系所別	組別	編號	考試科目
製造資訊與系統研究所	甲	199	自動控制
		200	工程數學
	乙	201	統計方法
		202	生產管理
	丙	203	計算機組織與系統
		204	程式設計

國立臺灣師範大學圖書館經費收遞知單

受文者	教務處第二組
受文日期	中華民國 102 年 12 月 04 日
受文字號	(102) 師圖資採薦購字第 004 號

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一、某一單位回授系統，其開迴路轉移函數為 $G(s) = \dfrac{10s+20}{s^2(s+20)}$

　　當輸入 $i(t) = 5 + 10t + 0.3t^2$，試求其穩態誤差？ (10%)

二、一具干擾的回授控制系統如圖 1 所示，試求下列:

(a) $E(s)$對$R(s)$之轉移函數? (4%)

(b) $E(s)$對$D(s)$之轉移函數? (4%)

(c) 由於$R(s)$所產生之穩態誤差$e_R(\infty)$? (4%)

(d) 由於$D(s)$所產生之穩態誤差$e_D(\infty)$? (4%)
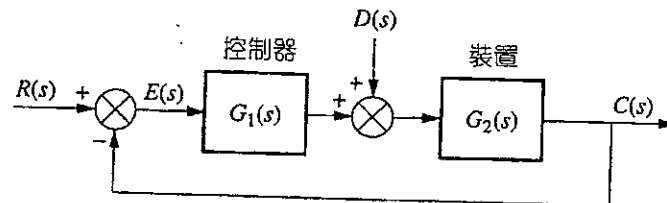
(e) 假設$D(s)$為一步階干擾，求因步階干擾產生的穩態誤差? (4%)

圖 1

三、一單位回授控制系統如圖 2 所示，其中 $G(s) = \dfrac{K(s-1)(s-2)}{s(s+1)}$

　　試求出下述：

(a) 其分離與會合點? (4%)

(b) 其$j\omega$軸交越點? (4%)

(c) 畫出其根軌跡圖。(4%)
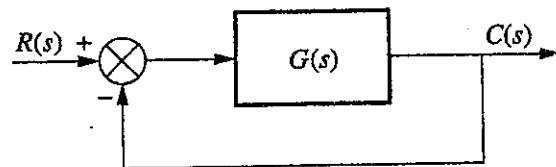
(d) 保持系統穩定的增益範圍? (4%)

(e) 求使其穩態系統具有阻尼比為 0.5 的 K 值? (4%)

圖 2

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

四、對於圖3之閉迴路系統，

$$R(s) \xrightarrow{+} \bigotimes \xrightarrow{-} \boxed{\dfrac{K}{s(s+6)}} \xrightarrow{} C(s)$$
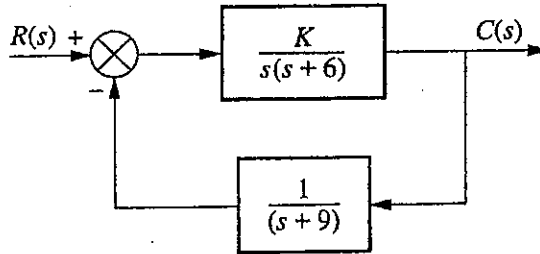
$$\boxed{\dfrac{1}{(s+9)}}$$

圖 3

(a)請畫出其奈氏圖? (10%)

(b)請利用奈氏準則，求使該系統穩定的 K 值範圍? (10%)

五、一單位回授系統G(s)的波德圖如圖4所示，試求下列：

(a) 增益邊限 (5%)　　　　　(b) 相位邊限 (5%)

(c) 0 分貝頻率 (3%)　　　　(d) 180°頻率 (3%)

