1. Choose and explain the corrective answer.

In the energy band diagrams, for a gallium rich GaAs semiconductor, the Fermi energy level; E_F is located at (1) Close to E_C above E_i ; (2) Close to E_V below E_i ; (3) in the middle between E_C above E_V ; (4) none of above. (20%)

2. Compare and explain "the characteristics between p-n diode and sckottky diode". (10%)

3. Describe and explain (a) the conditions of forming a better ohmic contact. (5 %) (b) In practice, how to obtain a ohmic contact ?. (5 %)

4. Describe and explain ;"how to obtain the dependence of the band gap on the temperature for a given semiconductor Si crystal." (20%)

5. Brief description "how to design a high gain and high current transistor". (20%).

6. Brief description the development and trend of semiconductor industry in Taiwan. (20%)

國立中山大學八十八學年度碩博士班招生考試試題

科 目：控制系統（電機工程學系博士班） 共 2 頁 第 1 頁

1. The following is an approximate mathematical model of a DC motor:

$$\ddot{\theta} + 65\dot{\theta} = 200v_a + 10w$$

The position error between θ and the reference angle θ_r is $e = \theta_r - \theta$. Consider using feedback of the error e and the motor speed $\dot{\theta}$ in the form

$$v_a = k_1(e - k_2\dot{\theta})$$

where k_1, k_2 are controller gains to be determined.

(a)(5%) If there is no load torque ($w = 0$), what speed (in rpm) results from $v_a = 100$ V?

(b)(5%) Find k_1, k_2 so that a step change in θ_r with zero load torque results in a transient that has an approximately 17% overshoot and that settles to within 5% of steady-state in less than 0.05 sec.

(c)(5%) Derive an expression for the steady-state error to an unit-step reference-angle input.

(d)(5%) Let $k_1 = 50$, $k_2 = 0.02$. Derive an expression for the steady-state error to an unit-step disturbance torque when $\theta_r = 0$.

2. (a)(5%) How can you modify the Routh criterion so that it can apply the case where all the poles are to be to the left of $-\alpha, \alpha > 0$?

(b)(10%) Apply your method to the polynomial

$$s^3 + (6 + k)s^2 + (5 + 6k)s + 5k = 0,$$

finding those values of k for which all poles have a real part less than -2.

3. The characteristic equation of a feedback control system is given by

$$s^3 + 12s^2 + ks + k = 0$$

where $0 \le k \le \infty$. Use Root-Locus Technique to find

(a)(3%) pole(s) of the closed-loop system for $k = 0$ and $k = \infty$.

(b)(3%) all the possible breakaway point(s).

(c)(2%) the intersections(centroid) of the asymptotes.

(d)(3%) the value of k at the point $(-8,\ 0)$, and

(e)(4%) sketch the root loci of the system.

4. Consider a control system with the loop transfer function

$$L(s) = \frac{K(s-1)}{s(s+1)}, \qquad -\infty \le K \le \infty$$

(a)(6%) Sketch the Nyquist Plot of this system for $K > 0$.

(b)(7%) Using Nyquist criterion, determine the range of $K(> 0)$ such that the closed-loop system is stable. If the system is unstable due to the range of K, find the number of closed-loop poles in the right-half of $s-$plane.

(c)(8%) Using Nyquist criterion and the Nyquist plot of $K > 0$, determine the range of $K(< 0)$ such that the closed-loop system is stable. If the system is unstable due to the range of K, find the number of closed-loop poles in the right-half of $s-$plane.

5.(14%) Is the following Jordan-form dynamical equation controllable? observable?

$$\dot{\mathbf{x}} = \left[\begin{array}{cc|ccc|cc} 7 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 7 & 0 & 0 & 0 & 0 & 0 \\ \hline 0 & 0 & 7 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 7 & 0 & 0 & 0 \\ \hline 0 & 0 & 0 & 0 & 9 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 9 & 0 \\ \hline 0 & 0 & 0 & 0 & 0 & 0 & 9 \end{array}\right] \mathbf{x} + \left[\begin{array}{ccc} 2 & 1 & 2 \\ 2 & 1 & 1 \\ \hline 1 & 0 & 1 \\ 3 & 2 & 1 \\ \hline -1 & 0 & 0 \\ 1 & 0 & 1 \\ \hline 1 & 0 & 0 \end{array}\right] \mathbf{u}$$

$$\mathbf{y} = \left[\begin{array}{cc|cc|cc|c} 2 & 1 & 1 & 3 & -1 & 1 & -1 \\ 1 & 1 & 1 & 2 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 & 1 & 1 \end{array}\right] \mathbf{x}$$

