國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：工程數學【醫科所碩士班選考】　　題號：428001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

1. Let matrix

$$A = \begin{pmatrix} 0 & 0 & -2 \\ 1 & 2 & 1 \\ 1 & 0 & 3 \end{pmatrix}$$

(a) Find the eigenvalues and the corresponding eigenvectors of the matrix A. (10%)
(b) Find matrix P that makes A diagonal, that is, $D = P^{-1}AP$ where D is a diagonal matrix. (5%)
(c) Find the n-th power of matrix A, that is, A^n. It is not necessary to explicitly compute P^{-1}. (5%)

2. Solve $x^3y''' - 2xy' + 4y = \ln x + x^3$ (5%)

3.Find the area and volume if the vertices are (1,1,1), (2,1,1), (1,5,1), (1,1,3). (10%)

4. Please use Laplace transform to solve the following initial value problem. (5%)

$$y''(t) + 3y'(t) + 2y(t) = 0,\ y(0) = 1,\ y'(0) = 0$$

5. For a system of non-linear ordinary equations (with m>0) in a two dimension phase plan.

$$y_1' = y_2 - 2$$

$$y_2' = \frac{2m}{\pi} y_1 - \sin y_1$$

(a) For m = 1, please find all the critical points in the phase plane. (10%)
(b) Find the range for the value of m such that this system of ordinary differential equation has seven values. (10%)

6. Let

$$A = \begin{pmatrix} 1 & 1/3 & -2/3 & 0 & 0 \\ 0 & 1/2 & 0 & 0 & 0 \\ 0 & -1/6 & 1/3 & 0 & 0 \\ -1/2 & -2/3 & 1/3 & 1/2 & 0 \\ 0 & -1/3 & 0 & 0 & 1/3 \end{pmatrix} \quad \text{and } b = \begin{pmatrix} 5 \\ 5 \\ 1 \\ 7 \\ 8 \end{pmatrix}$$

(a) Solve for x such that $Ax = b$. (6%)
(b) Find all eigenvalues of A, and list them in descending order. (6%)
(c) Find a 5×5 matrix X and X^{-1} such that $X^{-1}AX = D$, where D is the diagonal matrix whose diagonal elements are eigenvalues of A in descending order. (6%)
(d) Find the determinant of A and the inverse of A. (6%)
(e) Find e^A. (6%)

7. Find the Fourier transform of $f(t) = t^2 e^{-5|t|}$ (10%)

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：生理學【醫科所碩士班選考】　　題號：428002

※本科目依簡章規定「不可以」使用計算機(混合題)　　

一、問答題(請將答案卷中標示題號並依序作答)

1. 請詳敘胃液分泌的三個階段與其調節機制。(5%)
2. 請說明身體如何維持血鈣的恆定。(10%)
3. 請敘述腎臟如何濃縮尿液? (5%)
4. 小文因發生車禍，血壓忽然下降，請敘述他體內將發生哪些穩定血壓的機制?(請依照機制啟動的時間，由快至慢的順序列出) (10%)
5. 請說明何謂心輸出量(cardiac output)？並說明有哪些決定因子會影響心輸出量。(10%)

二、請將選擇題之最適答案作答於答案卡上(單選題，每題2分，共30題)