(e) 閉迴路頻寬 (3%)　　　　(f) 系統阻尼比 (3%)
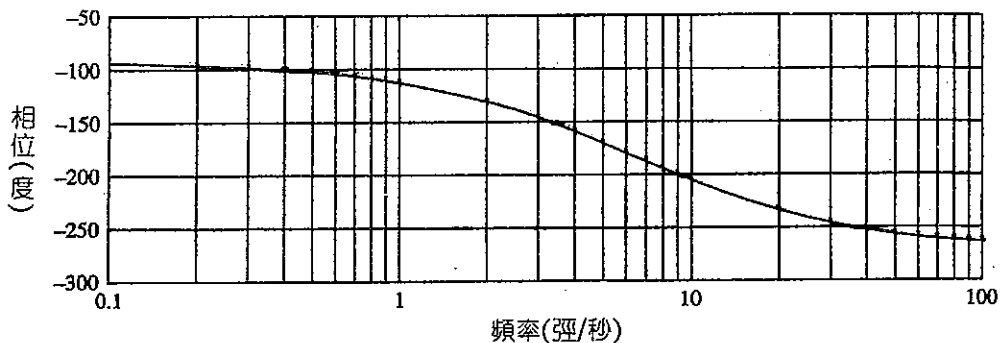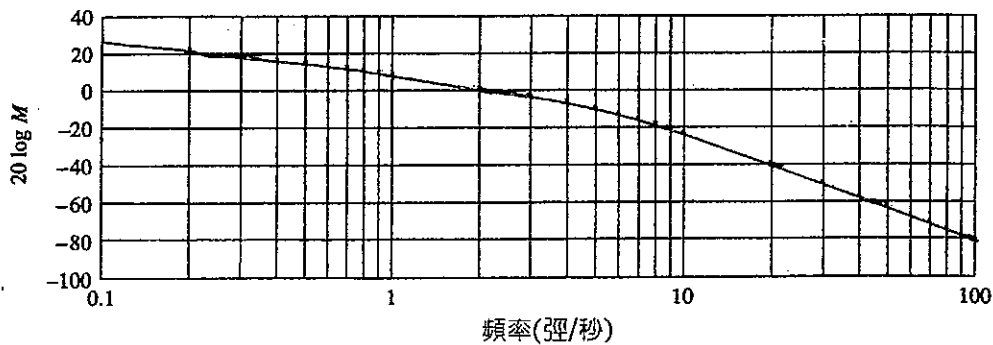
(g) 超越量百分比 (3%)　　　(h) 系統安定時間 (3%)

(i) 系統尖峰時間 (2%)

圖4

系　　　所：製造資訊與系統研究所

考試科目：自動控制　　　　　　　　　　　　　　　考試日期：0227，節次：1

※ 考生請注意：本試題 不可使用計算機。　　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

根號查表

$\sqrt{1.21}=1.1$	$\sqrt{1.61}\cong1.27$	$\sqrt{0.71}\cong0.84$
$\sqrt{1.22}\cong1.1$	$\sqrt{1.62}\cong1.27$	$\sqrt{0.72}\cong0.85$
$\sqrt{1.23}\cong1.11$	$\sqrt{1.63}\cong1.28$	$\sqrt{0.73}\cong0.85$
$\sqrt{1.24}\cong1.11$	$\sqrt{1.64}\cong1.28$	$\sqrt{0.74}\cong0.86$
$\sqrt{1.25}\cong1.12$	$\sqrt{1.65}\cong1.28$	$\sqrt{0.75}\cong0.87$
$\sqrt{1.26}\cong1.12$	$\sqrt{1.66}\cong1.29$	$\sqrt{0.76}\cong0.87$
$\sqrt{1.27}\cong1.13$	$\sqrt{1.67}\cong1.29$	$\sqrt{0.77}\cong0.88$
$\sqrt{1.28}\cong1.13$	$\sqrt{1.68}\cong1.3$	$\sqrt{0.78}\cong0.88$
$\sqrt{1.29}\cong1.14$	$\sqrt{1.69}\cong1.3$	$\sqrt{0.79}\cong0.89$
$\sqrt{1.3}\cong1.14$	$\sqrt{1.7}\cong1.3$	$\sqrt{0.8}\cong0.89$