6.(15%) If β is a real constant, show that the time-invariant linear state equation

$$\dot{\mathbf{x}}(t) = \mathbf{A}\mathbf{x}(t) + \mathbf{B}u(t)$$

is controllable iff

$$\dot{\mathbf{z}}(t) = (\mathbf{A} - \beta\mathbf{I})\mathbf{z}(t) + \mathbf{B}u(t)$$

is controllable.

國立中山大學八十八學年度碩博士班招生考試試題

科　目：計算機概論（電機工程學系博士班）　　共 / 頁 第 / 頁

注意事項: 1. 答題時務須將要點敘述清楚. 2. 部份分數以答中要點為考量

1. (10%) Given a set A of 8 distinct elements, how many of the binary relations on A are symmetric and reflexive?

2. (10%) Prove by induction $1^3 + 2^3 + 3^3 + ... + n^3 = (1 + 2 + 3 + ... + n)^2$.

3. (15%) In a graph G(V,E) which is a forest with k components, prove |V| = |E| + k.

4. (15%) Given a distance matrix D for N nodes where D(i,j) is the distance between node i and node j and D(i,j) = D(j,i) for all i, j, design an algorithm and data structures to perform a minimum spanning tree construction. Explain why your algorithm is correct. (You can use pseudo algorithm and data structure representation.)

5. (20%) Design a set data structure and the algorithms of the four operations performed on the set.

   - insert(set,key,data) : the operation inserts the data with the key into the set
   - get(set): the operation returns a data with its key in the set and remove it from the set
   - search(set,key): the operation returns a data in the set with its key equal the key parameter and remove it from the set if found, else return NULL value
   - empty(set): the operation can test whether the set is empty or not

   Hint: Use the linked list data structure.

6. (20%) Design a 4-digit BCD-to-binary code converter sequential circuit that accepts 4-digit BCD code B_3, B_2, B_1, B_0, where B_i is represented as binary format $b_{i,3}$, $b_{i,2}$, $b_{i,1}$, $b_{i,0}$ and input *serially* from the most significant digit (B_3) to the least significant digit (B_0), and generates 14-bit binary code a_{13}, a_{12}, a_{11}, a_{10}, a_9, a_8, a_7, a_6, a_5, a_4, a_3, a_2, a_1, a_0 as output. You can use several 4-bit adder modules and shift registers in your design.

   Hint: This converter performs decimal to binary conversion. The conversion result A can be computed with the following equation

   $$A = ((B_3 * 10 + B_2) * 10 + B_1) * 10 + B_0$$

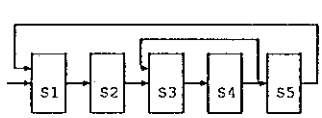
   Thus, you can use the recurrence equation

   $$A_{i+1} = A_i * 10 + B_{3-i}$$

   where $A_1 = B_3$ and $A = A_4$ to serially compute the result A_1, A_2, A_3, and A_4 (i.e. A). Note: You are required to design the circuit in this *serial* sequential circuit version.

7. (10%) A pipelined processor and its reservation table is shown in the following figure. Calculate its minimum average latency.

   Illustrate your calculation with reservation table, collision vector, and the state diagram for latency cycles.



pipelined configuration

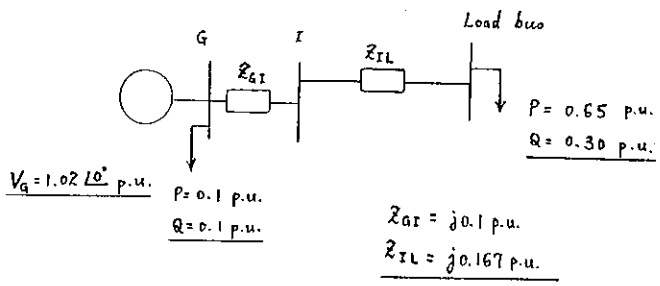
	1	2	3	4	5	6	7
S1	X					X	
S2		X					X
S3			X		X		
S4				X			
S5					X		

