

**SULIT**



**BAHAGIAN PEPERIKSAAN DAN PENILAIAN  
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI  
KEMENTERIAN PENDIDIKAN MALAYSIA**

**JABATAN KEJURUTERAAN ELEKTRIK**

**PEPERIKSAAN AKHIR**

**SESI JUN 2019**

**DEO40023 : OPTOELECTRONIC**

**TARIKH : 22 OKTOBER 2019**

**MASA : 8.30 PAGI- 10.30 PAGI (2JAM)**

---

Kertas ini mengandungi **ENAM (6)** halaman bercetak.  
Bahagian A : Soalan Struktur ( 4 soalan)  
Bahagian B : Soalan Esei ( 1 soalan)  
Dokumen sokongan yang disertakan : Formula, Jadual Berkala

---

**JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN**

(CLO yang tertera hanya sebagai rujukan)

**SULIT**

**SECTION A : 80 MARKS**  
**BAHAGIAN A : 80 MARKAH**

**INSTRUCTION:**

This section consists of **FOUR (4)** structured questions. Answer **ALL** questions.

**ARAHAN:**

*Bahagian ini mengandungi EMPAT (4) soalan berstruktur. Jawab SEMUA soalan.*

**QUESTION 1**  
**SOALAN 1**

CLO1  
C1

- (a) Define **TWO (2)** families of quark.  
*Takrifkan DUA (2) famili quark.*

[4 marks]  
[4 markah]

CLO1  
C2

- (b) Explain the energy band in solid state physics.  
*Terangkan jalur tenaga dalam fizik keadaan pepejal.*

[6 marks]  
[6 markah]

CLO1  
C3

- (b) With the aid of diagram, show the comparisons between insulator, semiconductor and metal.  
*Dengan bantuan rajah, tunjukkan perbandingan antara penebat, semikonduktor dan logam.*

[10 marks]  
[10 markah]

**QUESTION 2****SOALAN 2**CLO1  
C1

- (a) Describe the atom arrangement of semiconductor in a crystal periodic structure.

*Huraikan susunan atom semikonduktor dalam struktur kristal berkala.*

[4 marks]

[4 markah]

CLO1  
C3

- (b) Explain the solution to avoid photon loss in order to increase external efficiency of Light Emitting Diode (LED) using related diagram.

*Terangkan satu penyelesaian untuk mengelakkan kehilangan foton agar kecekapan keluaran Diod Pemancar Cahaya (LED) dapat ditingkatkan dengan menggunakan gambarajah yang berkaitan.*

[6 marks]

[6 markah]

CLO2  
C3

- (c) A GaAs laser diode emitting at 830 nm (jalur lebar ruang bebas) has an angular width of  $18^\circ$  (full wave half maximum, FWHM) perpendicular to the plane of the junction.

Calculate the thickness of the active region and the value of  $n$  in  $\cos^n \theta$  angular depending on the perpendicular to the junction.

*Satu diod laser GaAs yang memancar pada 830 nm (jalur lebar ruang bebas) mempunyai lebar sudut  $18^\circ$  (lebar penuh separuh maksimum, FWHM) berserenjang dengan satah persimpangan. Kirakan ketebalan rantau aktif dan nilai  $n$  dalam  $\cos^n \theta$  bergantung kepada sudut berserenjang dengan satah persimpangan.*

[10 marks]

[10 markah]

**QUESTION 3****SOALAN 3**

- CLO1  
C2 (a) Explain the operation mechanism of Light Emitting Diode (LED).  
*Terangkan mekanisma pengoperasian bagi diod pemancar cahaya (LED).*
- [4 marks]  
[4 markah]
- CLO1  
C2 (b) Calculate the external efficiency for a GaAs LED emitted into air. Given  $n_1 = 3.6$ ,  $n_2 = 1$  and  $\theta_c = 16^\circ$ . Calculate the external efficiency for a GaAs LED emitted into air.  
*Kirakan kecekapan luaran bagi suatu LED GaAs yang dipancarkan ke udara. Diberi  $n_1 = 3.6$ ,  $n_2 = 1$  dan  $\theta_c = 16^\circ$ .*
- [8 marks]  
[8 markah]
- CLO1  
C3 (c) With the aid of a diagram, relate your knowledge of photon detectors and suggest a solution to improve the sensitivity of vacuum photodiode.  
*Dengan bantuan gambar rajah, kaitkan pengetahuan anda tentang pengesanan foton untuk mencadangkan penyelesaian bagi memperbaiki sensitiviti bagi fotodiod vakum.*
- [8 marks]  
[8markah]

**QUESTION 4****SOALAN 4**CLO1  
C2

(a) Explain photodiode detector.

*Terangkan pengesanan fotodiod.*

[4 marks]

[4 markah]

CLO1  
C3

(b) With the aid of diagram, show the differences of photovoltaic and photoconductive modes.

*Dengan bantuan rajah, Tunjukkan perbezaan antara mod fotovolta dan fotokonduksi.*

[8 marks]

[8 markah]

CLO1  
C3

(c) Draw a simplified model to determine the time response of a thermal detector.

*Lukiskan model ringkas bagi menentukan masa tindak balas bagi pengesanan haba.*

[8 marks]

[8 markah]

**SECTION B : 20 MARKS****BAHAGIAN B : 20 MARKAH****INSTRUCTION:**

This section consists of **ONE (1)** essay questions. Answer **ALL** questions.

