UNIVERSITI SAINS MALAYSIA

Peperiksaan Semester Kedua
Sidang Akademik 2005/2006

April/Mei 2006

EEM 323 – SISTEM PERALATAN DAN PENGUKURAN

Masa : 3 Jam

ARAHAN KEPADA CALON:-

Sila pastikan kertas peperiksaan ini mengandungi **SEMBILAN** muka surat termasuk **DUA** muka surat **Lampiran** bercetak sebelum anda memulakan peperiksaan ini.

Jawab **LIMA** soalan.

Jawab semua soalan dalam Bahasa Inggeris. Walau bagaimanapun **SATU** soalan dibenarkan dijawab dalam Bahasa Malaysia.

...2/-

1. (a) Terangkan secara ringkas perbezaan utama antara Isyarat Elektrik dan Ultrasonik. Bagaimanakah isyarat Ultrasonik beroperasi? Dengan bantuan gambarajah yang sesuai, terangkan operasi sebuah sistem pengukuran anjakan Ultrasonik.

Briefly explain the main differences between Ultrasonic and Electrical Signals. How are Ultrasonic Signals generated? With the help of a suitable diagram, explain the operation of an Ultrasonic displacement measuring system.

(30%)

(b) Apakah teknik-teknik berbeza yang digunakan untuk pengukuran tekanan? Terangkan prinsip kerja sebuah penderia berasaskan kapasitor untuk pengukuran bezaan tekanan. Terbitkan persamaan antara voltan keluaran dan bezaan tekanan.

What are different techniques for the measurement of pressure? Explain the working principle of a differential pressure measuring system based on capacitive transducer and metallic diaphragm. Develop the expression between the output voltage and the differential pressure.

(35%)

(c) Terangkan kegunaan *anemometer* dawai panas rintangan malar dalam pengukuran halaju gas. Dapatkan persamaan di antara kelajuan cecair dalam arus yang melepasi dawai panas.

Explain the use of, constant resistance hotwire anemometer in the measurement of velocities of gases. Develop the expression between the velocity of fluid and the current passing through the hotwire.

(35%)

...3/-

2. (a) Takrifkan nilai pH bagi satu larutan. Terangkan dengan menggunakan gambarajah sesuai operasi bagi meter pH. Apakah faktor-faktor yang mempengaruhi ketepatannya?

Define the pH value of a liquid. Explain, with suitable diagram, the operation of a pH meter. What are the factors that govern its accuracy?

(30%)

(b) Apakah unsur-unsur penting didalam sebuah Sistem Pengambilan Data Digital? Terangkan kepentingannya secara ringkas.

What are the important elements of a Digital Data Acquisition System? Explain their importance briefly.

(35%)

(c) Apakah yang anda faham berkenaan pengantaramukaan? Bagaimanakah ia dilakukan didalam sistem analog dan digital? Terangkan secara ringkas.

What do you understand by interfacing? How is it done in analog and digital systems? Explain briefly.

(35%)

3. Tuliskan nota ringkas tentang mana-mana **EMPAT** daripada berikut.

*Write short notes on any **FOUR** of the following.*

(a) Alatubah Pembezaan Pembolehubah Linear (25%)
Linear Variable Differential Transformer (LVDT)

(b) Pengantaramukaan GPIB (25%)
GPIB Interfacing

(c) Tolok terikan dan kegunaannya (25%)
Strain gauges and their applications

(d) Sistem pengukuran tork jenis optik
Optical type torque measuring system (25%)

(e) Meter Pecutan Servo
Servo Accelerometer (25%)

...4/-

4. Dua bacaan berasingan yang sama panjang telah diambil bagi deretan denyut berkala yang telah dipancarkan melalui suatu saluran yang hingar. Bacaan sampel voltan tersebut ditunjukkan dalam Jadual 1.

Two separate recordings of equal length are made of a periodic pulse train being transmitted down a noisy channel. Table 1 shows the recorded values of the sampled voltages.

Jadual 1
Table 1

Recording 1	6.02	-5.98	7.92	-7.96	-0.78	-8.34	9.22	-2.65	-3.7	9.51
Recording 2	8.93	-7.20	-0.82	3.23	1.44	5.43	-9.88	-1.13	0.79	9.83
	5.53	3.50	-3.18	-8.85	8.21	1.69	-0.06	6.65	-8.00	-9.21
	-8.73	4.64	-8.49	-4.66	-8.84	5.55	-8.24	-0.37	2.71	4.63
	-0.78	7.27	-5.98	-3.97	9.11	4.23	2.99	-1.85	-5.27	3.81
	1.88	-0.92	-5.33	9.01	9.23	-3.7	5.08	-0.72	-5.08	-2.6
	6.62	-2.64	2.08	-5.91	-3.58	-1.65	3.64	-8.19	-3.50	4.84
	9.67	-8.55	-3.08	4.18	8.11	0.74	-3.87	-4.09	8.03	6.91

(a) Tentukan jumlah lengahan antara kedua-dua bacaan dan kala bagi bentuk gelombang tersebut.

Determine the amount of lag between the two recordings and the period of the waveform.

(20%)

(b) Terbitkan bentuk gelombang berkala tersebut.
Derive the periodic waveform.

(20%)

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(c) Nilaikan fungsi korelasi silang bagi bacaan 1 dan 2 dengan membetulkan dan tanpa membetulkan bagi kesan hujung. Anggarkan ralat akibat kesan hujung.