1. 下列有關腎上腺皮質產生的醣皮質固醇之敘述，何者是不正確的?(A)增加肝內胺基酸的代謝 (B)增加血液中淋巴球 (C)影響電解質的代謝 (D)影響水分的代謝
2. 肌細纖維在電子顯微鏡下面呈現明暗相間的橫行帶，其中明帶的部份稱為 (A)I 帶 (B)H 帶 (C)Z 帶 (D)A 帶
3. 肺臟的實質組織內有許多牽引接受器(stretch receptor)，這些接受器是藉由何種神經纖維與吸氣中樞的神經細胞相接處? (A)交感神經 (B)膈神經 (C)肋間神經 (D)迷走神經
4. 正常人肝臟內膽汁成分中，下列何者所佔百分比最多? (A)膽紅素 (B)膽固醇 (C) 卵磷脂 (D)膽鹽
5. 下列有關「A」型的血液的敘述，何者正確? (A)白血球的細胞膜上含有 A 凝集原，血漿內含有抗 B 凝集素 (B)紅血球的細胞膜上含有 A 凝集源，血漿內含有抗 B 凝集素 (C) 白血球的細胞膜上含有 B 凝集原，血漿內含有抗 A 凝集素 (D) 紅血球的細胞膜上含有 B 凝集源，血漿內含有抗 A 凝集素
6. 肌肉纖維的組合，其直徑大小依序為: (A)肌纖維>肌細纖維>肌絲>蛋白質分子 (B) 蛋白質分子>肌細纖維>肌絲> 肌纖維(C) 肌絲>肌細纖維>蛋白質分子>肌纖維(D) 肌細纖維>肌纖維>肌絲>蛋白質分子
7. 下列有關肌肉的化學成分之敘述何者是錯誤的? (A)肌肉蛋白質主要成分是肌凝蛋白和肌動蛋白 (B)肌漿中的肌色素能把血液中的氧輸送到肌肉裡 (C)肌肉裡所含的碳水化合物大都是乳醣 (D) Adenosine triphosphate 是肌肉收縮時最重要的的物質，是能量供應的樞紐。
8. 正常人心室收縮一次，從每一心室所排出的血量稱為下列何者? (A)心動週期 (B)心搏量 (C) 心輸出量 (D)心傳導量
9. 有關脊髓休克期(period of spinal shock)之敘述，下列何者正確? (A)脊髓切斷後，從脊髓反射消失到反射再出現的這一段時間稱之 (B)肢體的隨意動作及感覺仍存在 (C) 脊髓休克期後之反射中樞皆位於高及中樞，於脊髓則無 (D)血壓下降為休克期主要症狀，伸肌反射恢復較快。
10. Glucocorticoid 可以增加血液中下列何種血球之數目? (A)嗜酸性白血球 (B)淋巴球 (C) 嗜中性白血球 (D)嗜鹼性白血球。
11. 下列有關自主神經系統的敘述，何者正確? (A)主要分布在內臟且多半不受意識支配 (B)不包括交感神經節後纖維及副交感神經節前纖維 (C) 包括腦神經第二、五、九、十神經核 (D)副交感神經的節前纖維較交感神經的短。
12. 關於胃的敘述，下列何者錯誤? (A)胃內沒有食物的時候，其空間體積很小 (B)食物進入胃以後，先聚集再胃體 (C) 胃的平滑肌可引起強而有力的蠕動 (D)進入幽門部位的食物會隨即進入十二指腸
13. 下列何者為合成黑色素和多巴胺的前驅胺基酸? (A)cysteine (B)tyrosine (C)methionine (D)tryptophan
14. 體內的酮體大量堆積會造成酮酸中毒，下列何者不屬於酮體? (A)acetone (B)acetoacetic acid (C)pyruvic acid (D)β-hydroxybutyric acid

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：生理學【醫科所碩士班選考】　　題號：428002

※本科目依簡章規定「不可以」使用計算機(混合題)　　