**ARAHAN:**

*Bahagian ini mengandungi ONE (1) soalan esei. Jawab SEMUA soalan.*

**QUESTION 1****SOALAN 1**

CLO1  
C5

Three types of photodiodes are PIN, APD and Schottky photodiodes. With the function of optical photodetector, summarize Schottky photodiode in term of its structure, application, operation, advantages and disadvantages.

*Tiga jenis fotodiod iaitu iaitu fotodiod PIN, APD dan Schottky. Dengan fungsi sebagai pengesan foto optik, ringkaskan fotodiod Schottky dari segi struktur, aplikasi, operasi, kelebihan dan kekurangannya.*

[20 marks]  
[20 markah]

**SOALAN TAMAT**

## LISTS OF FORMULA

## SENARAI FORMULA

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

$$i = \frac{e\lambda P_{opt}}{n_i hc}$$

$$i_{n-dark} = [2eI_{do}M^{2+x}B]^{1/2}$$

$$i_{th} = J_{th} \times A$$

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

$$J_{th} = eB_r n_{th}^2 d$$

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

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

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

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

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

$$V_d = \frac{k_B T}{e} \ln\left(\frac{i}{i_0}\right)$$

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

# Periodic Table of the Elements

1																	18
1 <b>H</b> Hydrogen 1.008																	2 <b>He</b> Helium 4.003
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012											5 <b>B</b> Boron 10.811	6 <b>C</b> Carbon 12.011	7 <b>N</b> Nitrogen 14.007	8 <b>O</b> Oxygen 15.999	9 <b>F</b> Fluorine 18.998	10 <b>Ne</b> Neon 20.180
11 <b>Na</b> Sodium 22.990	12 <b>Mg</b> Magnesium 24.305											13 <b>Al</b> Aluminum 26.982	14 <b>Si</b> Silicon 28.086	15 <b>P</b> Phosphorus 30.974	16 <b>S</b> Sulfur 32.066	17 <b>Cl</b> Chlorine 35.453	18 <b>Ar</b> Argon 39.948
19 <b>K</b> Potassium 39.098	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.956	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.942	24 <b>Cr</b> Chromium 51.996	25 <b>Mn</b> Manganese 54.938	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933	28 <b>Ni</b> Nickel 58.693	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.631	33 <b>As</b> Arsenic 74.922	34 <b>Se</b> Selenium 78.971	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 83.798
37 <b>Rb</b> Rubidium 84.468	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.906	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.906	42 <b>Mo</b> Molybdenum 95.95	43 <b>Tc</b> Technetium 98.907	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.906	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.868	48 <b>Cd</b> Cadmium 112.414	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.711	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.904	54 <b>Xe</b> Xenon 131.29
55 <b>Cs</b> Cesium 132.905	56 <b>Ba</b> Barium 137.328	57-71 Lanthanides	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.948	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.217	78 <b>Pt</b> Platinum 195.085	79 <b>Au</b> Gold 196.967	80 <b>Hg</b> Mercury 200.592	81 <b>Tl</b> Thallium 204.383	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.980	84 <b>Po</b> Polonium [208.982]	85 <b>At</b> Astatine 209.987	86 <b>Rn</b> Radon 222.018
87 <b>Fr</b> Francium 223.020	88 <b>Ra</b> Radium 226.025	89-103 Actinides	104 <b>Rf</b> Rutherfordium [261]	105 <b>Db</b> Dubnium [262]	106 <b>Sg</b> Seaborgium [266]	107 <b>Bh</b> Bohrium [264]	108 <b>Hs</b> Hassium [269]	109 <b>Mt</b> Meitnerium [268]	110 <b>Ds</b> Darmstadtium [269]	111 <b>Rg</b> Roentgenium [272]	112 <b>Cn</b> Copernicium [277]	113 <b>Uut</b> Ununtrium unknown	114 <b>Fl</b> Flerovium [289]	115 <b>Uup</b> Ununpentium unknown	116 <b>Lv</b> Livermorium [298]	117 <b>Uus</b> Ununseptium unknown	118 <b>Uuo</b> Ununoctium unknown

57 <b>La</b> Lanthanum 138.905	58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.908	60 <b>Nd</b> Neodymium 144.243	61 <b>Pm</b> Promethium 144.913	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.925	66 <b>Dy</b> Dysprosium 162.500	67 <b>Ho</b> Holmium 164.930	68 <b>Er</b> Erbium 167.259	69 <b>Tm</b> Thulium 168.934	70 <b>Yb</b> Ytterbium 173.055	71 <b>Lu</b> Lutetium 174.967
89 <b>Ac</b> Actinium 227.028	90 <b>Th</b> Thorium 232.038	91 <b>Pa</b> Protactinium 231.036	92 <b>U</b> Uranium 238.029	93 <b>Np</b> Neptunium 237.048	94 <b>Pu</b> Plutonium 244.064	95 <b>Am</b> Americium 243.061	96 <b>Cm</b> Curium 247.070	97 <b>Bk</b> Berkelium 247.070	98 <b>Cf</b> Californium 251.080	99 <b>Es</b> Einsteinium [254]	100 <b>Fm</b> Fermium 257.095	101 <b>Md</b> Mendelevium 258.1	102 <b>No</b> Nobelium 259.101	103 <b>Lr</b> Lawrencium [262]