國立雲林科技大學 **102** 學年度　　系所：電子光電所
碩士班暨碩士在職專班招生考試試題　科目：工程數學**(3)**

1. Please solve for $y=y(x)$. (15%)
   (a) $y' = (4x^2 + y^2)/xy$ (5%)
   (b) $y'' - 8y = 0$ (5%)
   (c) $y'' - \frac{1}{x+2}y' + \frac{1}{(x+2)^2}y = 0$ (5%)

2. The ODE equation: $[\sin(x+2y) + 3x\cos(x+2y)]dx + 6x\cos(x+2y)dy = 0$ (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. Given the equation $y''' - y'' + y' - y = e^x + \cos x$ find the general solution.(10%)

4. Laplace equation: (10%)
   (a) If $L[f(t)] = F(S)$ Please prove $L[f'(t)] = SF(S) - f(0)$ (5%)
   (b) $f(t) = t\sin wt$ Find $L[f(t)]$ (5%)

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

6. Find the eigenvalues and eigenvectors of $A = \begin{pmatrix} 1 & 2 & 1 \\ 6 & -1 & 0 \\ -1 & -2 & -1 \end{pmatrix}$. (15%)

7. Find an equation of the tangent plane to the graph of $x^2 - 4y^2 + z^2 = 16$ at (2,1.4). (10%)

8. A lamina has the shape of the region in the first quadrant is bounded by the graphs of
   y = sinx , y = cosx , between x = 0 and x = $\frac{\pi}{4}$.
   Find its center of mass if the density is ρ(x,y) = y. (15%)

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本試題共 6 題，每題得分如各題中所示，共計 100 分。

1. (20%) If $G_m = 100mA/V$ and $C_L = 1pF$, please calculate (a) $\frac{v_{out}}{v_{in}}$ at low frequency and (b) f_{3dB}. ((a)：10%； (b)：10%)

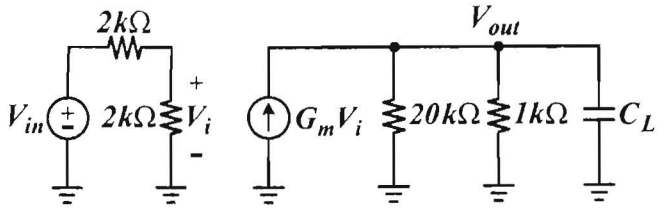

Fig. P1

2. (20%) If all the operational amplifier are ideal, please calculate $\frac{v_{out}}{v_2 - v_1}$.

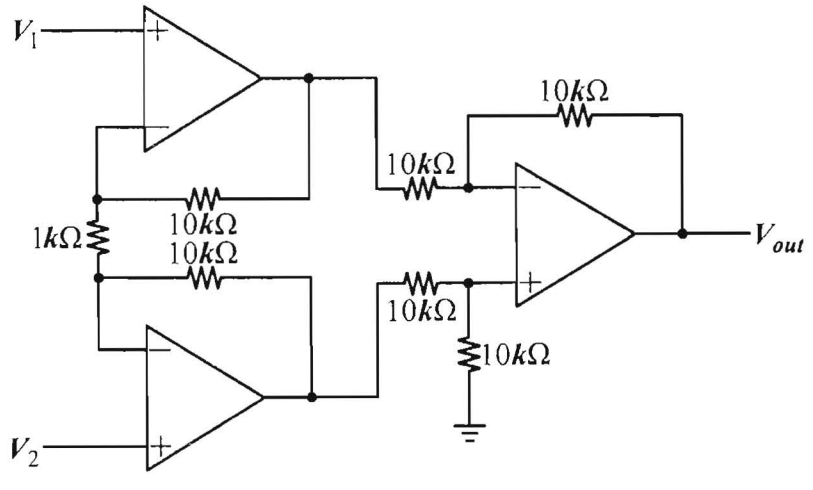

Fig. P2

3. (10%) Please write down the transfer function of $\frac{i_{out}}{i_{in}}(s)$.

