SULIT

KEMENTERIAN PENDIDIKAN TINGGI
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN ELEKTRIK

PEPERIKSAAN AKHIR

SESI I : 2025/2026

DEQ50043 : ENERGY EFFICIENCY ENGINEERING 2

TARIKH : 08 DISEMBER 2025
MASA : 8.30 PAGI – 10.30 PAGI (2 JAM)

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.
Bahagian A: Struktur (3 soalan)
Bahagian B: Esei (2 soalan)
Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SECTION A: 60 MARKS
BAHAGIAN A: 60 MARKAH

INSTRUCTION:
This section consists of **THREE (3)** structured questions. Answers **ALL** questions**.**

ARAHAN :
*Bahagian ini mengandungi **TIGA (3)** soalan struktur. Jawab **SEMUA** soalan.*

QUESTION 1
SOALAN 1

CLO1 (a) Energy efficient chiller is selected based on its cooling capacity. Discuss the required criteria of chiller that are suitable for a building with a cooling capacity of 300TR (Tons of Refrigeration).

Penyejuk yang cekap tenaga dipilih berdasarkan kepada kapasiti penyejukannya. Bincangkan keperluan-keperluan penyejuk yang sesuai bagi bangunan dengan kapasiti penyejukan 300TR.

[5 marks]
[*5 markah*]

CLO1 (b) Explain about the efficiency of a pump. Your answer should also include the explanation of **TWO (2)** important parameters in achieving energy efficient pump.

*Jelaskan tentang kecekapan sebuah pam. Jawapan anda perlu menerangkan **DUA (2)** parameter penting di dalam mencapai pam yang cekap tenaga.*

[5 marks]
[*5 markah*]

CLO1 (c) An Air Handling Unit (AHU) fitted with 10kW blower operates 10 hours per day. If a Variable Speed Drive (VSD) being installed and the power reduce to 5kW, calculate saving per year based on tariff RM0.4562/kWh.

Sebuah Unit Pengendalian Udara (AHU) yang dipasangkan dengan kipas berkuasa 10kW beroperasi selama 10 jam sehari. Jika Pemacu Kelajuan Pemalar (VSD) dipasang dan kuasa dikurangkan kepada 5kW, kiraan jimat setahun berdasarkan kadar RM0.4562/kWh.

[10 marks]
[*10 markah*]

QUESTION 2
SOALAN 2

CLO1 (a) Explain **FIVE (5)** ways to alter the flow of a fan.

*Jelaskan **LIMA (5)** cara untuk mengubah aliran kipas.*

[5 marks]
[*5 markah*]

CLO1 (b) Discuss the **FIVE (5)** important factors required to be considered when selecting a motor for any of the diversified industrial applications.

*Bincangkan **LIMA (5)** faktor reka bentuk penting yang perlu dipertimbangkan semasa memilih motor untuk mana-mana aplikasi industri.*

[5 marks]
[*5 markah*]

CLO1 (c) A small factory plans to reduce its electrical energy consumption by one of their motors in the production section. The existing old motor has the efficiency of 85 %, will be replaced by a new 95 % energy efficient motor. Calculate the power saving and energy consumption saving per day if the 50 HP motor operates 10 hours per day at a load of 0.80.

Sebuah kilang kecil merancang untuk mengurangkan tenaga elektrik yang digunakan oleh salah satu motor di bahagian pengeluaran. Motor sedia ada mempunyai kecekapan 85 %, akan digantikan dengan motor baru 95 % cekap tenaga. Kira penjimatan kuasa dan penjimatan penggunaan tenaga setiap hari jika motor 50 HP beroperasi 10 jam sehari pada beban 0.80.