reservation table

國立中山大學八十八學年度碩博士班招生考試試題

科　目：電力工程（電機工程學系博士班）　　共 1 頁 第 1 頁

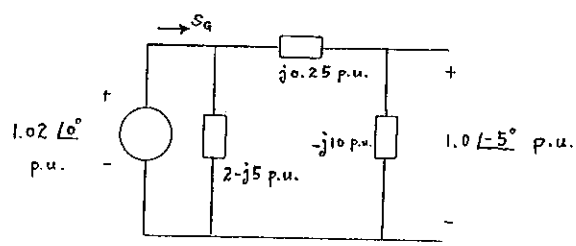
1. For the following power system, calculate the voltage at the load bus by using Gauss-Seidel method for 2 iterations (50%).



Initial: $V_I = 1.0\angle 0^\circ$, $V_{Load} = 1.0\angle 0^\circ$ } p.u.

Charging at: bus G = 0.05 p.u., bus I = 0.04 p.u., Load bus = 0.04 p.u. (all at 1.0 p.u voltage)

2. If the above system circuit is simplified into the form as shown below, what is the maximum real power (3-Φ) that can be supplied by the generator (30%)?



3. To simplify the dynamic and transient analyses of the above synchronous machine, some manipulations are generally required, what kind of transformation technique is commonly used and what advantages can be obtained by introducing such steps (20%)?

國立中山大學八十八學年度碩博士班招生考試試題

科　目：電磁波與光電工程導論

※本科試題包含兩大部份，請任選一部份作答。（電機工程學系博士班）

電磁波

1. Show that, if the wavelength of an electromagnetic wave in an unbounded medium characterized by μ and ε is greater than $2a$, then this wave cannot propagate in a rectangular waveguide of dimensions $a \times b$ with the dielectric inside the waveguide also characterized by μ and ε. (25%)

2. Derive the complete time-harmonic fields of the TE wave in a parallel-plate waveguide from the Helmholtz equation. (25%)

3. A uniform plane wave impinges obliquely on a plane interface between two dielectric materials of material constants (μ_1, ε_1) and (μ_2, ε_2). Derive the complete expressions of the fields of the reflected and transmitted waves for the perpendicular polarization case. (25%)

4. Briefly answer the following questions. (5% each)

a. What is the meaning of the polarization of a plane wave?

b. What is skin effect? Discuss your knowledge about skin effect.

c. Discuss the concept of the distributed circuit as compared to a lumped circuit.

d. Discuss the reasons for transmission-line matching and the principle behind matching.

e. What is a Brewster angle? Why is it also called a polarizing angle?

光電工程導論

1. 解釋 PMF 的特性及工作原理 (20%)

2. 解釋 Mach-Zehnder interferometer 及 Michelson interferometer 的結構及工作原理 (30%)

3. 解釋下列專有名詞 (50%)

(a) Holography

(b) f-number

(c) Helmhotz equation

(d) kerr effect

(e) photoconductive

(f) optical transfer function

(g) impule response function

(h) charge-carrier lifetime

(i) stimulated emission

(j) plane wave

國立中山大學八十八學年度[redacted]博士班招生考試試題

科 目：訊號與系統，（每題20分）　　共 1 頁 第 1 頁

一、試由 Linear Time-Invariant Lumped System 之內涵，推論系統輸出、輸入的單位脈衝响應之間的關係為 Convolution（疊積分）推論之系統為 discrete system.

二、什麼叫做 Parseval's Theorem，這个"帕氏定理"在信號分析上有何重要性？對於能量信號與功率信號各舉一个例子說明其內涵：

三、試推導 $f(k)=b^k$ ，$k\geq 0$ ，$b\in$ Complex number set 之 Z-轉換，並以此求

$g(k)=\sin k\omega_0 T$ ，$h(k)=\cos k\omega_0 T$ ，$k\geq 0$ 之 Z-轉換

四、什麼叫做 Transfer Function completely characterized System？這个"轉移函数可完全描述之系統"有何重要性，如果系統無法用轉移函数来完全表達，會出現什麼現象？如何克服？試以下列 discrete-time system 来討論之：

$$y(k)-y(k-1)-2y(k-2)=u(k-1)+u(k-2)$$

五、Find the Fourier Transform of

$$f(t)=e^{-|t|}\sin 10\cdot|t|\ ,\ \text{for all } t$$