國立雲林科技大學 105 學年度 碩士班招生考試試題

系所：電子系

科目：工程數學(3)

1. Please solve for $y=y(x)$. (15%)

   (a) $xyy' = 2y^2 + 3x^2$ (5%)

   (b) $y'' + 0.4y' + 9.04y = 0$ (5%)

   (c) $x^2y'' - 5xy' + 9y = 0$ (5%)

2. The ODE equation: $y^2dx + (1+xy)dy = 0$ (15%)

   (a) Verify the ODE is not exact. (5%)

   (b) Find the integrating factor $I(x,y)$. (5%)

   (c) Find the solution of the ODE. (5%)

3. Solve $y'' - 4y' + 3y = \sin 2x$ (10%)

4. Laplace equation: (10%)

   (a) If (a) $f(t) = \sin(wt + \theta_0)$, Find $L[f(t)]$,

   (b) $F(S) = \dfrac{1}{S(S^2+5)}$, Find $L^{-1}[F(S)]$

5. Consider the curve given by parametric equation : x=cost , y=sint , z=3t (15%)

   For $0 \leqq t \leqq 2\pi$, Please find

   (a) Position vector F (2%)

   (b) Tangent vector T (3%)

   (c) Total length L of this curve (10%)

6. Find the surface integral $\iint_{\Sigma} Z \cdot d\sigma$ with Σ that part of the plane

   x + y + z=4 lying above the rectangle $0 \le x \le 2$, $0 \le y \le 1$.(15%)

7. Find the inverse of $A = \begin{vmatrix} 2 & 2 & 0 \\ -2 & 1 & 1 \\ 3 & 0 & 1 \end{vmatrix}$ (10%)

8. Find the eigenvalues and eigenvectors of $A = \begin{pmatrix} 6 & -1 \\ 5 & 4 \end{pmatrix}$ (10%)

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系所：電子系

科目：半導體元件

1. Explain or define the following terms:
   (a) Donor impurities in Silicon (5%)
   (b) Space-charge region of p-n junction (5%)
   (c) Fermi level in a semiconductor (5%)
   (d) Hole mobility (5%)

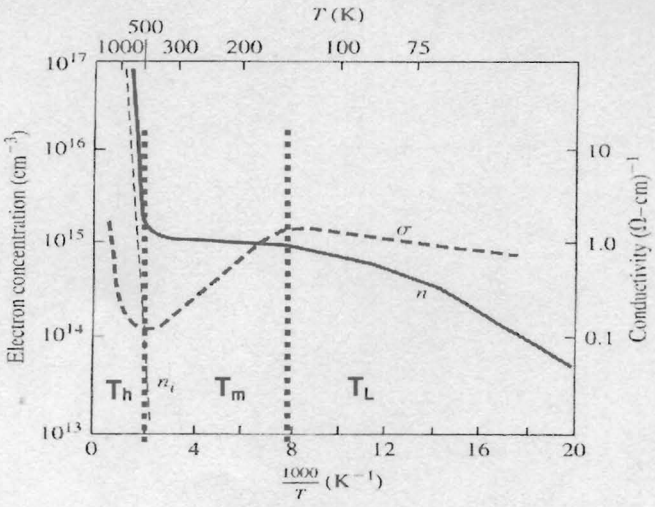
2. Describe the energy band diagram of a direct bandgap semiconductor. (15%)

3. Describe the temperature effects on the carrier mobility in semiconductors. (15%)

4. A Si sample is doped with 1×10^{16} phosphorus atoms/cm^3. What is the hole concentration p_0 at 300K? (5%)
   And calculate the Fermi-level position related to the intrinsic Fermi-level E_i. ($n_i(Si)=10^{10}$ cm^{-3}, kT=0.026eV, ln10=2.3) (10%)

5. Describe the principle and functions of the Hall Effect device. (15%)

6. Explain the variations of electron concentration n and the conductivity σ are depended on the temperature, as shown in followed figure. (20%)



