

**SULIT**

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First Semester Examination  
2022/2023 Academic Session

February 2023

**EEM355 – Mechatronic Systems  
(Sistem-Sistem Mekanik)**

Duration : 2 hours  
(Masa : 2 jam)

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Please check that this examination paper consists of **EIGHT (8)** pages of printed material including appendix before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **LAPAN (8)** muka surat yang bercetak termasuk lampiran sebelum anda memulakan peperiksaan ini.]*

**Instructions** : This paper consists of **FOUR (4)** questions. Answer **FOUR (4)** questions.

**Arahan** : Kertas ini mengandungi **EMPAT (4)** soalan. Jawab **EMPAT (4)** soalan.]

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

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

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**SULIT**

1. a) Digital signals from a sensor are polluted by noise and interference and are typically of the order of 100V or more. Explain how protection can be afforded for a microprocessor to which those signals are to be inputted.

*Isyarat digital dari suatu penderia yang tercemar oleh hingar dan gangguan, dan biasanya melebihi 100V. Jelaskan bagaimana perlindungan dapat diberikan untuk sebuah mikropemproses bagi isyarat yang akan dimasukkan.*

(20 marks/markah)

- b) An ADC (Analogue to Digital Converter) takes a finite time to do the conversion. Problem arises when the input signal changes during the conversion. Suggest a technique to overcome the problem by using hardware complete with circuit diagram.

*ADC (penukar analog-digit) mengambil masa terhad untuk melakukan penukaran. Masalah timbul apabila isyarat masukan berubah semasa penukaran. Cadangkan satu teknik untuk mengatasi masalah ini dengan menggunakan perkakasan lengkap dengan gambarajah litar.*

(30 marks/markah)

- c) An automatic control system for the temperature of a hot water tank consists of a reference voltage fed into a difference amplifier. This is connected to a relay which then switches on or off the electrical power to a heater in the water. Negative feedback is provided by a measurement system which feeds a voltage into the difference amplifier. Sketch a block diagram of the system and explain how the error signal is acquired.

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*Sistem kawalan automatik untuk suhu tangki air panas terdiri daripada voltan rujukan dimasukkan ke dalam penguat kebezaan. Ia dihubungkan dengan geganti yang kemudian akan menghidup atau mematikan kuasa elektrik untuk pemanas di dalam air tersebut. Suap balik negatif diberikan oleh sistem pengukuran yang menyuap voltan ke penguat kebezaan. Lakarkan gambarajah blok sistem dan jelaskan bagaimana isyarat ralat tersebut diperolehi.*

(50 marks/markah)

2. a) State four processes that can occur in signal conditioning.

*Nyatakan empat proses yang boleh berlaku dalam penyesuaian isyarat.*

(20 marks/markah)

- b) In a production line, an alarm system needs to be installed to give signals (audible and visible) if a problem occurs at the line. You are required to design an alarm system which meets the afore-mentioned objective. For your design, you are required (but not limited) to use the following integrated circuits: 7474 (dual positive edge triggered D-type flip-flop), 7408 (Quad 2-input AND gate). Discuss in detail the following issues:

*Dalam talian pengeluaran, pemasangan sistem penggera diperlukan untuk memberi isyarat (bunyi dan visual) jika masalah terjadi di talian. Anda dikehendaki untuk mereka bentuk suatu sistem penggera yang memenuhi objektif tersebut di atas. Untuk reka bentuk anda, anda dikehendaki (tetapi tidak terhad) untuk menggunakan litar bersepadu berikut: 7474, 7408. Bincangkan secara terperinci isu-isu berikut:*

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- (i). Logic gates connection

*Sambungan get logik*

- (ii). Overview of the system

*Gambaran keseluruhan sistem*

- (iii). Triggering the alarm

*Picuan penggera*

- (iv). Resetting the system

*Set semula sistem*

(80 marks/markah)

3. a) A two-pole, 50 Hz induction motor supplies 15 kW to a load at a speed of 2950 rpm.

*Satu dua-kutub, 50 Hz motor aruhan membekalkan 15 kW ke satu beban pada kelajuan 2950 rpm.*

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- (i). What is the induced torque in the motor under these conditions?  
State your assumption.

*Apakah kilas teraruh bagi motor dalam keadaan tersebut?  
Nyatakan andaian anda.*

- (ii). What will be the operating speed of the motor if its torque is doubled?

*Apakah kelajuan motor sekiranya kilas motor digandakan?*

(55 marks/markah)

- b) With the aid of circuit diagram and rotor current waveform, explain the rotor resistance control used in an induction motor by having a bridge rectifier and a switching transistor.

*Dengan bantuan gambarajah litar dan gelombang arus pemutar, terangkan kaedah kawalan rintangan pemutar yang digunakan dalam satu motor aruhan dengan adanya penerus titi dan pensuisan transistor.*

(45 marks/markah)

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4. a) The speed of a 20-hp, 300-V, 900-rpm separately excited DC motor is controlled by a three-phase full converter. The field circuit is also controlled by a three-phase full converter. The AC input to the armature and field converters is three-phase, Y-connected, 208 V, 60 Hz. The armature resistance is  $R_a = 0.25 \Omega$ , the field circuit resistance is  $R_f = 145 \Omega$ , and the motor voltage constant is  $k_v = 1.2 \text{ V/A rad/s}$ . The viscous friction and no-load losses can be considered negligible. The armature and field currents are continuous and ripple free. If the field converter is operated at the maximum field current and the developed torque is 116 Nm at 900 rpm, determine the delay angle of the armature converter.

*Kelajuan bagi satu 20-hp, 300-V, 900-rpm motor AT teruja-diri dikawal oleh satu tiga-fasa penukar penuh. Litar medan juga dikawal oleh satu tiga-fasa penukar penuh. Masukan AU ke penukar angker dan penukar medan adalah tiga-fasa, sambungan Y, 208 V, 60 Hz. Rintangan angker ialah  $R_a = 0.25 \Omega$ , rintangan litar medan ialah  $R_f = 145 \Omega$ , dan pemalar voltan motor ialah  $k_v = 1.2 \text{ V/A rad/s}$ . Geseran likat dan kehilangan tanpa beban boleh diabaikan. Arus angker dan arus medan adalah berterusan dan tanpa riak. Sekiranya penukar medan beroperasi pada arus medan maksimum dan kilas terorak ialah 116 Nm pada 900 rpm, tentukan sudut lengah bagi penukar angker.*

(70 marks/markah)

- (b) With the aid of circuit diagram, explain the principle of regenerative brake control.

*Dengan bantuan gambarajah litar, terangkan prinsip kawalan pembrekan jana semula.*

(30 marks/markah)

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**APPENDIX****LAMPIRAN**

<b>Question</b>	<b>Course Outcome (CO)</b>	<b>Programme Outcome (PO)</b>
1	2	PO2
2	3	PO3
3	2	PO2
4	3	PO3