國立中正大學
115 學年度碩士班招生考試
試 題

[第 3 節]

科目名稱	電磁學
系所組別	電機工程學系-電磁晶片組

－作答注意事項－

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國立中正大學115學年度碩士班招生考試試題

科目名稱：電磁學　　本科目共 2 頁　第 1 頁

系所組別：電機工程學系-電磁晶片組

1. **(10%)** (a) 若 $f=4x^5yz^2-3x$，求∇f。

   (10%) (b) 若 $\vec{F}=r\hat{r}+z\hat{z}$，求$\nabla F$。

   (10%) (c) 半徑 5cm 圓環的電荷密度 $\rho_\ell=3\sin\phi$ (C/cm)，求位於此圓環高度 10cm 的電位是多少?

2. **(10%)** (a) 若阻抗分析儀僅可量測輸入阻抗，請問如何快速求得一已知電氣長度傳輸線的阻抗?

   (10%) (b) 請分別描述λ/2 與λ/4 傳輸線的特性？

3. **(10%)** For the electric dipole in free space shown in Fig. 1 with $d = 0.1$ cm and $Q = 2.0$ C, find the electric field intensity $\vec{E}$ at $R = 2$ m ($\gg d$) and $\theta = 45°$.

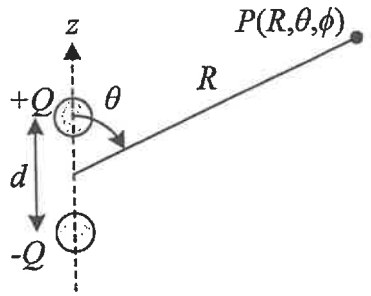


Fig. 1

4. **(10%)** The spherical capacitor shown in Fig. 2 consists of two concentric conducting spheres: an inner sphere of radius a and an outer sphere of radius c. Two dielectrics fill the region between the spheres with ϵ_{r1} for $a<r<b$ and ϵ_{r2} for $b<r<c$, respectively. Given $\epsilon_{r1}=6$, $\epsilon_{r2}=12$, $a=0.5$ mm, $b=1.0$ mm, and $c=2$ mm, calculate the capacitance of this structure.

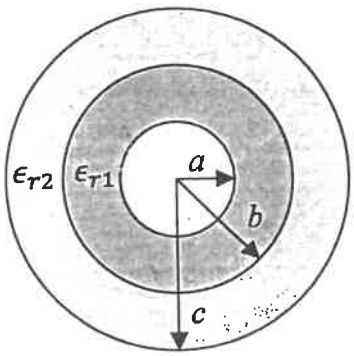


Fig. 2

5. **(10%)** A glass isosceles prism as illustrated in Fig. 3 is employed in an optical instrument to deflect the light ray. Assuming the relative permittivity $\epsilon_r=3.24$ for glass, find the ratio of the transmitted power density to incident power density.

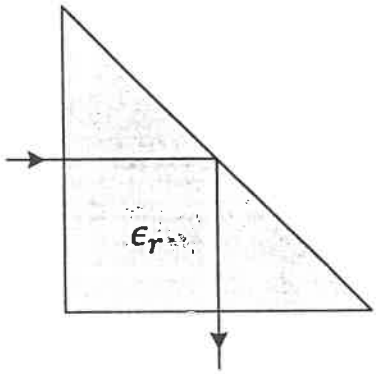


Fig. 3

6. **(10%)** A DC voltage source $V_S = 5\,\text{V}$ is applied at $t = 0$ to the input terminal of a lossless transmission line of length $\ell = 30$ cm. The line has a characteristic impedance Z_0 of 75 Ω, a phase velocity v_p of 1.5×10^8 m/s, and is terminated in a load impedance $Z_L = 25\,\Omega$. Sketch the voltage $V(\ell, t)$ at the load for $0 < t < 6l/v_p$.

7. **(10%)** A 1-V/m 100-MHz uniform plane wave traveling in free space is incident normal to the surface of a lossless and non-magnetic material having $\epsilon_r = 4$ and $\mu_r = 1$. Assume the boundary surface is defined by the plane $z = 0$.
   (a) (5%) Find the maximum value of the electric field intensity for the standing wave in free space.
   (b) (5%) Find the locations of maximum electric field intensity for the standing-wave pattern in free space.