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系所：電子系

科目：物理學

1. As shown in Fig. 1, the frictionless AB is 1/4 of a circle of radius 2 m. The BC is 3 m with a coefficient of kinetic friction $\mu_k = 0.25$. The section CD is frictionless. A block of mass 1 kg is released from rest at A. After sliding on the track, it compresses the spring by 0.2 m. Please find: (*a*) the velocity of the block at point B; (*b*) the energy lost as the block slides from B to C; (*c*) the velocity of the block at point C; (*d*) the stiffness constant *k* for the spring. (12%)

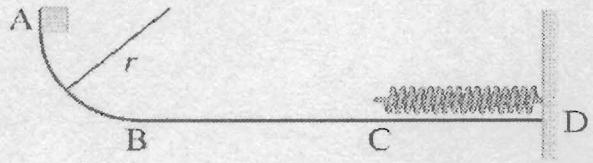

Fig. 1

2. A 0.45-kg object *A* moving east with a speed of 4.8 m/s has a head-on collision with another 0.9 kg object *B* initially at rest. Assuming a perfectly elastic collision, what will be the speed and direction of each object after the collision? (8%)

3. Consider Fig. 2. Two masses, m_A and m_B, which are connected by a massless inelastic cord that passes over a pulley. If the pulley has radius *R* and moment of inertia *I* about its axle, determine the acceleration. (8%)

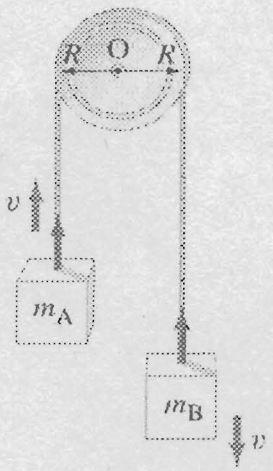

Fig. 2

4. Consider Fig. 3. A wheel of mass *M* with radius *R* rests on the floor. A horizontal force *F* exert at its axle so that it will climb a step which height is *h*, where $h < R$. What minimum force *F* is needed ? (8%)

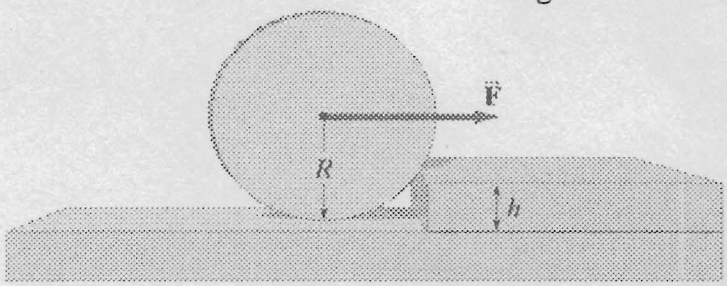

Fig. 3

5. Consider Fig. 4. A man jumps and leaving at 45° above the horizontal with "takeoff" speed $v_0 = 8.9$ m/s from the edge of the left bank which is 2.5 m vertically above the river. If he is exactly on the opposite bank, please calculated the distance of the river. (8%)

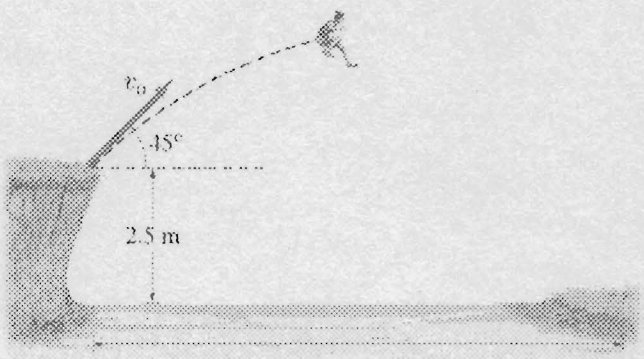

Fig. 4

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系所：電子系

科目：物理學

6. Please explain briefly the following terms. (6%)
   (a) Moment of inertia, (b) Angular momentum, (c) The Newton's "Third law of motion".