e 查表

$e^{-1.51}\cong0.221$	$e^{-1.61}\cong0.2$	$e^{-1.71}\cong0.181$	$e^{-1.81}\cong0.164$	$e^{-1.91}\cong0.148$
$e^{-1.52}\cong0.219$	$e^{-1.62}\cong0.198$	$e^{-1.72}\cong0.179$	$e^{-1.82}\cong0.162$	$e^{-1.92}\cong0.147$
$e^{-1.53}\cong0.217$	$e^{-1.63}\cong0.196$	$e^{-1.73}\cong0.177$	$e^{-1.83}\cong0.160$	$e^{-1.93}\cong0.145$
$e^{-1.54}\cong0.214$	$e^{-1.64}\cong0.194$	$e^{-1.74}\cong0.176$	$e^{-1.84}\cong0.159$	$e^{-1.94}\cong0.144$
$e^{-1.55}\cong0.212$	$e^{-1.65}\cong0.192$	$e^{-1.75}\cong0.174$	$e^{-1.85}\cong0.157$	$e^{-1.95}\cong0.142$
$e^{-1.56}\cong0.21$	$e^{-1.66}\cong0.19$	$e^{-1.76}\cong0.172$	$e^{-1.86}\cong0.156$	$e^{-1.96}\cong0.141$
$e^{-1.57}\cong0.208$	$e^{-1.67}\cong0.188$	$e^{-1.77}\cong0.170$	$e^{-1.87}\cong0.154$	$e^{-1.97}\cong0.139$
$e^{-1.58}\cong0.206$	$e^{-1.68}\cong0.186$	$e^{-1.78}\cong0.169$	$e^{-1.88}\cong0.152$	$e^{-1.98}\cong0.138$
$e^{-1.59}\cong0.204$	$e^{-1.69}\cong0.185$	$e^{-1.79}\cong0.167$	$e^{-1.89}\cong0.151$	$e^{-1.99}\cong0.137$
$e^{-1.6}\cong0.202$	$e^{-1.7}\cong0.183$	$e^{-1.8}\cong0.165$	$e^{-1.9}\cong0.15$	$e^{-2}\cong0.135$

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Find the angle between vectors **a** = 2**i** + 3**j** + **k** and **b** = -**i** + 5**j** + **k**?　(20%)

   (Hint: For the answer, you just write, for example, $\theta = \tan^{-1}(x/y)$. You don't need to solve x/y value. "tan" is just an example, it can be sin, cos, or tan.)

2. Find an equation of the plane with normal vector **n** = 2**i** + 8**j** − 5**k** containing the point (4, -1, 3)?　(20%)

3. Given following equations:

$$2x_1 - 9x_2 = 15$$
$$3x_1 + 6x_2 = 16.$$

   1) Please write them to be the format as Ax=b, where A is a 2x2 matrix, x is a 2x1 vector and b is also a 2x1 vector.　(10%)

   2) Please solve unknown x vector?　(10%)

4. Find the eigenvalues and eigenvectors of **A** = $\begin{pmatrix} 3 & 4 \\ -1 & 7 \end{pmatrix}$?　(20%)

5. Convert $(-\sqrt{2},\ \sqrt{2},\ 1)$ in (x,y,z) rectangular coordinates to cylindrical coordinates (r, θ ,z) ?　(20%)

※ 考生請注意：本試題不可使用計算機。　請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、

單選題 (72%)：每題 4 分，答錯者倒扣 1 分

1. The most common types of variables are quantitative variable (continuous and discrete), Ranked (ordinary) variables and categorical data. For the categorical data is
   A. Length, weight, temperature, volume, and height
   B. Trees per hectare, arms per sea star, or items per quadrat
   C. Species, gender, genotype, healthy/disease, and material status
   D. None of above

2. According to previous question (1.), which appropriate method can be used for testing a hypothesis involving two independent samples?
   A. Chi-square test
   B. Unpaired *t* test
   C. Wilcoxon rank sum test
   D. Welch's approximate *t* test

3. Beside sample variance, standard deviation, and range to obtain measures of the spread and variability, "quartiles" divide a distribution in quarters and generate five-number summaries. The visual counterpart to a five-number summary is
   A. Scatter plot
   B. Box plot
   C. Histogram
   D. Bar chart/graph

4. Suppose that on a field trip to Guatemala (瓜地馬拉) you decide to study handsome fungus beetles (偽瓢蟲科). The population you investigate is composed of 70% females and 30% males. Additionally, it has two color morphs, dull brown (60%) and bronze (40%). Half of all the insects are dull brown females. What is the probability that a randomly selected individual is either dull brown or female?
   A. 0.8
   B. 0.7
   C. 0.2
   D. 0.6

5. For probability distributions, we generally consider two classes of random variables, discrete and continuous. Which one in the following is NOT used for a discrete variable distribution?
   A. Binomial distribution
   B. Normal distribution
   C. Poisson distribution
   D. None of above

6. The probability that a continuous random variable (X) takes any specific value (c), P($X=c$),
    A. depends on the probability density function
    B. is very closed to 1.0
    C. is at least 0.5
    D. is equal to zero

7. Which following distribution is used to estimate confidence interval for the variance?
    A. Binomial distribution
    B. Student's t distribution
    C. F distribution
    D. X^2 distribution