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試 題

[第 3 節]

科目名稱	計算機組織
系所組別	電機工程學系- 晶片系統組

－作答注意事項－

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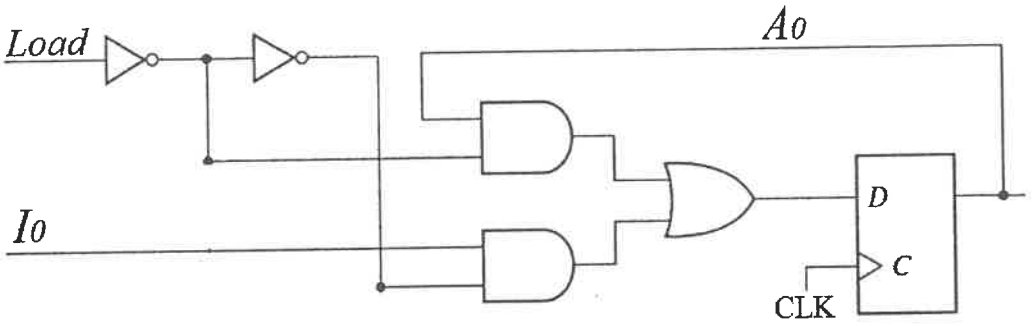
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國立中正大學115學年度碩士班招生考試試題

科目名稱：計算機組織　　本科目共 2 頁　第 1 頁

系所組別：電機工程學系-晶片系統組

1. (20%) Modify the register circuit below based on the function table:
   (a). (10%) Simplify the modified circuit for the input *D* using Karnaugh maps.
   (b). (10%) Based on (a), redraw the simplified circuit.



Load	*Clear*	*D*	*Operation*
0	*0*	A_0	*No change*
0	*1*	*0*	*Clear to 0*
1	*x*	I_0	*Load input*

2. (20%) The results of the SPEC CPU2006 bzip2 benchmark running on an AMD Barcelona have an instruction count of 2E12, an execution time of 550 s.
   (a) (10%) Find the CPI if the clock cycle time is 0.4 ns.

   (b) (10%) Find the increase in CPU time if the number of instructions of the benchmark is increased by 10% and the CPI is increased by 5%.

3. (20%) Translate the following MIPS assembly code to C code. Use a minimum number of instructions. Assume that the values of a, b, i, and j are in registers $s0, $s1, $t0, and $t1, respectively. Also, assume that register $s2 holds the base address of the array D.

```
        addi $t0, $0, 0
        beq  $0,  $0, TEST1
LOOP1:  addi $t1, $0, 0
        beq  $0,  $0, TEST2
LOOP2:  add  $t3, $t0, $t1
        sll  $t2, $t1, 4
        add  $t2, $t2, $s2
        sw   $t3, ($t2)
        addi $t1, $t1, 1
TEST2:  slt  $t2, $t1, $s1
        bne  $t2, $0, LOOP2
        addi $t0, $t0, 1
TEST1:  slt  $t2, $t0, $s0
        bne  $t2, $0, LOOP1
```

4. (10%) Assume that the breakdown of dynamic instructions into various instruction categories is as follows:

R-type	beq /bne	jal	lw	sw
40%	25%	5%	25%	5%

Also, assume the following branch predictor accuracies:

Always-Taken	Always-Not-Taken	2-Bit
45%	55%	85%

Stall cycles due to mispredicted branches increase the CPI. What is the extra CPI due to mispredicted branches with the always-taken predictor? Assume that branch outcomes are determined in the ID stage and applied in the EX stage, that there are no data hazards, and that no delay slots are used.

5. (30%) Consider the fragment of MIPS assembly below:

```
sw  $s5, 12($s3)
lw  $s5, 8($s3)
sub $s4, $s2, $s1
beq $s4, label
add $s2, $s0, $s1
sub $s2, $s6, $s1
```

Suppose we modify the pipeline so that it has only one memory (that handles both instructions and data). In this case, there will be a structural hazard whenever a program fetches an instruction during the same cycle as another instruction accesses data.

(a). (10%) Draw a pipeline diagram to show where the code above will stall.

(b). (10%) In general, is it possible to reduce the number of stalls/NOPs resulting from this structural hazard by reordering code?

(c). (10%) Must this structural hazard be handled in hardware? We have seen that data hazards can be eliminated by adding NOPs to the code. Can you do the same with this structural hazard? If so, explain how. If not, explain why not.