15. 食物進入胃後可產生 Gastroileal reflex，是由於下列哪種原因所致? (A)膽囊收縮素分泌之故 (B)腸抑胃激素分泌所致 (C)自主神經之副交感神經興奮所致 (D)胃泌素分泌之故
16. 鐵的吸收部分主要在何處? (A)十二指腸 (B)迴腸 (C)結腸 (D)空腸
17. 蠶豆症是屬於哪一種溶血症? (A)球狀紅血球症 (B)鐮刀狀紅血球症 (C)地中海型貧血 (D)G-6-DP 缺乏症
18. ADH 及 Aldosterone 之最主要生理功能是: (A)使周邊血管阻力上升 (B)做周邊血管阻力下降 (C)使尿流量增加 (D)使循環血量增加
19. 腎上腺素作用在肝細胞引起肝醣分解的過程中，下列何者不是中間的訊息傳遞者? (A)GTP binding protein (B)β-adrenergic receptor (C)Postagalandin (D)Cyclic AMP
20. Cushing's syndrome 的成因是由於: (A)葡萄糖皮質類固醇過量 (B)生長激素不足 (C)礦物質皮質激素過量 (D)以上皆非
21. 心電圖(ECG)的 T 波是下列何者所構成? (A)心房 Repolarization (B)心室 Repolarization (C)心房 Depolarization (D)心室 Depolarization
22. 當血液中 pH 值下降、HCO_3^-下降、PCO_2下降時，為: (A)代謝性酸中毒 (B)呼吸性酸中毒 (C)代謝性鹼中毒 (D)呼吸性鹼中毒
23. 肺泡表面具有什麼物質，可以防止肺泡塌陷? (A)表面張力劑 (B)黏液 (C)膽固醇 (D)脂肪
24. 控制膀胱迫尿肌收縮的神經為: (A)脊神經 (B)交感神經 (C)會陰神經 (D)副交感神經
25. Goodpasture's syndrome 的臨床特徵中，除了腎小球腎炎的症狀外，尚有哪種特徵? (A)通常可以自癒 (B)好發於年輕女性 (C)肺出血與咳血症狀 (D)以上皆是
26. 阿茲海默症和腦神經細胞缺乏哪種物質有關? (A)PABP (B)GABA (C)Dopamine (D)Acetylcholine
27. 鈣離子與下列何者結合後，可引發骨骼肌的收縮? (A)Troponin I (B)Tropnmyosin (C)Troponin T (D)Troponin C
28. 靜止膜電位主要是由哪一種離子所造成? (A)Cl^- (B)K^+ (C)Na^+ (D)Ca^{2+}
29. 巴金森氏症是因何種物質所分泌減少所致? (A)乙醯膽鹼 (B)多巴胺 (C)新腎上腺素 (D)血清胺
30. 沉睡時不易被喚醒的腦波為? (A)θ 波 (B)α 波 (C)δ 波 (D)β 波

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：普通化學【醫科所碩士班選考】　　題號：428004

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（混合題）　　

一、問答與計算題（請將答案卷中標示題號並依序作答）

1. Define "the second law of thermodynamics", " collision model". (6 %)
2. An inverse concentration dependence on one of the species taking part in the reaction. Explain the meaning of it. (4 %)
3. A 1.00L solution was made from dissolving 20g of NaCl in enough water. Assume that the density of the solution is 1.00 g/cm^3. Please calculate the molality, molarity and mole fraction of NaCl of this solution. Suppose sodium chloride dissociates completely in aqueous solution, please calculate the boiling point and freezing point of this solution. (K_b = 0.51℃ Kg/mol; K_f = 1.86 Kg/mol for water, NaCl: 58.44 g/mol; H_2O = 18.0 g/mol) (10%)
4. The best laboratory vacuum system can pump down to as few as 1.0×10^9 molecules per cubic meter of gas. Calculate the corresponding pressure, in atmospheres, assuming a temperature of 0℃. (10%)
5. Answer the following questions about the Lewis Acid boron trifluoride.
   (1) Draw the Lewis Structure of boron trifluoride. (3 %)
   (2) Draw a VSEPR diagram of boron trifluoride. Label the bond angles. (3 %)
   (3) Is this molecule polar? Draw all bond dipoles and explain. (4 %)

二、請將選擇題之<u>最適</u>答案作答於<u>答案卡上</u>(單選題，每題3分，共20題)

1. Which one of the following statements about transition metal species is incorrect?
   (A) $TiCl_4$ is an ionic compound
   (B) MnO is a basic oxide
   (C) CrO_3 is an acidic oxide
   (D) $ZnCl_4^{2-}$ is colorless

2. The average mass of a boron atom is 10.81. If you were able to isolate a single boron atom, what is the chance that you would randomly get an atom with mass 10.81?
   (A) 0% (B) 0.81% (C) about 11% (D)10.81%

3. The compound 2-germaacetic (GeH_3COOH) is an unstable weak acid. At 25℃, a 0.050 M solution of 2-germaacetic acid has a pH of 2.42. Determine the k_a of 2-germaacetic acid.
   (A) 3.12×10^{-4} (B) 0.076 (C)2.42 (D) 0.38