7. Assume the permittivity and permeability of a medium are $\varepsilon = (1/9\pi)\times 10^{-9}\ \mathrm{C^2/Nm^2}$ and $\mu = 4\pi \times 10^{-7}$ Tm/A.
   (a) What is the speed of light in the medium? (5%)
   (b) If the frequency of light is 3×10^{14} Hz, what is the wavelength? (5%)

8. Consider Fig. 5. A man stands 120 cm before a flat vertical mirror. The man is 180 cm tall, and his eyes are 160 cm above the floor. He wants to see his whole body (from the head to the feet) in the mirror.
   (a) What is the minimum height h of the mirror? (5%)
   (b) What is the distance d between the floor and the lower edge of the mirror ? (5%)

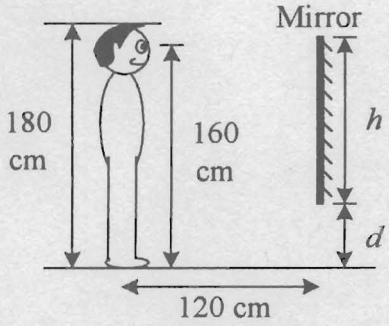

Fig. 5

9. Consider Fig. 6. A beam of light is incident on a plate of glass at an incident angle of 45°. Assume the refractive index of the glass is $\sqrt{2}$.
   (a) What is the refraction angle θ_1 in the glass? (5%)
   (b) What is the emerging angle θ_2? (5%)

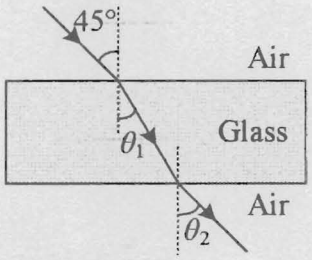

Fig. 6

10. Consider Fig. 7. An object is placed before a converging lens. The focal points before and behind the lens are denoted as F and F', respectively. Plot the image position by ray tracing on the answer sheet. (10%)

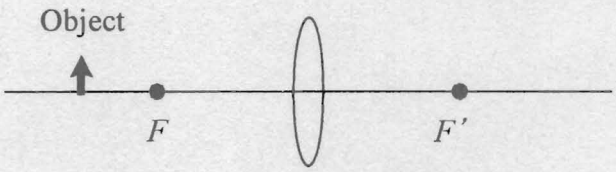

Fig. 7

11. Please explain the following principles.
   (a) Huygen's principle. (5%)
   (b) Fermat's principle. (5%)

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本試題共六題，每題得分如各題中所示，共計 100 分，請依題號作答並將答案寫在答案卷上，違者不予計分。

1. Fig. P1 depicts an amplifier composed of a cascade of three stages.
   (a) (10 分) Find the overall voltage gain $A_v = v_L/v_s$.
   (b) (5 分) Find the overall current gain $A_i = i_o/i_i$.
   (c) (5 分) Find the overall power gain $A_p = P_L/P_I$.