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試 題

[第3節]

科目名稱	電路學
系所組別	電機工程學系-電力與電能處理甲組

—作答注意事項—

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國立中正大學 115 學年度碩士班招生考試試題

科目名稱：電路學　　本科目共 1 頁　第 1 頁

系所組別：電機工程學系-電力與電能處理甲組

1. As shown in Fig.1, to determine R_L (10 points) and maximum power transferred (10 points).

2. As shown in Fig. 2; to prove the V_{out} formula as shown in the following equation. (20 points)

$$V_{OUT} = -\left(\frac{R_f}{R_1}V_{IN1} + \frac{R_f}{R_2}V_{IN2} + \cdots + \frac{R_f}{R_n}V_{INn}\right)$$

3.As shown in Fig. 3; to find $v_o(t)$. (20 points)

4.As shown in Fig. 4; to find $v_o(t)$ when t>0. (20 points)

5.As shown in Fig. 5; to find I_o. (20 points)

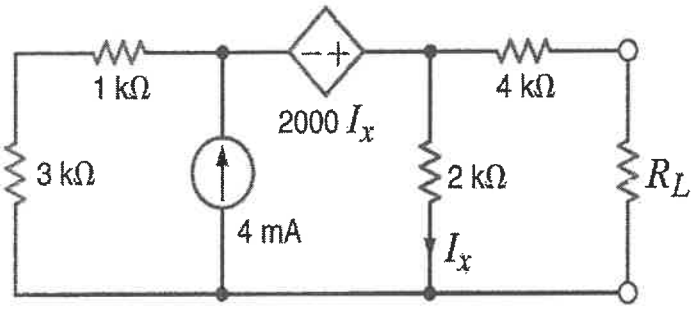


Fig. 1

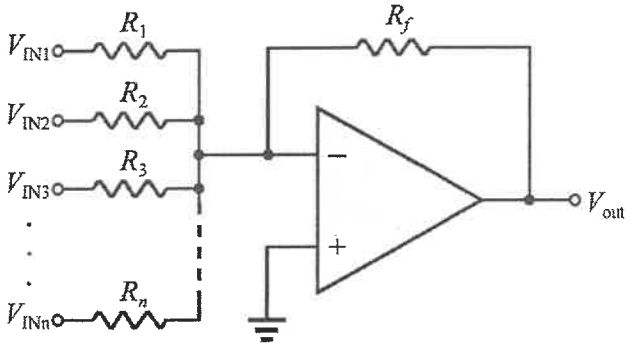
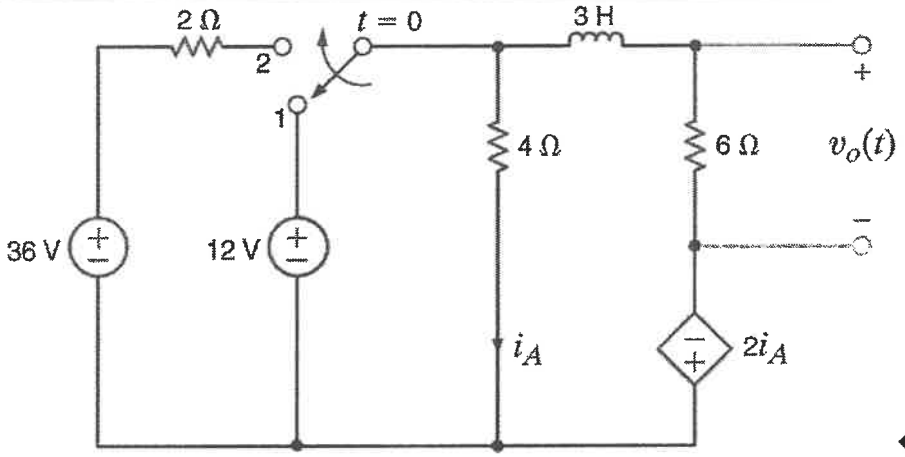