4. Which one of the following statements is incorrect?
   (A) IE_1: P>Al>Na
   (B) EN: Cl>Se>Br
   (C) Atomic size: Si>P>N
   (D) Number of valence electrons: S>Sb>Cs

5. The reaction, 2A+B→C, has the following proposed mechanism:
   Step 1: A+B→D (fast equilibrium)
   Step 2: D+B→E
   Step 3: E+A→C+B
   If step 2 is the rate-determining step, then the rate of formation of C should equal: (A) $k[A]$ (B) $k[A]^2[B]$ (C) $k[A]^2[B]^2$ (D)$k[A][B]^2$

6. Which of the following species can function as an enzyme in organisms?
   (A) DNA (B) protein (C) cellulose (D) fatty acids

7. The indicator cresol red has $K_a=5.0\times10^{-9}$. Over what proximate pH range does it change color? (A) 7.3 — 9.3 (B) 4.3 — 6.3 (C) 8.3 — 10.3 (D) 6.3 — 8.3

8. Calculate the wavelength, in nanometers, of an x-ray that has frequency of $5.15\times10^{16}\ s^{-1}$. (A) 5.83 nm (B) 17.2 nm (C) 583 nm (D) 0.172 nm

9. The best explanation for the fact that oxygen forms only OF_2 with fluorine, while sulfur forms SF_2, SF_4 and SF_6, is that
(A) oxygen is more electronegative than sulfur.
(B) sulfur is less electronegative than oxygen.
(C) oxygen is smaller than sulfur.
(D) sulfur has d orbitals available for bonding.

10. A stock bottle of nitric acid indicates that the solution is 67.0% HNO_3 by mass and has a density of 1.40 g/mL. Calculate the molarity of the solution. (H=1.00, N=14.0, O=16.0)
(A) 22.2 (B) 14.9 (C)10.6 (D) 0.0148

11. If the half life of a reaction with respect to a reactant concentration is $0.693/k$, what is the reaction order of the reactant? (A) First order (B) Second order (C) Third order (D) Zero order.

12. A carbon that has four different groups attached to it is a ____ carbon?
(A) chimerical (B) typical (C)phospholipids (D) chiral

13. If an endothermic reaction is spontaneous at 298 K, which of the following must be true for the reaction?
I. ΔG is greater than zero.
II. ΔH is greater than zero.
III. ΔS is greater than zero.
(A) I only (B) II only (C) I and II only (D) II and III only

14. Compound X_2Y is 60% X by mass. Calculate the percent Y by mass of the compound X_2Y_2.
(A) 20% (B) 30% (C) 40% (D)60%

15. Calculate ΔG for the isothermal compression of 1 mol of an ideal monatomic gas from 1.4 atm to 5.6 atm at 23℃.
(A) 3.4×10^3 J (B) 1.6×10^3 J (C) -3.4×10^3 J (D) -1.6×10^3 J

16. How many electrons in an atom can have the quantum numbers n=3, l=1?
(A) 10 (B) 2 (C)6 (D) 18

17. Please order the Ka values for a series of oxyacids: HOCl, HOBr, HOI, $HOCH_3$.
(A) HOI>HOBr>HOCl>$HOCH_3$
(B) $HOCH_3$>HOI>HOBr>HOCl
(C) $HOCH_3$>HOCl>HOBr>HOI
(D) HOCl>HOBr>HOI>$HOCH_3$

18. The percent dissociation in a 0.10 M aqueous solution of monoprotic acid is 2.5%. Please calculate the value of K_a for this acid. (A) 1.23×10^{-4} (B) 2.5×10^{-3} (C) 6.4×10^{-5} (D) 7.4×10^{-6}

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：普通化學【醫科所碩士班選考】　　題號：428004

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（混合題）

19. Which of the following is state function?
(A) work (B) heat (C) enthalpy (D) none of these

20. The half-life of a radioactive nuclide is 14 hours. Without doing calculations, how long would it take for a sample to decay to 12% of its present activity? (A) 3 hours (B) 14 hours (C) 28 hours (D) 42 hours