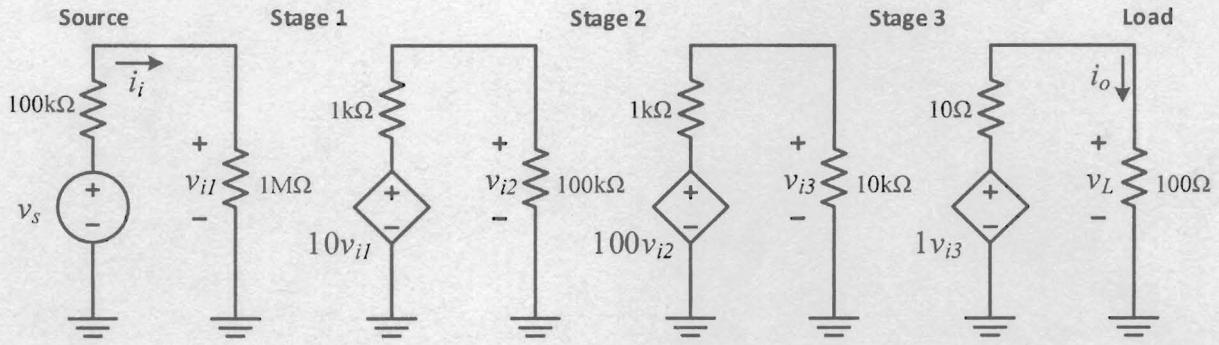

Fig. P1

2. Sketch the CMOS logic circuits that realizes the function with a minimum of MOS transistors:
   (a) (10 分) $Y = \overline{A \cdot (A + B)}$.
   (b) (10 分). $Y = (A + B) \cdot (\overline{A} + \overline{B})$

3. An op amp has a rated output voltage of ±5 V and a slew rate of 2 V/μs.
   (a) (5 分) What is its full-power band width?
   (b) (5 分) If an input sinusoid with frequency $f = 5f_M$ is applied to a unity-gain follower constructed using this op amp, what is the maximum possible amplitude that can be accommodated at the output without incurring SR distortion?

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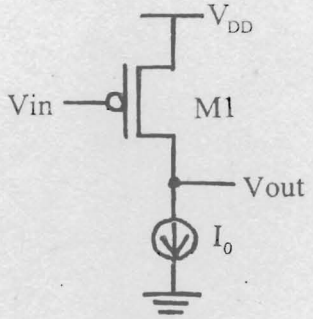
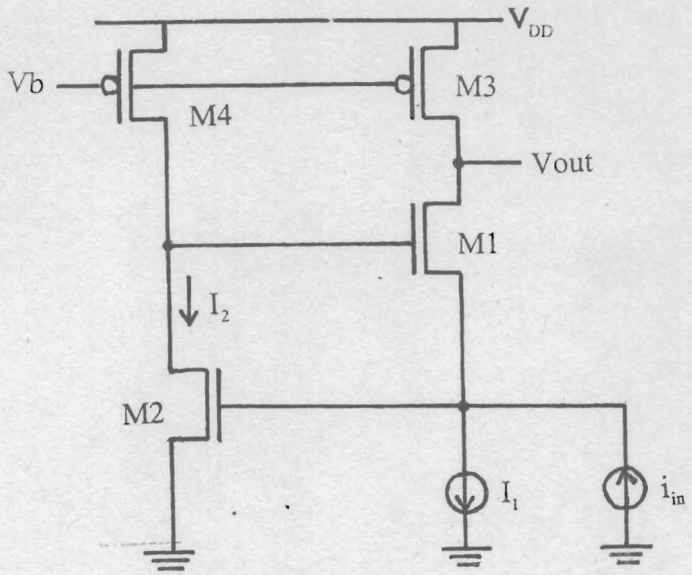
4. For the amplifier shown, please
   (a) (10 分) write down the gain and
   (b) (10 分) calculate the gain.
   $W/L = 100$, $\mu_p C_{ox} = 50\mu A/V^2$, $V_{tp} = -0.5V$, $\lambda_p = 0.1V^{-1}$, $V_{DD} = 1.8V$, and $I_0 = 10mA$.



5. (10 分) Design a source follower to drive a 50Ω load with a voltage gain of 0.5. The power budget is 10mW. Please use NMOS transistor.
   $\lambda = 0$, $\gamma = 0$, $\mu_n C_{ox} = 100\mu A/V^2$, $V_{DD} = 1.8V$.

