

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 II : 2024/2025

DEO40023 : OPTOELECTRONIC

TARIKH : 14 MEI 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 : Jadual Berkala, Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

SECTION A: 60 MARKS**BAHAGIAN A: 60 MARKAH****INSTRUCTION:**

This section consists of **THREE (3)** subjective questions. Answer **ALL** questions.

ARAHAN:

*Bahagian ini mengandungi **TIGA (3)** soalan subjektif. Jawab **SEMUA** soalan.*

QUESTION 1**SOALAN 1**

- CLO1 (a) With the aid of diagram, explain energy bands diagram.
Dengan bantuan gambarajah, terangkan gambar rajah jalur tenaga.
[5 marks]
[5 markah]
- CLO1 (b) Compare the energy band diagram of silicon and aluminum.
Bandingkan gambar rajah jalur tenaga bagi silikon dan aluminium.
[5 marks]
[5 markah]
- CLO1 (c) Examine the resistance of semiconductor, insulator and conductor regarding to band gap and temperature with an explanation.
Telitikan rintangan semikonduktor, penebat dan konduktor berkenaan dengan jurang jalur dan suhu dengan penjelasan.
[10 marks]
[10 markah]

QUESTION 2**SOALAN 2**

- CLO1 (a) Explain photon emission in LED.
Terangkan pancaran foton dalam LED.
[5 marks]
[5 markah]
- CLO1 (b) Discuss emission efficiency of LED.
Bincangkan kecekapan pancaran bagi LED.
[5 marks]
[5 markah]
- CLO1 (c) Solve the reabsorption issue that reduced emission efficiency of LED with appropriate structure.
Selesaikan isu penyerapan semula yang mengurangkan kecekapan pancaran LED dengan struktur yang sesuai.
[10 marks]
[10 markah]

QUESTION 3**SOALAN 3**

- CLO1 (a) Discuss the energy and momentum for direct radiative transition.

Bincangkan tenaga dan momentum bagi peralihan pancaran secara langsung.

[5 marks]

[5 markah]

- CLO1 (b) Explain radiative efficiency.

Terangkan kecekapan sinaran.

[5 marks]

[5 markah]

- CLO1 (c) Table A3(c) shown the value of energy gap, Auger constant and constant of proportionality for two material, GaAs and InGaAs. Calculate the radiative efficiency for both materials for the same electron density $n = 5 \times 10^{18} \text{cm}^{-3}$

Jadual A3(c) menunjukkan nilai bagi jurang tenaga, pemalar Auger dan pemalar perkadaran bagi dua bahan, GaAs dan InGaAs. Kirakan kecekapan sinaran bagi kedua-dua bahan dengan nilai ketumpatan elektron yang sama, $n = 5 \times 10^{18} \text{cm}^{-3}$.

Table A3(c)/ Jadual A3(c)

Materials/ Bahan	Energy gap/ Jurang tenaga (E _g)	Auger Constant/ Pemalar Auger (C _A)	Proportionality/ Perkadaran (B _r)
GaAs	1.42eV	$5 \times 10^{-30} \text{cm}^6/\text{s}$	$7.2 \times 10^{-10} \text{cm}^3/\text{s}$
InGaAs	0.74eV	$1 \times 10^{-28} \text{cm}^6/\text{s}$	$4 \times 10^{-11} \text{cm}^3/\text{s}$

[10 marks]

[10 markah]

SECTION B: 40 MARKS**BAHAGIAN B :40 MARKAH****INSTRUCTION:**

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

ARAHAN:

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

QUESTION 1**SOALAN 1**

CLO1

Photon detectors operate by the direct conversion of photons into charge carriers. Generated charge carriers need to be collected to obtain the signal. Demonstrate ways to collect these charge carriers with the help of suitable diagram.

Pengesan foton beroperasi melalui penukaran foton kepada pembawa cas secara langsung. Pembawa cas yang dihasilkan perlu dikumpulkan bagi menghasilkan isyarat. Demonstrasikan cara bagi mengumpulkan pembawa cas dengan bantuan rajah yang sesuai.

[20 marks]

[20 markah]

QUESTION 2**SOALAN 2**

CLO1

The avalanche multiplication process is the method to increase generated signal by PIN photodiode. Summarize this process with the help of appropriate diagram.

Proses gandaan runtuh adalah kaedah bagi meningkatkan isyarat yang dihasilkan oleh fotodiod PIN. Ringkaskan proses ini dengan menggunakan rajah yang sesuai

[20 marks]

[20 markah]

SOALAN TAMAT

LISTS OF FORMULA

SENARAI FORMULA

$$w = \frac{\lambda}{\Delta\theta_{\perp}}$$

$$P_{out} = \cos^n \theta$$

$$\sin \theta_c = \frac{n_2}{n_1}$$

$$I_{ph} = \frac{\eta e \lambda P_{opt}}{hc}$$

$$\frac{1}{2} = (1 - \cos \theta_c)$$

$$\eta_{ext} = \frac{\Omega}{4\pi} (T)$$

$$P_{opt} = \frac{2hcB}{\eta\lambda}$$

$$R = \frac{V_s - V_d}{i}$$

$$R = \frac{e\eta}{hv}$$

$$T = 1 - \left(\frac{n_1 - n_2}{n_1 + n_2} \right)$$

$$V_d = \frac{k_B T}{e} \ln \ln \left(\frac{i}{i_o} \right)$$

$$\Omega = \pi \theta_c^2$$

PERIODIC TABLE
JADUAL BERKALA

Periodic Table of the Elements

1 H Hydrogen 1.008	2 He Helium 4.002											13 B Boron 10.811	14 C Carbon 12.011	15 N Nitrogen 14.007	16 O Oxygen 15.999	17 F Fluorine 18.998	18 Ne Neon 20.180
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.887	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.905	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.905	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71 Lanthanides	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.222	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.387	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium 209	85 At Astatine 210	86 Rn Radon 222
87 Fr Francium 223	88 Ra Radium 226	89-103 Actinides	104 Rf Rutherfordium 261	105 Db Dubnium 262	106 Sg Seaborgium 266	107 Bh Bohrium 264	108 Hs Hassium 277	109 Mt Meitnerium 268	110 Ds Darmstadtium 271	111 Rg Roentgenium 272	112 Cn Copernicium 285	113 Uut Ununtrium 284	114 Fl Flerovium 289	115 Uup Ununpentium 288	116 Lv Livermorium 293	117 Uus Ununseptium 294	118 Uuo Ununoctium 294

57 La Lanthanum 138.905	58 Ce Cerium 140.12	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.967
89 Ac Actinium 227	90 Th Thorium 232	91 Pa Protactinium 231	92 U Uranium 238	93 Np Neptunium 237	94 Pu Plutonium 244	95 Am Americium 243	96 Cm Curium 247	97 Bk Berkelium 247	98 Cf Californium 251	99 Es Einsteinium 252	100 Fm Fermium 257	101 Md Mendelevium 258	102 No Nobelium 259	103 Lr Lawrencium 262

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