國立中山大學104學年度碩士暨碩士專班招生考試試題

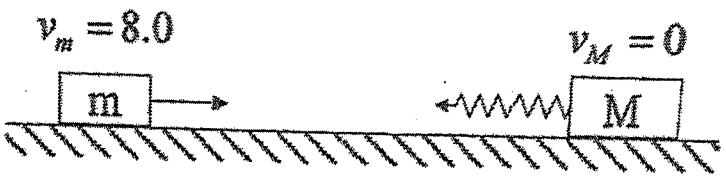
科目名稱：普通物理【醫科所碩士班選考】　　題號：428005

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

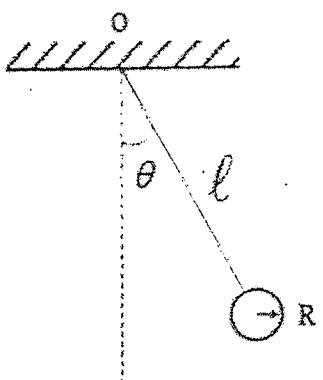
1. A stone of weight W is thrown vertically upward into the air with an initial speed u. A constant force f due to air resistance on the stone during its flight.
(a) Find the maximum height reached by stone. (5%)
(b) Find the speed of the stone upon impact with the ground. (5%)

2. Two objects with masses of m_1 and m_2 have the same kinetic energy and are both moving to the right. The same constant force F is applied to the left to both masses. If $m_1=4m_2$, what is the ratio of the stopping distance of m_1 to that of m_2? (10%)

3. A 2.0 kg block slides on the top of a frictionless table with a speed of 8.0 m/s toward another block (at rest) of mass 4.5 kg. A spring has spring constant k=850 N/m, is attached to the second block as shown in figure.
(a) What will be the maximum value when the spring is compressed? (10%)
(b) What will be the final velocities of the two blocks? (10%)



4. A cylindrical disk of mass M and radius R is hung by light string of length *l* on the rim. It is released from rest. See figure. What is the tension on the string when the disk swings to the lowest point? (10%)



5. A capacitor consists of two long concentric metal cylinders, the length L with the line charge density λ. The inner and outer cylinders have radii a and b, respectively.
(a) Find the capacitance in this cylindrical capacitor. (10%)
(b) Find the energy stored in this cylindrical capacitor in terms of line charge density. (10%)

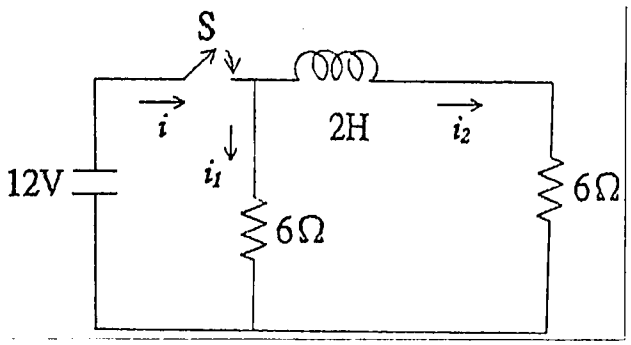
6. Resistor 1 has twice the resistance of resistor 2. They are connected in parallel to a battery. What is the ratio of the thermal energy generation rate in 1 to that in 2? (10%)

國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：普通物理【醫科所碩士班選考】　　題號：428005

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

7. The circuit shown in figure consists of a switch S, a DC power support of 12V, an inductor of inductance 2H and two resistors of 6Ω. The switch S was open for long time and close at t = 0. Determine the current i_1 and i_2 under the conditions (a) immediately after the switch is closed, (b) after the switch has been left closed for several minutes, (c) immediately after the switch is opened, (d) after the switch has been opened for long time. (20%)



國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：解剖學【醫科所碩士班選考】　　題號：428006

※本科目依簡章規定「不可以」使用計算機(混合題)　　

一、單選題(每題4分，共20分)