Fig. 2



←Fig. 3

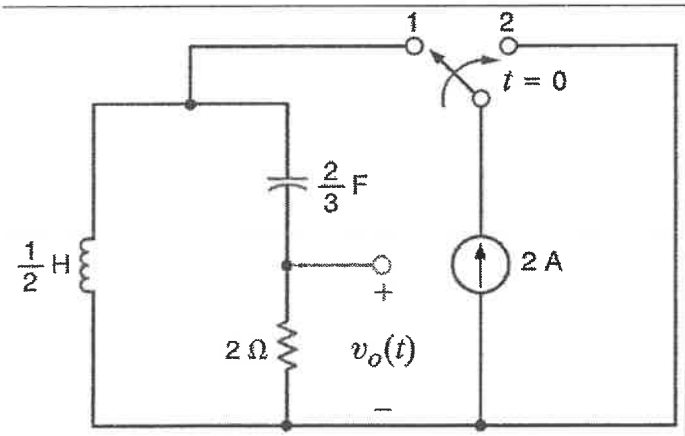


Fig. 4

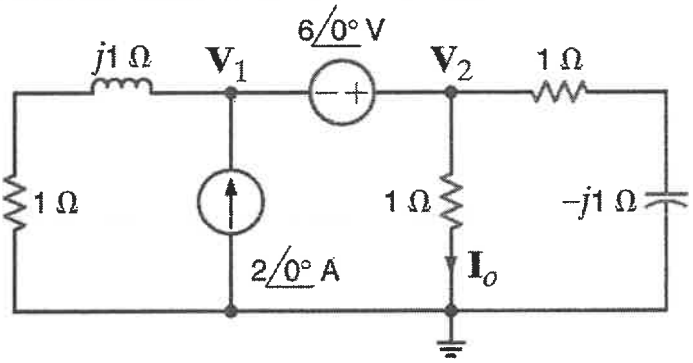


Fig. 5

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試 題

[第3節]

科目名稱	控制系統
系所組別	電機工程學系-電力與電能處理甲組

—作答注意事項—

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國立中正大學 115 學年度碩士班招生考試試題

科目名稱：控制系統　　本科目共 1 頁　第 1 頁

系所組別：電機工程學系-電力與電能處理甲組

1. (20%) Fig.1 shows the block diagram of a servomotor. Assume $J=1$ and $a=1$. If the maximum overshoot of the unit-step input and the peak time are 0.2 and 0.1 sec., respectively.

(a) (10%) Find its damping ratio and natural frequency.

(b) (10%) Find the gain K and velocity feedback F. Also, calculate the settling time.

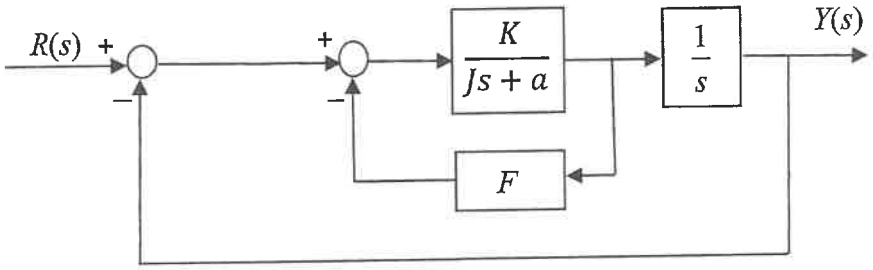


Fig. 1

2. (20%) The forward-path transfer function of a unity-feedback control system is

$$G(s)=\frac{K(s^2+2s+8)}{s(s+5)(s+10)}$$

(a) (10%) Sketch the root loci for $K\geqq 0$.

(b) (10%) Find the value of K that makes the relative damping ratio of the closed-loop system (measured by the dominant complex characteristic equation roots) equal to 0.707.

3. (30%) The forward-path transfer function of a unity-feedback control system with $K\geqq 0$ is

$$G(s)=\frac{K}{(s+5)^3}$$

(a) (10%) Determine the range of K for stability by the Nyquist criterion.

(b) (10%) Check the answer in part (a) with the Routh-Hurwitz criterion.

(c) (10%) Find the value of K so that the gain margin of the system is 20 dB.

4. (30%) The transfer function of a linear control system is

$$G(s)=\frac{s+a}{s^3+7s^2+14s+8}$$

(a) (10%) Determine the values of a so that the system is either uncontrollable or unobservable.

(b) (10%) With the values of a found in part (a), define the state variables so that one of them is uncontrollable.

(c) (10%) With the values of a found in part (a), define the state variables so that one of them is unobservable.