8. To determine a confidence interval for the population mean, which number is NOT required?
    A. Null and alternative hypotheses
    B. A point estimate, the sample mean
    C. A measure of variability, the standard error of the mean
    D. The sampling distribution of the point estimate, standard normal distribution

9. Which typical steps in the following is NOT included in the general methodology of a statistical test of hypothesis?
    A. Formulate null and alternative hypotheses based on problem statement
    B. Determine the critical value and P value based on the level of significance and appropriate test statistic
    C. Estimate sample size based on confidence interval of the sample mean
    D. Compare the test statistic to critical value and compare the P value to the chosen level of significance

10. We define the margin of error for a (1-α) 100% confidence interval for a population proportion to be $m = z_{1-\alpha/2}\text{SE}_{\hat{p}} = z_{1-\alpha/2}\sqrt{\dfrac{\hat{p}(1-\hat{p})}{n}}$. The researcher specifies m and the confidence level, whose value of $z_{1-\alpha/2}$ is determined. Thus, to solve for the sample size n we simply need $\hat{p}$. However, since researcher has not yet done the study, is unknown. The way to solve for this equation is to fix the value (n) and maximize the term of $\hat{p}(1-\hat{p})$. By doing this, we will obtain

   A. $m \le z_{1-\alpha/2}\sqrt{\dfrac{0.25}{n}}$

   B. $m \le z_{1-\alpha/2}\sqrt{\dfrac{0.50}{n}}$

   C. $m \le z_{1-\alpha/2}\sqrt{\dfrac{0.90}{n}}$

D. $m \leq z_{1-\alpha/2} \sqrt{\dfrac{0.99}{n}}$

11. When the confident level increases from 95% to 99%, the range of confident interval will
 A. become narrower
 B. be not changed
 C. become wider
 D. result in increasing P value

12. When applying chi-square test to your data, you find that at least one of the expected values is/are less than 5. What is the proper way to improve this statistical testing?
 A. Use Yales' correction for further analysis
 B. Change to Fisher's exact test
 C. Use Bonferroni correction for further analysis
 D. Change to Wilcoxon rank sum test

13. What type of error is the probability of accepting a false null hypothesis?
 A. Type I (α)
 B. Type II (β)
 C. Either Type I or Type II, depending on the level of significance
 D. Either Type I or Type II, depending on whether the test is one-tailed or two-tailed

14. If the level of significance of a hypothesis test is decline from 0.05 to 0.01, the power of the test
 A. Will also decrees from 0.05 to 0.01
 B. Will not change
 C. Will increase
 D. Will decrease

15. In which following condition, Student's t distribution will approximate to the standard normal distribution?
 A. Increase sample size
 B. Decrease degree of freedom
 C. Raise confident level
 D. Lower Type I error

16. Before applying two-sample test of hypothesis to you data, which following option is NOT necessary:
 A. Check whether population's distribution is normal or non-parametric
 B. Check if the two populations are normal and have equal variances
 C. Check the power of the test
 D. Check the dependence between two samples

17. The following option is NOT required for the estimation of sample size?
 A. The intrinsic variability among observations, σ, standard deviation of population
 B. Degree of freedom

    C.　Type I error (α)

    D.　Type II error (β)

18. Regarding the model for regression analysis, the error term is a random variable with a mean or expected value of

    A.　one

    B.　sample mean

    C.　any positive value

    D.　zero

二、

簡答題 (28%):

1. What's difference between standard (標準差) deviation and standard error/standard error of the mean (SEM, 標準誤)? (6%)

2. A researcher found his (her) experimental results with statistical test was P = 0.051. To our common understanding, this *p* value shows there is no statistical significance on your data, please answer and discuss the following questions

    a)　How do you explain this *p* value properly and encourage him/her? (5%)

    b)　How do you help him/her? (5%)

3. Normally economy-sized boxes of potato chips average 50 oz with a standard deviation of 5.0 oz. To improve quality control a new process is developed that you hope will significantly decrease variability. Forty boxes packed by the new process are weighted and have a standard deviation of 4.0 oz.

    a.　Please write down the formulation of null and alternative hypotheses in terms of the variance (5%)

    b.　What is the name of the statistic that is used to test hull hypothesis? And write down the mathematical equation to express the statistic. (Hint: *n* → sample size, *s* → sample standard deviation, and σ → population standard deviation) (7%)