1. 圖一為甲苯酚紫(cresyl violet)染色的大鼠腦切片，請問此切片屬於何種方位切片？
(A) 水平 (B) 矢狀 (C) 冠狀 切面

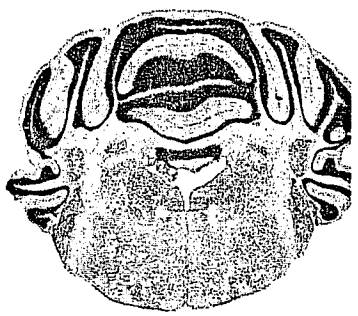
2. 圖二為人類大腦皮質的分區。請問哪個分區的活化可直接驅動四肢的運動功能？
(A) Area 4 (B) Area 5 (C) Area 6 (D) Area 7

3. 圖三為人類心臟的剖面圖。請問標示的哪個區域具有自發性放電的特性？
(A) 甲、乙 (B) 乙、丙 (C) 丙、丁 (D) 甲、丁

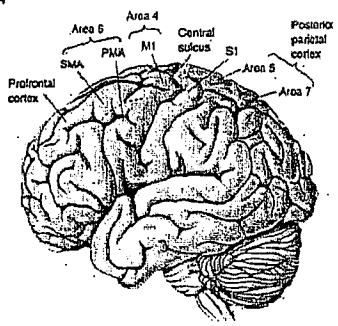
4. 圖四為人體呼吸系統的架構圖，請問哪個構造的活化或收縮會造成吸氣活動？
(A) Trachea (B) Diaphragm (C) Larynx (D) Pharynx

5. 圖五為人類膀胱的示意圖，請問哪個部位的肌肉可受到意識的控制？
(A) 甲 (B) 乙 (C) 丙

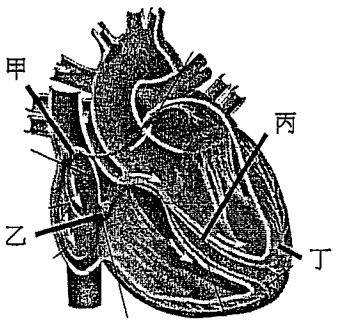
圖一



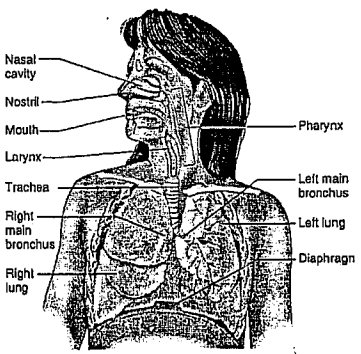
圖二



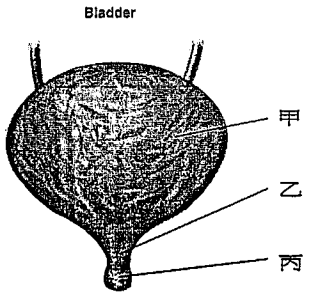
圖三



圖四



圖五



國立中山大學104學年度碩士暨碩士專班招生考試試題

科目名稱：解剖學【醫科所碩士班選考】　　題號：428006

※本科目依簡章規定「不可以」使用計算機(混合題)　　

二、問答題(共50分)

1. 請描繪一個典型的神經細胞並標示及說明以下構造(樹突、軸突、髓鞘、突觸)的功能。(15分)

2. 請描繪一個腎元的構造並說明尿液形成的機制。(15分)

3. 請描繪與標示大靜脈的結構並說明靜脈回心血受到哪些因素的調控。(10%)

4. 呼吸系統中有所謂的死腔(dead space)，請解釋生理(physiologic dead space)與解剖(anatomic dead space)死腔的定義。(10分)

三、閱讀與實驗設計(共30分)

1. 請閱讀下方文章內容並寫出中文摘要。(20%)
2. 請設計實驗驗證此篇論文所使用的神經追蹤劑的確是"activity-dependent"。(10%)

文章來源 **Exp Neurol. 261:440-50, 2014**

Injection of WGA-Alexa 488 into the ipsilateral hemidiaphragm of acutely and chronically C2 hemisected rats reveals activity-dependent synaptic plasticity in the respiratory motor pathways.