國立中正大學
115 學年度碩士班招生考試
試 題

[第 4 節]

科目名稱	電子學
系所組別	電機工程學系－電磁晶片組 晶片系統組

－作答注意事項－

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國立中正大學 115 學年度碩士班招生考試試題

科目名稱：電子學

系所組別：電機工程學系-電磁晶片組、晶片系統組

If the parameter ungiven in the question, you can specify it in the answer sheet.

1. (20%) For a common-source amplifier (Fig.1), please determine (at first, skip the existences of R_L and R_S, neglecting r_o)
   (a) (5%) the input resistance R_{in} and output resistance R_o
   (b) (5%) voltage gain A_v
   (c) (5%) after adding the source degeneration resistor R_S, what happens to the voltage gain A_v
   (d) (5%) If the output connects with load R_L, what happens to the voltage gain A_v?

2. (20%) For the circuit of Fig.2, please answer the following questions :
   (a) (5%) to derive the corresponding transfer function, is it low-pass or high-pass?
   (b) (5%) what's the high frequency gain
   (c) (5%) what's the 3-dB frequency
   (d) (5%) At what frequency does the magnitude of high frequency gain reduce to unity?

3. (20%) For an NMOS differential pair (Fig.3) with a common-mode voltage V_{CM} (0.5V) applied, assume $V_{DD} = V_{SS} = 1.8$ V, $k_n' = 0.5$ mA/V^2, $(W/L)_{1,2} = 10$, $V_{tn} = 0.5$ V, $I = 0.2$ mA, $R_D = 10$ kΩ, and neglect channel-length modulation.
   (a) (5%) Please find V_{OV} and V_{GS} for each transistor.
   (b) (5%) Please find V_S, I_{D1}, I_{D2}, V_{D1} and V_{D2}.
   (c) (5%) What is the highest value of V_{CM} for which Q_1 and Q_2 remain in saturation?
   (d) (5%) If current source I requires a minimum voltage of 0.3 V to operate properly, what is the minimum required V_S and hence also for V_{CM}?

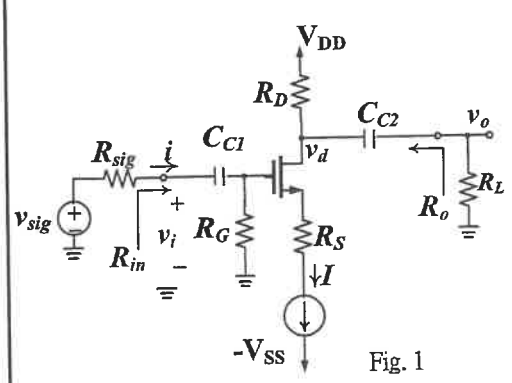


Fig. 1

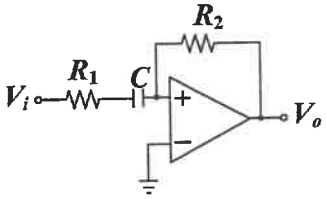


Fig.2

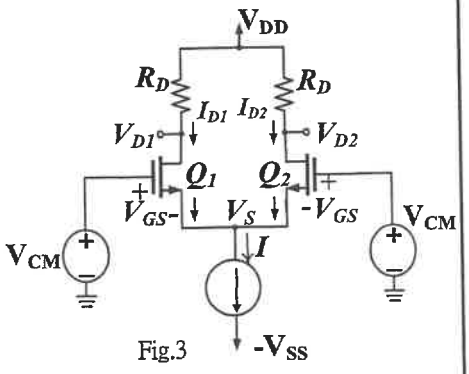


Fig.3

4. (20%) Assume the current (I) flowing through Q_1 is 100μA in Fig.4, for Q_1, $\mu_n C_{ox}$= 80μA/V^2, V_A = 15 V, W/L = 100μm/0.18μm, C_{gs} = 0.2 pF, C_{gd} = 0.015 pF, and C_{db} = 20 fF.
For Q_2 and Q_3, C_{gd} = 0.015 pF, C_{db} = 36 fF, assume the resistance of the input signal generator being negligibly small and the signal voltage at the gate of Q_2 being zero, please find
(a) (5%) the low-frequency gain,
(b) (5%) the transfer function $\frac{V_o}{V_i}$
(c) (5%) the frequency of the pole, and
(d) (5%) the frequency of the zero.