[10 marks]
[*10 markah*]

QUESTION 3
SOALAN 3

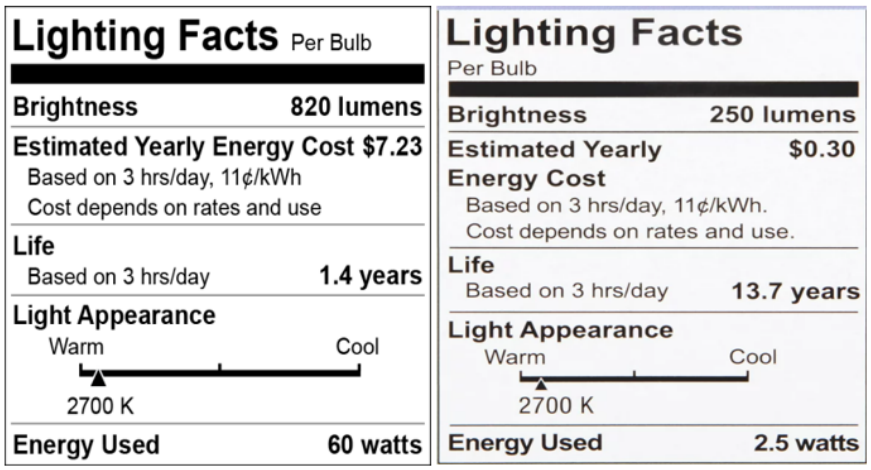
CLO1 (a) Explain the difference between Illuminance and Luminance.

Terangkan perbezaan antara Illuminance dan Luminance.

[4 marks]
[*4 markah*]

CLO1 (b) Figure A3(b) shows a lighting fact label for two different types of light bulb. Calculate the efficiency of both bulbs. From the calculation, which bulb is more efficient. Then, calculate the energy consumption per day for the efficient light bulb if it operates 10 hours per day.

Rajah A3(b) menunjukkan label fakta pencahayaan untuk dua jenis mentol lampu yang berbeza. Kira kecekapan kedua-duanya mentol. Dari pengiraan manakah mentol yang lebih cekap. Kemudian kira penggunaan tenaga setiap hari untuk mentol lampu yang cekap jika ia beroperasi 10 jam sehari.



Light bulb A **Light bulb B**

Figure A3(b) / Rajah A3(b)

[8 marks]

[*8 markah*]

CLO1 (c) A classroom is currently fitted with 120 fluorescent 30W lamps. All lamps operate 8 hours per day. If all lamps are replaced with 18W energy efficient LED which is cost RM 10.00 per lamp, and electric charge is RM0.4562/kWh, calculate the annual energy savings when using LED lamps.

Sebuah bilik darjah dipasang dengan 120 lampu pendarfluor 30W. Semua lampu beroperasi selama 8 jam sehari. Jika semua lampu tersebut digantikan dengan lampu LED cekap tenaga 18W yang berharga RM10.00 setiap satu, dan caj elektrik ialah RM0.4562/kWh, kirakan penjimatan tenaga tahunan apabila menggunakan lampu LED.

[8 marks]

[*8 markah*]

SECTION B : 40 MARKS

BAHAGIAN B :40 MARKAH

INSTRUCTION:

This section consists of **TWO (2)** essay questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **DUA (2)** soalan esei. Jawab **SEMUA** soalan.*

CLO1

QUESTION 1

SOALAN 1

A Plant requires an air maximum demand of 3,500 cfm for a compress air system. There are two option of compressor available. The compressor will run 8000 hours per year. The two options are shown in table B1. With an average tariff of RM0.4562/kWh, calculate the best option if the air demand required is 85% consumes 170 kW and power on VSD compressor is operated at the range of 86 – 302kW and its consumes 170kW.

Sebuah loji memerlukan permintaan udara maksimum sebanyak 3,500 cfm untuk sistem udara termampat. Terdapat dua pilihan pemampat yang tersedia. Pemampat tersebut akan beroperasi selama 8,000 jam setahun. Kedua-dua pilihan tersebut ditunjukkan dalam Jadual B1. Dengan kadar tarif purata sebanyak RM0.4562/kWh, kira pilihan terbaik jika permintaan udara yang diperlukan ialah 85%, dan kuasa bagi pemampat VSD berada dalam julat 86–302 kW serta ia menggunakan 170kW.