WGA-Alexa 488 is a fluorescent neuronal tracer that demonstrates transsynaptic transport in the central nervous system. The transsynaptic transport occurs over physiologically active synaptic connections rather than less active or silent connections. Immediately following C2 spinal cord hemisection (C2Hx), when WGA-Alexa 488 is injected into the ipsilateral hemidiaphragm, the tracer diffuses across the midline of the diaphragm and retrogradely labels the phrenic nuclei (PN) bilaterally in the spinal cord. Subsequently, the tracer is transsynaptically transported bilaterally to the rostral Ventral Respiratory Groups (rVRGs) in the medulla over physiologically active connections. No other neurons are labeled in the acute C2Hx model at the level of the phrenic nuclei or in the medulla. However, with a recovery period of at least 7 weeks (chronic C2Hx), the pattern of WGA-Alexa 488 labeling is notably changed. In addition to the bilateral PN and rVRG labeling, the chronic C2Hx model reveals fluorescence in the ipsilateral ventral and dorsal spinocerebellar tracts, and the ipsilateral reticulospinal tract. Furthermore, interneurons are labeled bilaterally in laminae VII and VIII of the spinal cord as well as neurons in the motor nuclei bilaterally of the intercostal and forelimb muscles. Moreover, in the chronic C2Hx model, there is bilateral labeling of additional medullary centers including raphe, hypoglossal, spinal trigeminal, parvicellular reticular, gigantocellular reticular, and intermediate reticular nuclei. The selective WGA-Alexa 488 labeling of additional locations in the chronic C2Hx model is presumably due to a hyperactive state of the synaptic pathways and nuclei previously shown to connect with the respiratory centers in a non-injured model. The present study suggests that hyperactivity not only occurs in neuronal centers and pathways caudal to spinal cord injury, but in supraspinal centers as well. The significance of such injury-induced plasticity is that hyperactivity may be a mechanism to re-establish lost function by compensatory routes which were initially physiologically inactive.

國立中山大學 104 學年度碩士暨碩士專班招生考試試題

科目名稱：電子學【醫科所碩士班選考】　　題號：428007

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共 2 頁第 1 頁

總分 100 分，請在答案紙上作答。

1. (18%) The parameters of the transistor in the circuit of Figure 1 are V_{TP} = -1.8 V and k_p = 2 mA/V^2. Design the circuit such that I_D = 4 mA, V_{SD} = 6 V, and R_{in} = 80 kΩ.

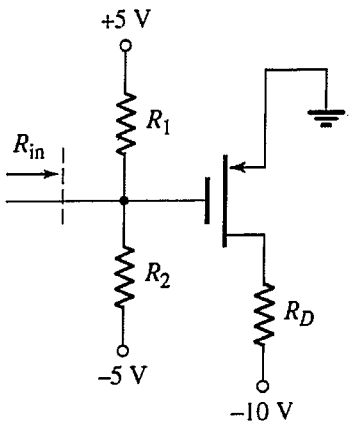


Figure 1

2. (24%) The transistor parameters for the circuit in Figure 2 are β = 200, V_A = 50 V, V_{EB} (on) = 0.7 V, and V_T = 0.026 V.
   (1) Find the voltage gain (A_v) of this amplifier. (8%)
   (2) Find the output resistance R_o. (8%)
   (3) Given the signal source $v_s(t)$ = 4 sinωt in unit of Volt, determine $i_o(t)$ and $v_o(t)$. (8%)

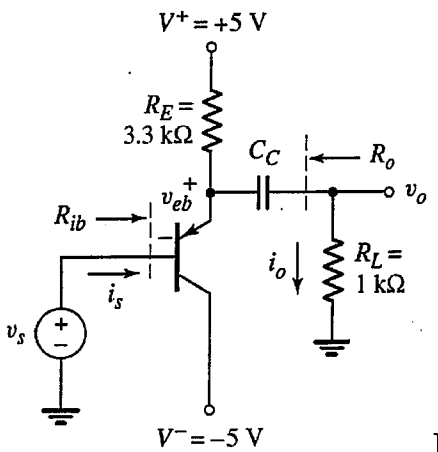


Figure 2

3. (16%) Two inverting operational amplifiers are connected in cascade (Figure 3). For an input voltage (v_I) of 5 mV with R_1 = 1 kΩ, R_2 = 10 kΩ, R_3 = 50 kΩ, and R_4 = 1 MΩ, determine
   (1) v_{O1} and v_O. (8%)
   (2) the current into or out of the output terminal of each op-amp. (8%)