5. (20%) A Miller integrator (Fig. 5) includes a resistor R of 100 k ohm and a capacitor C of 10 nF.
(a) (5%) Which frequency (in Hz) makes the input and output signals equal in amplitude?
(b) (5%) How does the phase of the output sine wave relate to that of the input (leading or lag)?
(c) (5%) If the frequency is lowered by a factor of 10 from that found in (a), by what factor does the output voltage change?
(d) (5%) What is the phase relation between the input and output in the situation of (c)

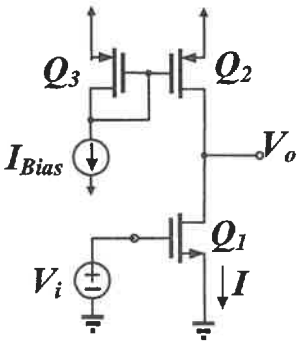


Fig. 4

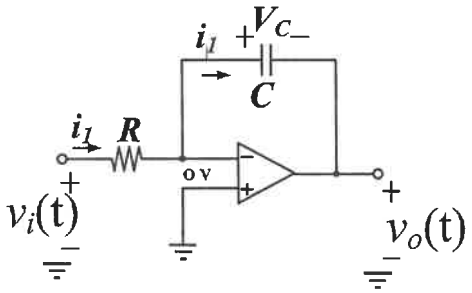


Fig. 5

國立中正大學
115學年度碩士班招生考試
試 題

[第4節]

科目名稱	線性代數與微分方程
系所組別	電機工程學系－ 電磁晶片組 電力與電能處理甲組

－作答注意事項－

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3. 入場後於考試開始40分鐘內不得離場。
4. 全部答題均須在試卷（答案卷）作答區內完成。
5. 試卷作答限用藍色或黑色筆（含鉛筆）書寫。
6. 試題須隨試卷繳還。

國立中正大學115學年度碩士班招生考試試題

科目名稱：線性代數與微分方程　　本科目共 3 頁　第 1 頁

系所組別：電機工程學系-電磁晶片組、電力與電能處理甲組

Differential Equations

Every correct answer earns 2 points; every wrong answer deducts 2 points (down to a minimum of 0); no answer gives 0 point.

1. (10%) Which of the following statements are true.

   (a) The domain of a solution to a differential equation (DE) can be $(-\infty, 0) \cup (0, \infty)$.

   (b) The initial value problem $y' = x\sqrt{y}$ with $y(0) = 0$ has a unique solution in the neighborhood of $x = 0$, where y' denotes the first order derivative of y.

   (c) Given any first-order linear ordinary DE (ODE): $y' + P(x)y = f(x)$, the only integrating factor $\mu(x)$ is of the form $\mu(x) = e^{-\int P(x)\mathrm{d}x}$.

   (d) The solution curve to the ODE $y' = \sin(y)$ cannot oscillate or be periodic.

   (e) The power series $y(x) = 1 + x + \sum_{n=2}^{\infty}(n-1)!x^n$ is a solution to the ODE $x^2y' = y - x - 1$ about $x = 0$.

2. (10%) Which of the following statements are true.

   (a) The functions $\sin x$ and $\cos x$ are linearly dependent on the interval $(0, \pi)$.

   (b) A particular solution y_p of a non-homogeneous linear ODE must be linearly independent of y_h, the solution of its homogenous counterpart.

   (c) The solutions to the ODE $y'' - 2y' + y = 0$ are solutions to the ODE $y^{(3)} - 4y'' + 5y' - 2y = 0$, where $y^{(n)}$ denotes the n-th order derivative of y with $y^{(2)} = y''$.

   (d) If $y_1 = \sin 5x$ is a solution of a homogeneous linear second-order ODE, then the general solution of the ODE is $y = c_1 \sin 5x + c_2 \cos 5x$, where $c_1, c_2 \in \mathbb{R}$.

   (e) Given a solution $y_1 = x^2$ of the ODE $x^2y'' - 3xy' + 4y = 0$ on the interval $(0, \infty)$, the general solution of the ODE is given by $y = c_1x^2 + c_2x^2 \ln x$, where $c_1, c_2 \in \mathbb{R}$.

