

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: 2024/2025

DEO40023: OPTOELECTRONIC

**TARIKH : 11 DISEMBER 2024
MASA : 08.30 PAGI – 10.30 PAGI (2 JAM)**

Kertas ini mengandungi **LAPAN (8)** halaman bercetak.

Bahagian A: Subjektif (3 soalan)

Bahagian B: Esei (2 soalan)

Dokumen sokongan yang disertakan : Formula, Jadual Berkala

JANGAN BUKA KERTAS SOALANINI 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) Discuss the creation of an electron in conduction band and hole in valence band.

Bincangkan tentang penghasilan elektron dalam jurang konduksi dan lubang dalam jurang valen.

[5 marks]

[5 markah]

- CLO1 (b) Explain energy band in solid state.

Terangkan jurang tenaga dalam keadaan pepejal.

[5 marks]

[5 markah]

- CLO1 (c) Show energy band diagram of insulator, semiconductor and conductor with an explanation.

Tunjukkan rajah jurang tenaga bagi penebat, semikonduktor dan konuktor 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 total internal reflection (TIR).

Bincangkan pantulan dalam penuh (TIR).

[5 marks]

[5 markah]

- CLO1 (c) Calculate the external efficiency for an indium gallium arsenide (InGaAs) LED emitting into air. Given refraction index for InGaAs is 3.99.

Kirakan kecekapan luaran bagi LED indium gallium arsenide (InGaAs) yang dipancarkan ke udara.

[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 heterojunction semiconductor.

Terangkan simpang hetero bagi semikonduktor.

[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 of $n = 5 \times 10^{18} \text{ cm}^{-3}$.

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, iaitu $n = 5 \times 10^{18} \text{ cm}^{-3}$.

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. Examine 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. Telitikan 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 multiplikasi runtuhannya 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***

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

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

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

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

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

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

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

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

$$\mathcal{R} = \frac{e\eta}{h\nu}$$

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

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

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

PERIODIC TABLE
JADUAL BERKALA

1

Periodic Table of the Elements

18

1	H Hydrogen 1.008	2
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13	14	15	16	17
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
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8

11 Na Sodium 22.990	12 Mg Magnesium 24.305
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13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.064	17 Cl Chlorine 35.453
18 Ar Argon 39.948				

19 K Potassium 39.09	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.937	23 V Vanadium 50.941	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.697	29 Cu Copper 63.54	30 Zn Zinc 65.39	31 Ga Gallium 69.723	32 Ge Germanium 72.621	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.94	
37 Rb Rubidium 84.468	38 Sr Strontium 87.620	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.966	42 Mo Molybdenum 95.955	43 Tc Technetium 98.907	44 Ru Ruthenium 101.027	45 Rh Rhodium 102.906	46 Pd Palladium 104.40	47 Ag Silver 107.868	48 Cd Cadmium 111.214	49 In Indium 111.818	50 Sn Tin 112.460	51 Sb Antimony 112.46	52 Te Tellurium 122.6	53 I Iodine 126.904	54 Xe Xenon 131.269

55 Cs Cesium 122.905	56 Ba Barium 137.328	57 Hf Hafnium 178.49	72 Ta Tantalum 180.942	73 Ta Tungsten 183.4	74 W Rhenium 186.207	75 Re Rhodium 192.217	76 Os Osmium 190.223	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Pt Platinum 196.967	80 Au Gold 196.972	81 Hg Mercury 204.993	82 Tl Thallium 207.2	83 Pb Lead 208.990	84 Po Polonium 208.992	85 At Astatine 219.997	86 Rn Radium 222.016
87 Fr Francium 223.020	88 Ra Radium 226.025	89 Ac Actinium 227.028	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Sesquium [263]	107 Bh Bohrium [264]	108 Hs Hassium [265]	109 Mt Meitnerium [266]	110 Ds Darmstadtium [267]	111 Rg Roentgenium [272]	112 Cn Copernicium [273]	113 Uut Ununtrium [274]	114 Fl Florium [285]	115 Uup Ununpentium [289]	116 Lv Livermorium [292]	117 Uus Ununseptium [293]	118 Uuo Ununoctium [294]

57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 144.943	60 Nd Neodymium 144.953	61 Pm Promethium 145.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967
89 Ac Actinium 227.028	90 Th Thorium 227.028	91 Pa Protactinium 227.029	92 U Uranium 238.029	93 Np Neptunium 237.029	94 Pu Plutonium 239.029	95 Am Americium 243.029	96 Cm Curium 247.029	97 Bk Berkelium 247.030	98 Cf Californium 251.030	99 Es Einsteinium 252.030	100 Fm Fermium 257.030	101 Md Mendelevium 258.031	102 No Nobelium 259.031	103 Lr Lawrencium 259.032