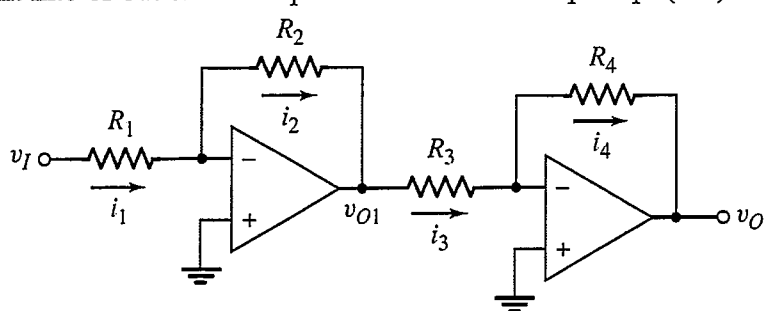


Figure 3

4. (20%) Figure 4 shows a differential amplifier consisting of two stages. The common-mode rejection ratio (CMRR) of stage 2 is 60 dB.
(1) For R_1 = 2 kΩ and R_2 = 5 kΩ, calculate the CMRR of stage 1. Then calculate the total CMRR provided by both stages. (10%)
(2) The ideal CMRR of stage 2 is infinitely large, but in practice it's not. For example, it's 60 dB in this case. Please explain the possible reason. (4%)
(3) As part of an amplifier, what is the main advantage(s) of each stage? (6%)

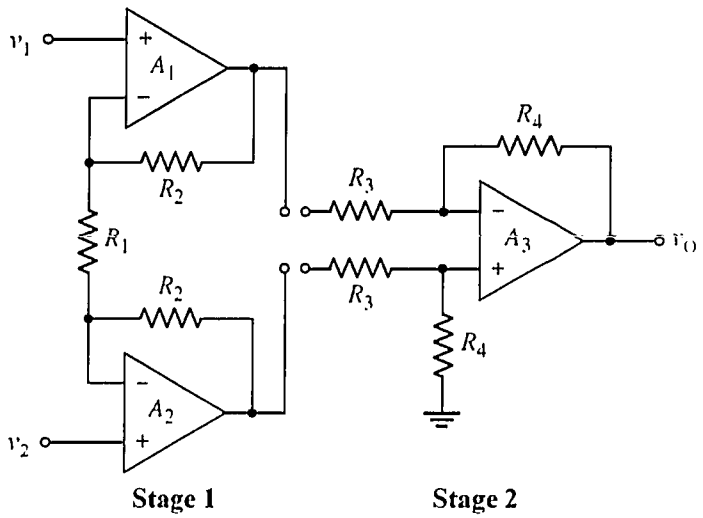


Figure 4

5. (22%) The non-inverting amplifier in Figure 5 consists of a basic op amplifier with an input resistance of $R_i = \infty$, an output resistance of $R_o = 0\ \Omega$, and a finite open-loop voltage gain of A.
(1) Express the closed-loop voltage gain (A_f) of this feedback circuit in the form of

$$A_f = \frac{v_o}{v_s} = \frac{A}{1+\beta A}$$

What is the expression of β? (8%)
(2) Given that $A = 10^5$ and $A_f = 20$, what is the corresponding R_2/R_1? (6%)
(3) If A increases by 10 percents, what is the percent change in A_f? (8%)

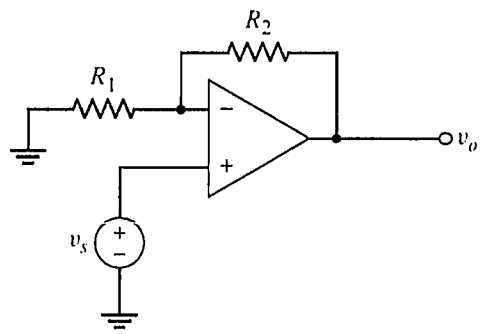


Figure 5