + y$, where $x, y \in \mathbb{R}$.

   (b) (10%) Find the minimum value of $f(x,y) = e^{xy}$ subject to the constraint $x^2 + y^2 = 4$.

6. (10%) Evaluate the double integral $\displaystyle\int\int_R xye^{xy}\, dA$, where R is inside the first-quadrant region lying between the graphs of

$$y = x,\ y = 2x,\ xy = 1,\ xy = 3.$$

～全卷完～

國立中山大學102學年度轉學考招生考試試題

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◎請在答案卷上標明選擇題題號與答案如下：

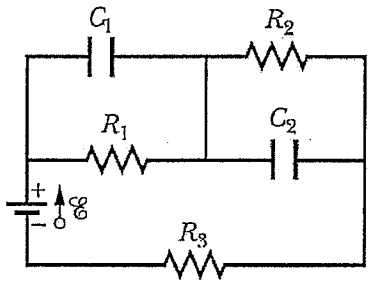
1._____ 2._____ 3._____ 4._____ 5._____ 6._____.

7._____ 8._____ 9._____ 10._____ 11._____ 12._____.

13._____ 14._____ 15._____ 16._____ 17._____.

一、單選題(每題 5 分，不倒扣)：

1. A particle with a mass of 1 kg is acted on by two forces, $\mathbf{F}_1$ and $\mathbf{F}_2$ and accelerates at $5\mathbf{i} - 5\mathbf{j} + 3\mathbf{k}$ (m/s^2). If $\mathbf{F}_1 = -\mathbf{i} + 2\mathbf{j} + 6\mathbf{k}$ (N), then $\mathbf{F}_2$= (A) $2\mathbf{i} - 7\mathbf{j} - 3\mathbf{k}$, (B) $2\mathbf{i} - 5\mathbf{j} + 5\mathbf{k}$, (C) $\mathbf{F}_2 = 6\mathbf{i} - 5\mathbf{j} + 5\mathbf{k}$, (D) $\mathbf{F}_2 = 6\mathbf{i} - 7\mathbf{j} - 3\mathbf{k}$, (E) $\mathbf{F}_2 = 2\mathbf{i} - 5\mathbf{j}$ (N).
2. If a particle moves along the x-axis according to the equation $3t = x^2 + 4x + 1$, where x is the position in meter and t is the time in second, what is its speed at x =1.0 m?
(A) 2.0, (B) 1.5, (C) 1, (D) 0.5, (E) 0.1 ms^{-1}.
3. Which in the following does *not* represent the dimension of force?
(A) ma, (B) kx, (C) qE, (D) qB, (E) mv^2/x, (m: mass, x: position, v: speed, a: acceleration, k: force constant, q: charge, E:electric field, B: magnetic induction).
4. A solid wheel with mass M, radius R, rolls *without sliding* on a horizontal surface and its rotational inertia is $MR^2/2$. If the center of mass is accelerating at a. Find the applied force F acting on the *axle* and the frictional force f on the wheel surface. (F, f) =
(A) (Ma, 0), (B) (Ma, $Ma/2$), (C) ($2Ma$, Ma), (D) ($2Ma$, $Ma/2$), (E) ($3Ma/2$, $Ma/2$).
5. A wheel takes 3.00 s to rotate 36.0 rounds. Its angular speed at the end of the 3.00-s interval is 27.0 π rad/s. What is the constant angular acceleration of the wheel?
(A)2.0, (B) 1.0, (C) 3.0, (D) 0.5, (E) 4.0 ($rad \cdot s^2$).
6. A charge of 10 C is first put on a spherical conducting shell and then another point charge of −3 C is put at the center. Find the net charge on the outer surface of the shell:
(A) −7 C, (B) −3 C, (C) 0 C, (D) +3 C, (E) +7 C.
7. A capacitor of capacitance C and an inductor of inductance L are connected on both ends, the resonance angular frequency is:
(A) LC, (B) $(LC)^{1/2}$, (C) $(LC)^2$, (D) $(1/LC)^{1/2}$, (E) L/C.
8. A magnetic field B passing in perpendicular through a square wire loop of area A. The magnetic flux through the loop is: (A) 0, (B) $BA/2$, (C) BA, (D) $2BA$, (E) $3BA$.
9. In the right figure, R_1=5 Ω, R_2=10 Ω, R_3= 15 Ω, C_1 = 5 μF, C_2 = 10 μF and the ideal battery has an emf $\mathscr{E}$= 20 V. In steady state, the total energy stored in the two capacitors is: (A) 2.78×10^{-5}, (B) 1.12×10^{-4}, (C) 2.22×10^{-4}, (D) 2.50×10^{-4}, (E) 4.72×10^{-4} (J).