Evaluate the cross-correlation functions of recordings 1 and 2 with and without correcting for the end effect. Estimate the errors introduced by the end effect.

(30%)

(d) Apakah peratusan korelasi antara bacaan 1 dan 2 yang dinilai pada ekoran sifar? Andaikan peratusan korelasi ditakrifkan sebagai pekali korelasi ρ_{12}, didarab dengan 100%.

What is the percentage correlation between recordings 1 and 2 evaluated at zero lag? Assume percentage correlation is defined as the correlation coefficient ρ_{12}, multiplied by 100%.

(30%)

5. (a) Tunjukkan bahawa spektrum tenaga bagi isyarat nyata x(t) boleh didapati dengan menilai Jelmaan Fourier bagi fungsi autokorelasi.

Show that the energy spectrum of a real signal x(t) may be obtained by evaluating the Fourier Transform of its autocorrelation function.

(30%)

(b) Lakarkan spektrum ketumpatan tenaga bagi fungsi:-
Plot the energy spectral density of the function:-

...6/-

$$y(t) = \begin{cases} \sin\left[\frac{2\pi}{T}\left(t + \frac{3T}{4}\right)\right] & -\frac{3T}{4} \le t \le -\frac{T}{2} \\ 1.0 & -\frac{T}{2} \le t \le \frac{T}{2} \\ \sin\left[\frac{2\pi}{T}\left(t - \frac{3T}{4}\right)\right] & \frac{T}{2} \le t \le \frac{3T}{4} \\ 0 & \frac{3T}{4} \le t \le -\frac{3T}{4} \end{cases}$$

dimana T = 4 s.
where T = 4 s. (70%)

6. (a) Apakah kaedah-kaedah yang berbeza untuk menyukat suhu?

What are the different methods to measure temperature?

(10%)

(b) Apakah bahan yang biasa digunakan untuk meter suhu berasaskan rintangan?

What are the materials commonly used for resistance thermometer.

(10%)

(c) Terangkan prinsip kerja bagi termistor dan meter suhu berasaskan rintangan. Apakah perbezaannya?

Describe the working principle of a thermistor and resistance thermometer. What are the differences?

(35%)

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(d) Sebuah meter suhu berasaskan rintangan platinum diletakkan didalam satu salur untuk mengukur suhu bagi arus aliran udara. Meter suhu tersebut diletakkan didalam kelompang silinder berkeratan rentas 6 mm yang permukaan luarnya telah dikilatkan dengan kebertelusan $\epsilon = 0.08 \pm 0.02$. Kelajuan arus udara adalah 3 m/s dan bertekanan 1.0 atm. Meter suhu menunjukkan suhu sebanyak 115°C. Suhu dinding salur berukuran 193°C. Kirakan **suhu sebenar udara** dan anggarkan **ketakpastian** suhu ini. Anggapkan ketakpastian dalam pekali pemindahan haba secara olakan yang dikira menggunakan formula bersesuaian dari Jadual A yang disertakan dalam lampiran adalah ± 15 peratus. Anggap ketakpastian pada meter suhu rintangan adalah ± 0.03°C.

A platinum resistance thermometer is placed in a duct to measure the temperature of an airflow stream. The thermometer is placed inside a cylindrical shell 6 mm in diameter which has a polished outside surface with $\epsilon = 0.08 \pm 0.02$. *The airstream velocity is known to be 3 m/s and the pressure is 1.0 atm. The thermometer indicates a temperature of 115°C. The duct wall temperature is measured at 193°C. Calculate the* ***true air temperature*** *and estimate the* ***uncertainty*** *in this temperature. Assume that the uncertainty in the convection heat-transfer coefficient calculated with the appropriate formula from Table A attached is ± 15 percent. Assume that the uncertainty in the resistance-thermometer is ± 0.03°C.*

(45%)

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Formula sheet

Flow measurement:

Volumetric flow rate: $$Q = A_2\mu_2 = \frac{A_2}{\sqrt{1-(A_2/A_1)^2}}\sqrt{\frac{2g_c}{\rho}(P_1-P_2)}$$

Reversible adiabatic flow: $$c_pT_1 + \frac{\mu_1^2}{2g_c} = c_pT_2 + \frac{\mu_2^2}{2g_c}$$

Mass flow rate: $$\dot{m} = A_2\sqrt{\frac{2g_cP_2}{RT_1}(P_1-P_2)}$$

For compressible flow: $$\dot{m} = YKA_2\sqrt{2g_c\rho_1(P_1-P_2)}$$

Volume flow rate in rotameter: $$Q = A\left[\frac{1}{C_d}\frac{2g_cv_b}{A_b}\left(\frac{\rho_b}{\rho_f}-1\right)\right]^{1/2}$$

A = annular area = $$\frac{\pi}{4}\left[(D+ay)^2 - d^2\right]$$

A may become nearly linear, then: $$\dot{m} = C_1y\sqrt{(\rho_b-\rho_f)\rho_f}$$

Heat transfer-rate from the fine wire: $$q = (a+bu^{1/2})(T_\omega - T_\infty)$$

Also, $$q = i^2R_\omega = i^2R_0\left[1+\alpha(T_\omega - T_\infty)\right]$$

Temperature measurement:

The radius of curvature in bimetallic strip:

$$r = \frac{t\left\{3(1+m)^2 + (1+mn)\left[m^2 + (1/mn)\right]\right\}}{6(\alpha_2-\alpha_1)(T-T_0)(1+m)^2}$$

Linear temperature coefficient of resistance in resistance thermometer: