Second Semester Examination
2017/2018 Academic Session

May / June 2018

EEM323 - INSTRUMENTATION AND MEASUREMENT SYSTEMS

[SISTEM PERALATAN DAN PENGUKURAN]

Duration : 3 hours
[Masa : 3 jam]

Please ensure that this examination paper consists of **SEVENTEEN (17)** pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **TUJUH BELAS (17)** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

Instructions: This question paper consists of **SIX (6)** questions. Answer **FIVE (5)** questions. All questions carry the same marks.

[***Arahan:*** *Kertas soalan ini mengandungi **ENAM (6)** soalan. Jawab **LIMA (5)** soalan. Semua soalan membawa jumlah markah yang sama.]*

In the event of any discrepancies, the English version shall be used.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah digunapakai.]

You are not allowed to take this question paper out of the examination hall.
Anda tidak dibenarkan membawa kertas soalan ini keluar daripada dewan peperiksaan.

1. (a) Using suitable diagram, explain the difference between passive and active transducers. Give one example for each transducer.

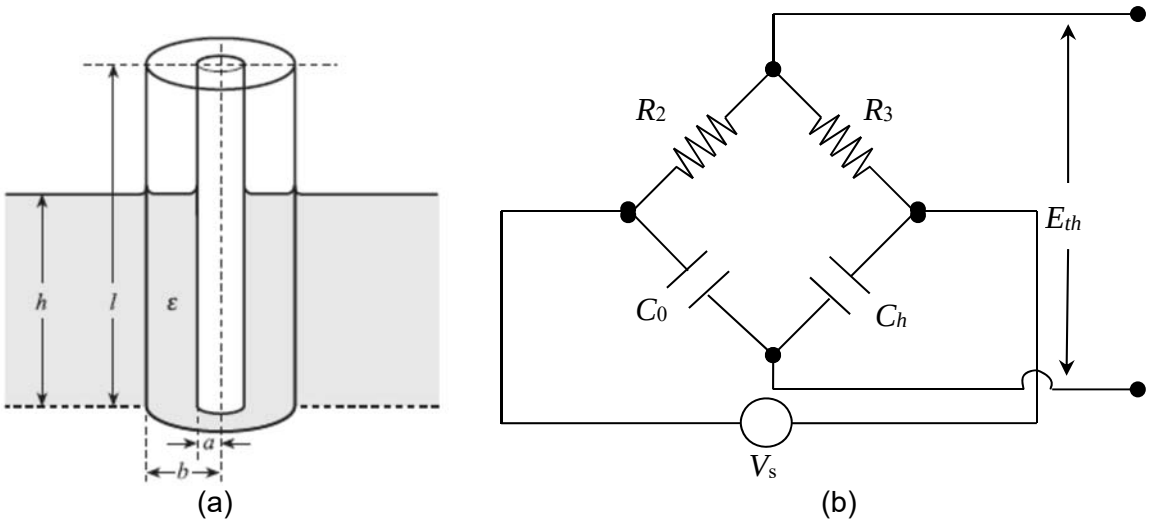
Menggunakan rajah yang sesuai, terangkan perbezaan di antara transduser pasif dan aktif. Beri satu contoh untuk setiap transduser.

(40 marks/markah)

(b) The capacitive sensor for level measurement is shown in Figure 1(a). The sensor consists of two concentric metal cylinders with inner and outer diameters of $2a$ and $2b$ respectively, and length l. The space between the cylinders is filled with a liquid of dielectric permitivity ε and at level h. The sensor is incorporated into the deflection bridge as shown in Figure 1(b). In this figure R_2, R_3 and C_0 are pure impedances. Meanwhile the capcitance of a sensor is given by:

Penderia kapasitan untuk pengukuran paras ditunjukkan di dalam Rajah 1(a)*. Penderia mengandungi dua silider logam berpusat dengan garis pusat* $2a$ *dan* $2b$ *masing-masingnya*, *dan panjang* l. *Ruang di antara silinder dipenuhi cecair dengan permitiviti dielektrik* ε*, dan pada paras* h. *Penderia dimasukkan ke dalam tetimbang pesongan seperti yang ditunjukkan di dalam Rajah* 1(b). *Di dalam rajah ini* R_2, R_3 *dan* C_0 *adalah impedans tulen. Manakala itu kapasitan penderia diberikan oleh*:

$$C_h = \frac{2\pi\varepsilon_0}{\ln\left(\frac{b}{a}\right)}[l + (\varepsilon - 1)h]$$



(a) (b)

Figure 1
Rajah 1

(i) derive the actual Thevenin voltage, $E_{th}(\text{actual})$,

terbit voltan Thevenin sebenar, $E_{th}(\text{sebenar})$

(20 marks/markah)

(ii) assuming $\varepsilon_0 = 1$, $\varepsilon = 5$, $l = 10$ m, $\frac{b}{a} = 1.2$, $V_s = 10$ V (rms) and $R_2 = R_3$, plot E_{th} versus h for $h = (0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0)$ m ,

mengandaikan $\varepsilon_0 = 1$, $\varepsilon = 5$, $l = 10$ *m*, $\frac{b}{a} = 1.2$, $V_s = 10$ *V (rms) dan* $R_2 = R_3$, *plot* E_{th} *lawan* h *untuk* h *= (0.5, 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0, 10.0) m,*

(15 marks/markah)

(iii) from 1(b)(ii), calculate the maximum non-linearity, $N(I)$, and,
daripada 1(b)(ii), kira tidak-lineariti maksimum, $N(I)$, dan,

(15 marks/markah)

(iv) suggest one way to reduce $N(I)$.
cadang satu cara untuk mengurangkan $N(I)$.

(10 marks/markah)

2. (a) State Nyquist sampling theorem. Hence explain the importance of this theorem in signal acquisition.

Nyatakan teorem pensampelan Nyquist. Terangkan kepentingan teorem ini di dalam perolehan isyarat.

(40 marks/markah)

(b) The sample-and-hold (S/H) circuit with FET switch is shown in Figure 2.
Litar sampel-dan-pegang (S/H) dengan suis FET ditunjukkan di dalam Rajah 2.

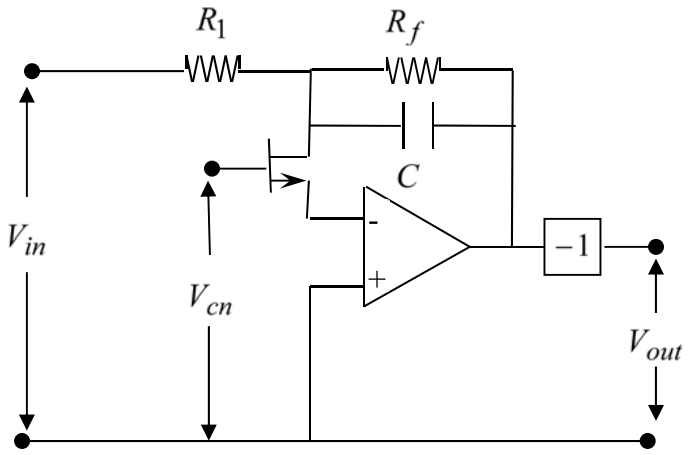


Figure 2
Rajah 2

(i) explain how S/H circuit in Figure 2 works,
terangkan bagaimana litar S/H di dalam Rajah 2 bekerja,

(20 marks/markah)

(ii) assuming step input of amplitude 5 V, and $R_1 = R_f = R$, design S/H circuit in Figure 2 so that V_{out} tracks V_{in} within 0.5 % in 1 ms,

andaikan input langkah dengan amplitud 5 V, dan $R_1 = R_f = R$, rekabentuk litar Rajah 2 supaya V_{out} menjejaki V_{in} dalam lingkingan 0.5 % *di dalam 1 ms*,

(20 marks/markah)

(iii) if the leakage current of op-amp $i = 10$ nA and internal holding time $i_h = 100$ ns, redesign the circuit in 2(b)(ii) so that the drop is within 0.5%.

jika arus tiris op-amp ialah $i = 10$ nA *dan masa tunggu dalaman* $i_h = 100$ ns*, rekabentuk semula litar dalam 2(b)(ii) supaya kejatuhan dalam lingkungan 0.5 %*.

(20 marks/markah)

Given/*Diberikan*

$\mathcal{L}\ k = \frac{k}{s}$

$\mathcal{L}^{-1}\ \frac{a}{s(s+a)} = 1 - e^{-at}$

3. (a) Briefly explain the following terms when referring to Universal Serial Bus (USB) communication.

Secara ringkasnya jelaskan terma-terma berikut apabila merujuk kepada Bus Universal Bersiri (USB)

(i) Master/slave communication
Komunikasi tuan/hamba

(ii) Half-duplex mode
Mod setengah dupleks

(iii) Non Return to Zero Inverted (NRZI)
Tidak Kembali ke Sifar Songsang (NRZI)

(iv) Bit stuffing
Pemadatan bit

(40 marks/markah)

(b) Figure 3 shows a sequence of digital raw data which is being transmitted from master to slave in a typical USB bus.

Rajah 3 menunjukkan jujukan data mentah berdigit yang sedang dihantar daripada tuan ke hamba di dalam bus USB yang tipikal.

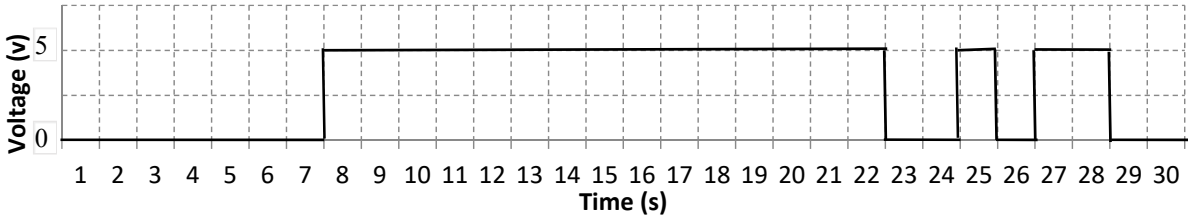


Figure 3
Rajah 3

Plot the new sequence after
Plot jujukan baru selepas

(i) bit stuffing, and,
pemadatan bit, dan, (30 marks/markah)

(ii) NRZI encoding.
Pengekodan NRZI. (30 marks/markah)