Table B1 */ Rajah B1*

Compressor Option / Pilihan Pemampat	**Option 1**	**Option 2**
	Two (2) medium size compressors	One (1) medium Compressor (specification as in Option 1) + One (1) compressor with VSD (parameters listed below)
Delivered Flow/ Aliran Penghantaran	1,621cfm	498 – 1,728cfm
Full Load Power/ Kuasa Muatan Penuh	271kW	86 – 302kW
Specific Power/ Kuasa Tentu	0.15kW/cfm	Variable
Specific Power/ Kuasa Tentu	100kW	-

[20 marks]

[*20 markah*]

CLO1

QUESTION 2

SOALAN 2

An office building is currently fitted with two units of 500 Refrigerant Ton (RT) Chiller. The specifications are shown in Table B2. The chiller operates 12 hours daily, 264 days per year with 3168 total yearly operating hours and a diversity factor of 0.80. The office building is charged by TNB with C1 Tariff as the maximum demand is RM19.50 per kW and energy charged at RM0.4562 per kWh. The current chiller is considered aging and the R11 refrigerant has also phased out soon. Since air conditioning still a must in the building, the chiller needs to be replaced with TWO (2) new energy efficiency chiller units. The cost of replacement is RM 1,000,000. The new chiller specification is shown in Table B2. Analyze the energy saving and return of investment (ROI) for the replacement of the new chiller.

Sebuah bangunan pejabat kini dipasang dengan dua unit pendingin air berkapasiti 500 Refrigerant Ton (RT). Spesifikasi terperinci ditunjukkan dalam Jadual B2. Pendingin air ini beroperasi selama 12 jam sehari, 264 hari setahun dengan jumlah masa operasi tahunan sebanyak 3168 jam, serta mempunyai faktor kepelbagaian

(diversity factor) sebanyak 0.80. Bangunan pejabat ini dikenakan caj oleh TNB di bawah Tarif C1, iaitu kadar caj permintaan maksimum sebanyak RM19.50/kW dan caj tenaga sebanyak RM0.4562/kWh. Pendingin air sedia ada dianggap telah usang dan bahan penyejuk R11 juga akan dihentikan penggunaannya tidak lama lagi. Oleh kerana penyaman udara masih diperlukan di bangunan ini, pendingin air tersebut perlu digantikan dengan dua unit pendingin air baharu yang lebih cekap tenaga. Kos penggantian dianggarkan sebanyak RM1,000,000. Spesifikasi pendingin air baharu ditunjukkan dalam Jadual B2. Analisis penjimatan tenaga dan pulangan pelaburan (ROI) bagi penggantian pendingin air baharu tersebut.

Table B2 / *Jadual B2*

Specification / Spesifikasi	Old/Lama	New/Baru
Capacity/ Kapasiti	500 RT (each)	500 RT (each)
Refrigerant Type/ Jenis Penyejuk	R11	R134a
Average Efficiency/ Keberkesanan purata	0.83kWe/RT	0.62kWe/RT
Evaporator in/out temperature/ Suhu masuk/keluar penyejat	44/54 F	44/54 F
Flowrate/ Kadar aliran	1,200 USGPM	1,200 USGPM
Condenser in/out temperature/ Suhu masuk/keluar pemeluwap	87/97 F	87/97 F
Flowrate/ Kadar aliran	1,500 USGPM	1,500 USGPM
Maintenance cost per year/ Kos penyelenggaraan setahun	RM84,000	RM60,000

[20 marks]

[*20 markah*]

SOALAN TAMAT

IMPORTANT FORMULA:

1. Energy Consumption:

Daily energy consumption = Power x Operating hours per day

Annual energy consumption = Daily energy consumption x Days per year

Total Energy Consumption (kWh)=Total RT× Efficiency × Total Yearly Hours × Diversity Factor

Energy consumption light bulb = power x operation hour

Energy consumption fluorescent per year = power x no of bulb x operation hour x 365

2. Operating Cost:

Total annual operating cost = Annual energy consumption x Tariff

Energy Saving per Day = Power Saving x Operating Hours per Day

ROI=Total Annual Savings / Replacement Cost

Efficiency bulb = Luminous flux (lumen) / input power (watt)

3. Power:

Motor input power = (0.7457 x hp x load) / efficiency (η)

Loading Power = Specific Power × Air Demand × Operating Hours

Peak Demand (kW) = Total RT × Efficiency