3. (10%) Given $y'' + y = 4\delta(t - 2\pi)$ with initial conditions $y(0) = 1$ and $y'(0) = 0$, where $\delta(t)$ denotes the Dirac delta function, the Laplace transform $Y(s)$ of the solution $y(t)$ is

   (a) $\frac{s}{s^2+1} + 4\frac{e^{-2\pi s}}{s^2+1}$

   (b) $\frac{s}{s^2+1} + 4\frac{e^{2\pi s}}{s^2+1}$

   (c) $-\frac{s}{s^2+1} + 4\frac{e^{-2\pi s}}{s^2+1}$

   (d) $-\frac{s}{s^2+1} + 4\frac{e^{2\pi s}}{s^2+1}$

   (e) None of the above.

4. (10%) Consider the function

$$y(x) = \cos x + \sin x + \frac{1}{4}x\cos x - \frac{1}{2}x\sin x + \frac{1}{4}x^2\sin x.$$

Determine which of the following ODEs has $y(x)$ as a solution.

(a) $y'' + y = x\cos x + \cos x$

(b) $y'' + y = x\cos x - \cos x$

(c) $y'' + y = x\sin x + \sin x$

(d) $y'' + y = x\sin x - \sin x$

(e) None of the above.

5. (10%) Consider

$$y' = y^2 - \frac{y}{x} - \frac{4}{x^2},$$

where $y_1(x) = \frac{2}{x}$ is a known solution of the ODE. Let $y(x) = y_1(x) + u(x)$. Which of the following ODEs does $u(x)$ satisfy?

(a) $u' = u^2 + \frac{3}{x}u$

(b) $u' = u^2 - \frac{3}{x}u$

(c) $u' = -u^2 + \frac{3}{x}u$

(d) $u' = -u^2 + \frac{3}{x}u$

(e) None of the above.

Continued on next page

Linear Algebra

6. Consider the following system of linear equations:

$$\begin{aligned} x_1 + x_2 + x_3 &= 2 \\ x_2 + 2x_3 &= 1 \\ (a^2 - 9)x_3 &= a - 2 \end{aligned}$$

Based on the parameter a, answer the following questions and explain your reasoning:

(a) (3%) For which condition(s) of a does the system have exactly one solution?

(b) (3%) For which value(s) of a does the system have zero solutions?

(c) (3%) For which value(s) of a does the system have infinitely many solutions?

7. Let $\mathbf{W}$ be the plane with equation $x + 2y - 3z = 0$.

(a) (3%) Find a basis for $\mathbf{W}$.

(b) (6%) Find the standard matrix for the orthogonal projection onto $\mathbf{W}$.

(c) (3%) Use the matrix obtained in (b) to find the orthogonal projection of a point $P_0(x_0, y_0, z_0)$ onto $\mathbf{W}$.

(d) (3%) Find the distance between the point $P_0(-1, 1, -1)$ and the plane $\mathbf{W}$, and check your result.

8. Consider the bases $B = \{\mathbf{u}_1, \mathbf{u}_2, \mathbf{u}_3\}$ and $B' = \{\mathbf{v}_1, \mathbf{v}_2, \mathbf{v}_3\}$ for R^3, where

$$\mathbf{u}_1 = \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix}, \mathbf{u}_2 = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}, \mathbf{u}_3 = \begin{bmatrix} -1 \\ 0 \\ 2 \end{bmatrix}, \quad \mathbf{v}_1 = \begin{bmatrix} -1 \\ 1 \\ 2 \end{bmatrix}, \mathbf{v}_2 = \begin{bmatrix} 0 \\ 1 \\ -2 \end{bmatrix}, \mathbf{v}_3 = \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix}$$

(a) (6%) Find the transition matrix $P_{B,B'}$ from B to B'.

(b) (6%) Find the transition matrix $P_{B',B}$ from B' to B.

(c) (2%) Compute the coordinate matrix $[\mathbf{w}]_{B'}$ where $\mathbf{w} = \begin{bmatrix} 0 \\ 0 \\ 2 \end{bmatrix}$.

9.

$$M = \begin{bmatrix} 0 & 2 & 3 \\ 0 & 2 & 0 \\ 1 & 0 & 1 \end{bmatrix}$$

(a) (6%) Find a diagonalization $M = PDP^{-1}$ and use it to compute the matrix power M^7.

(b) (6%) Compute a QR-decomposition of M; that is, find a matrix Q whose columns form an orthonormal set and an upper triangular matrix R such that $M = QR$.