10. A monochromatic light (λ = 560 nm) is incident on a thin film with refractive index n = 1.40. How thick must the film be in order for destructive interference to occur when reflected? (A) 100, (B) 200, (C) 150, (D) 250, (E) 50 (nm).
11. Assume the pupil diameter is 0.50 cm and n = 1.22 for the naked eye. What is the maximal distance if one is to distinguish between two blue lights (λ = 500 nm) separated by 1.5 m?
(A) 6.0, (B) 12, (C) 9.0, (D) 3.0, (E) 15 (km).
12. For diffraction of waves by a single slit of width a at a distance D from the screen, which is right?
(A) the first maximum occurs at $a\sin\theta = \lambda$, (B) smaller a will result in larger separations between minima, (C) the intensity of each maximum is the same, (D) the diffraction is more easily observed for lights of shorter wavelength than those of longer wavelength, (E) the first maximum occurs at $a\sin\theta = \lambda/2$.

背面有題

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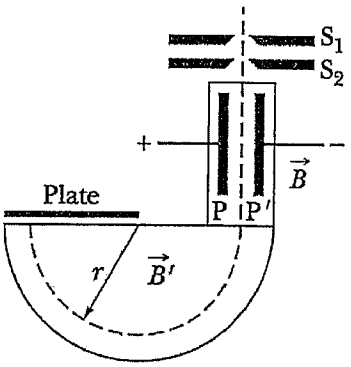
二、複選題(每題 6 分，答錯倒扣)：

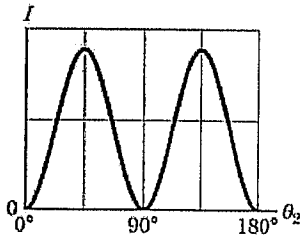
13. Two charged particles of the same charge q but different massed m_1 and m_2 are accelerated by a potential difference V. They then enter a uniform field B' following a circular path, as illustrate to the right. Select the correct answers:
(A) The kinetic energy is qVB' for both particles, (B) the speed of m_1 is $(2qV/m_1)^{1/2}$, (C) the radius of the path in B' for m_2 is $(m_2V/qB'^2)^{1/2}$, (D) $r_1/r_2 = (m_2/m_1)^{1/2}$, (E) $r_1/r_2 = (m_1/m_2)^{1/2}$.



14. A solid sphere of radius R has a volume charge density $\rho = \alpha r/R$, where r is radial distance from the sphere's center.
(A) The Gaussian law cannot be applied in this case, (B) the sphere's total charge is $\alpha\pi R^3$, (C) the magnitude of the electric field at $r = 0$ is zero, (D) the magnitude of the electric field at $r = R/2$ is 1/16 $\alpha R/\varepsilon_0$, (E) the magnitude of the electric field at $r = R$ is $\alpha R/\varepsilon_0$.

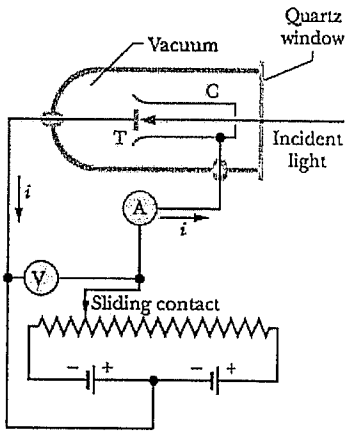
15. Which of the following are correct?
(A) There can be no electric field inside a solid conducting sphere, (B) the Gauss's Theorem of magnetism suggests that no magnetic monopole exists, (C) electric current flowing in a wire will produce a magnetic field, (D) a static magnetic field threaded through a loop will cause an emf, (E) alternately changing electric and magnetic fields will generate an electromagnetic wave.

16. An unpolarized light is sent into three polarizing sheets (angles: θ_1, θ_2, θ_3 from positive y-axis). Angles θ_1 and θ_3 are fixed, but angle θ_2 is varied. The transmission intensity of the light as a function of θ_2 is shown in the right figure.



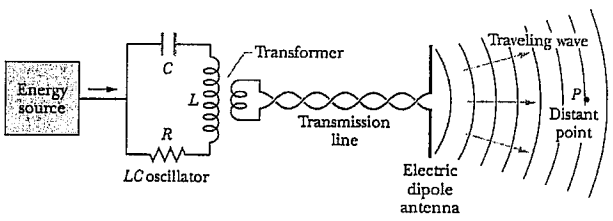
(A) Both θ_1 or θ_3 are located at 90°, (B) transmission rate of the unpolarized light after sheet 1 is 1/2, (C) two sheets 1 and 3 are perpendicular to each other, (D) transmission intensity is 0 if one takes out the sheet 2, (E) transmission rate is 1/8 if $\theta_2 = 30°$.

17. A setup of photoelectric effect is illustrated in the right figure.
(A) The kinetic energy K_{max} is proportional to the stopping potential, (B) for a light of given frequency, K_{max} does not depend on the intensity of the light source, (C) increasing the intensity of the light source should cause larger K_{max}, (D) the slope of a "*stopping potential vs. incident light frequency*" plot depends on the metals, (E) the work function of the target metal can be derived (T is the target, C is the cathode in the diagram).



三、計算題(10 分)：

An oscillator antenna, as shown in the right figure, is connected through a transmission line and a transformer to an LCR oscillator circuit. If R is so small that one can take R=0, what is the (A) speed (4%), (B) angular frequency (3%), and (C) wavelength of the electromagnetic wave emitted by the antenna, assuming $L = 0.4\ \mu$H and $C = 22.5$ pF (3%)?



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