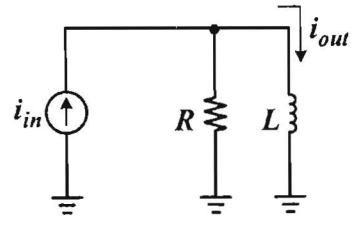

Fig. P3

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4. It is required to design the circuit of Fig. P4 to obtain an output current I_0.
   (a) (6%)Find the expression of R if Q_1 and Q_2 are matched and biased in saturation, and have channel lengths of L, channel widths of W, threshold voltages of V_t, and process transconductance parameters of k_n', ignoring the effect of channel-length modulations..
   (b) (5%)What is the expression of lowest possible value of V_O, ignoring the effect of channel-length modulations?
   (c) (5%)Assuming that for this process technology the Early voltage V_A, find the expression of the output resistance of the current source.

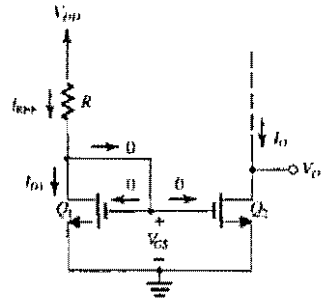

Fig. P4 Circuit for a basic MOSFET constant-current source.

5. A MOS differential pair sown in Fig. P5 is operated at a total bias current I, if Q_1 and Q_2 are matched and biased in saturation, and have channel lengths of L, channel widths of W, threshold voltages of V_t, the Early voltages of V_A, and process transconductance parameters of k_n', ignoring the effect of channel-length modulations..
   (a) (4%)Find the expression of excess gate voltages V_{OV} of Q_1 and Q_2.
   (b) (4%)Find the expression of transconductances g_m of Q_1 and Q_2.
   (c) (4%)Find the expression of output resistances r_o of Q_1 and Q_2.
   (d) (5%)Find the expression of differential gain $A_d = \dfrac{v_{o2} - v_{o1}}{v_{id}}$.

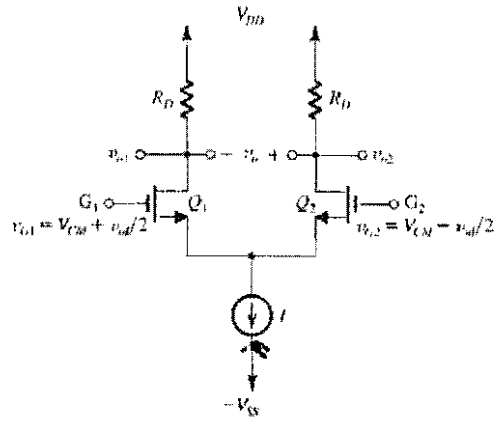

Fig. P5 The MOS differential amplifier.

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6. An amplifier with a low-frequency gain of A_0 and poles at ω_{p1} and ω_{p2} is incorporated in a negative-feedback loop with feedback factor β.
   (a) (4%)For what expression of of β do the poles of the closed-loop amplifier coincide?
   (b) (4%)What is the corresponding expression of Q of the resulting second-order system in (a)?
   (c) (4%)For what expression of β is a maximally flat response achieved?
   (d) (5%)What is the expression of the low-frequency closed-loop gain in the maximally flat case?

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1. Discuss in detail the advantages and disadvantages of a single-cycle processor and a pipelined processor. 10%
2. Discuss the major differences between an Intel processor (e.g., CORE i5) for a PC and an ARM (or MIPS) processor such as one used in a smartphone. 10%
3. Draw the datapath of a load (from memory) instruction for a MIPS processor and describe what happens during the stages of instruction fetch, instruction decoding, ALU execution, data memory read and write, write-back. 10%
4. Describe three different kinds of instructions for a MIPS processor. Show how they are used in an assembly language program. 10%
5. 繪圖說明 Random Access 記憶体基本結構，並說明如何運作? 15%
6. 請用暫存器設計 4-bit x 8 記憶体. 15%
7. PROM 內容如下，其中 A0~A9 爲 don't care，其輸出 O3, O2, O1, O0 控制記憶体 enable(low active)，請找出 O3, O2, O1, O0 控制記憶体地址位置範圍. 15%

A13	A12	A11	A10	O3, O2, O1, O0
0	0	1	0	1 1 1 0
0	1	1	0	1 1 0 1
1	0	1	0	1 0 1 1
1	1	1	0	0 1 1 1

8. 設計算術邏輯電路，如下表 15%

控制信號 S1, S0	功能(Function)
0 0	F=A+B (加)
0 1	F=A-B (減)
1 0	F= A<<2 (移位)
1 1	F=A OR B ("或"邏輯)