6. All MOS transistors operate in the saturation region. Please calculate
   (a) (10 分) the small-signal, low-frequency gain and
   (b) (10 分) input resistance of the amplifier.
   $(W/L)_{M1,M2} = 100$, $\mu_n C_{ox} = 100\mu A/V^2$, $V_{tn} = 0.5V$, $\lambda_n = 0$, $\gamma_n = 0$, $I_1 = 1mA$.
   $(W/L)_{M3,M4} = 200$, $\mu_p C_{ox} = 50\mu A/V^2$, $V_{tp} = -0.5V$, $\lambda_p = 0.1V^{-1}$,
   $V_{DD} = 3.3V$, $I_2 = 1mA$



國立雲林科技大學 105 學年度 碩士班招生考試試題

系所：電子系

科目：電磁學

Useful constant:

constant	value
free space permittivity ε_0	$10^{-9}/(36\pi)$ F/m
free space permeability μ_0	$4\pi \times 10^{-7}$ H/m
Planck's constant	6.63×10^{-34} J-s
Charge of an electron	-1.602×10^{-19} C

1. For a general field that is a function of x, y, and z position coordinates as well as time t, given by $A(x, y, z, t) = A(x, y, z)\cos(\omega t + \phi)$, write down the phasor form A_s of this function. (10%)

2. Calculate the relaxation time for (a) copper and (b) polystyrene at room temperature, and give some physical explanations. (15%)

material	Conductivity (S/m)	Relative permittivity
copper	5.8×10^{7}	1.00
polystyrene	1.0×10^{-17}	2.56

3. A 40.0-nC point charge exists at P(0.00, 0.00, -4.00 m). Where must a 10.0-nC charge be located to make the total field zero at the origin? (5 %)

4. A spherical volume charge density is given by $\rho_v = \rho_a (r/a)$ for $0 \le r \le a$ and $\rho_v = 0$ for $r > a$. Derive equations for the electric flux density for all r. (10%)

5. In Cylindrical coordinates:

   For $\rho \le 2$m, $\varepsilon_{r1} = 2$ and $\mathbf{E}_1 = 6\mathbf{a}_\rho + 5\mathbf{a}_\phi + 9\mathbf{a}_z$ V/m. For $\rho > 2$m, $\varepsilon_{r2} = 3$.

   Determine $\mathbf{E}_2$. (10%)

6. An infinite length line with a 4 A current in the +ax direction exists along the x-axis. Find the magnitude and direction of the magnetic field H(0, 1 m, 0).

   (請計算磁場之大小、方向，並寫出單位) (15%)

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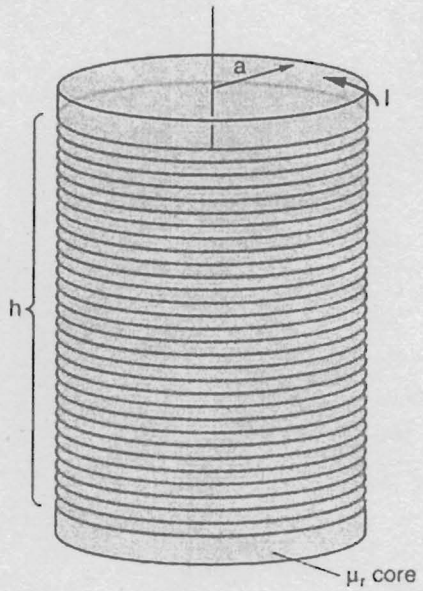
7. At a particular instant in time, in a region of space where **E** = 0 and **B** = 6 $\mathbf{a}_y$ Wb/m^2, a 2-kg particle of charge 1 *C* moves with velocity 2 $\mathbf{a}_x$ m/s. What is the particle's acceleration due to the magnetic field? (*C*: Coulomb; **B**: magnetic flux density) (15%)

8. Calculate the inductance for a solenoid with *N* turns wrapped around a μ_r core as shown in the figure. (15%)



9. Please explain what the dielectric strength is, and why it is an important design criterion in high-power or high-voltage applications involving dielectrics. (5%)