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1. Explain or define the following terms:
   (a) Diamond structure (5%)
   (b) Fermi-Dirac distribution function of electrons (5%)
   (c) Extrinsic semiconductor (5%)
   (d) Intrinsic carrier concentration of a semiconductor (5%)

2. Make a comparison between the direct and indirect bandgap semiconductors. (15%)

3. Sketch the simplified energy band diagram of a silicon p-n junction diode in equilibrium. (15%)

4. Describe the breakdown mechanism of p^+n and p^+n^+ junctions, respectively. (15%)

5. How to make metal-semiconductor to form ohmic contact? (20%)

6. Figure 1 shows ideal C-V curve and measured C-V curve of a MOS capacitance. Explain the reason of difference between two curves and find the fixed oxide charge. (15%)

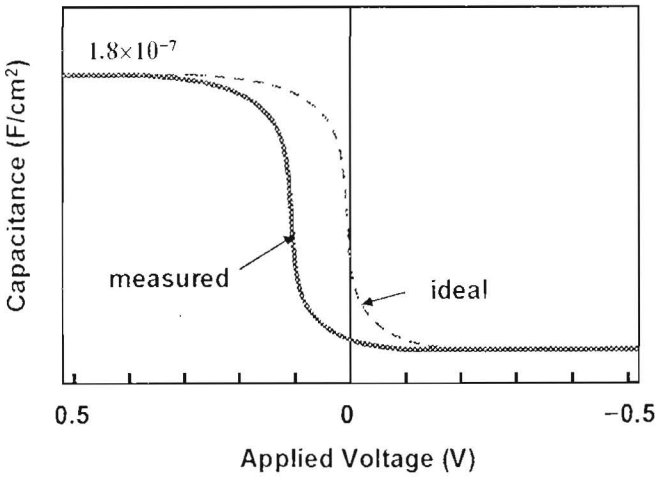

Fig. 1

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Useful Physical Constants: $\varepsilon_0 \approx \frac{10^{-9}}{36\pi}$ (F/m); $\mu_0 = 4\pi \times 10^{-7}$ (H/m)

1. A 10.0 MHz electric field travels in a fluid for which the propagation velocity is 2.0×10^8 m/sec. Initially, the field is $E_x(z = 0, t = 0) = 2.0$ V/m. The Amplitude drops to 1.0 V/m after the wave travels 5.0 meters in the $+z$ direction. Find the general expression for this wave. (15%)

2. A surface charge $\rho_s = 3.00$ nC/m^2 exists on a surface at $y = 0$. For $0 \leq y \leq 1$m, $\varepsilon_{r1} = 9$; for $y > 1$m, $\varepsilon_{r2} = 12$. Determine the vectors $\mathbf{E}_1$ and $\mathbf{E}_2$. (20%)

3. An infinite length line of 3.0-A current in the $+\mathbf{a}_z$ direction lies on the z-axis. Find the magnetic flux density at P(2.0 m, 0, 0) in units of (a) teslas (5%), (b) Wb/m^2 (5%), and (c) gauss(5%).

4. A magnetic field propagating in free space is given by $\mathbf{H}(z, t) = 10 \sin(2\pi \times 10^8 t + \beta z)\, \mathbf{a}_x$ A/m. Find f, β, λ, $\mathbf{E}(z, t)$, and the direction of propagation. (15%)

5. In a lossless, nonmagnetic material with $\varepsilon_r = 16$, $\mathbf{H} = 100 \cos(\omega t - 10y)\, \mathbf{a}_z$ mA/m. Determine the propagation velocity, the angular frequency, and the instantaneous expression for the electric field intensity. (15%)

6. A 2.4-GHz signal is launched on a 2.0-m length of transmission line terminated in a matched load. It takes 10.0 ns to reach the load and suffers 1.74 dB of loss. Find the propagation constant. (1 Np ≈ 8.7 dB) (10%)

7. Write down the four Maxwell's equation for EM waves in the vacuum space, and explain the physical meaning of each equation. (10%)