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

DEO50033: OPTOSEMICONDUCTOR

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

Kertas soalan ini mengandungi **ENAM (6)** 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)** subjective questions. Answer **ALL** questions.

ARAHAN:

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

QUESTION 1

SOALAN 1

CLO1 (a) Explain Organic light emitting diode (OLED).

Terangkan diod pemancar cahaya organik (OLED).

[5 marks]
[5 *markah*]

CLO1 (b) Explain radiative recombination for low – level excitation.

Terangkan penggabungan semula bersinar bagi pengujaan paras rendah.

[5 marks]
[*5 markah*]

CLO1 (c) GaAs at T=300 K with acceptor concentration, $N_A = 4 \times 10^{18}\ cm^{-3}$,donor concentration, $N_D = 2 \times 10^{18}\ cm^{-3}$ emits photons of 10^{16} per second at active region when 10^{17} electrons are injected. Given bias voltage = 5.0V, $\frac{kT}{q}$ = 25mV, $\eta_i = 1.79 \times 10^6\ cm^{-3}$ and extraction efficiency is 80 %. Calculate V_D , $\eta_{internal}$ and number of photons emitted into free space.

GaAs pada T=300 K dengan kepekatan penerima, $N_A = 4 \times 10^{18}\ cm^{-3}$, kepekatan penderma, $N_D = 2 \times 10^{18}\ cm^{-3}$ *memancarkan* 10^{16} *foton sesaat di kawasan aktif apabila* 10^{17} *elektron disuntikkan. Diberi voltan pincangan= 5.0V,* $\frac{kT}{q}$ = 25mV, $\eta_i = 1.79 \times 10^6\ cm^{-3}$ *dan kecekapan pengekstrakan adalah 80 %. Kirakan* V_D , $\eta_{internal}$ *dan bilangan foton yang dipancarkan ke dalam ruang bebas.*

[10 marks]
[*10 markah*]

QUESTION 2

SOALAN 2

CLO1 (a) Explain internal efficiency, extraction efficiency and external efficiency of an LED.

Terangkan kecekapan dalaman, kecekapan pengekstrakan dan kecekapan luaran untuk LED.

[5 marks]

[*5 markah*]

CLO1 (b) Elaborate the source of the heat generated in the junction.

Huraikan punca kepada haba yang dijana dalam simpang.

[5 marks]

[5 *markah*]

CLO1 (c) Write the pulsed calibration procedures to establish the forward voltage versus junction temperature.

Tuliskan prosedur – prosedur penentukuran denyutan untuk menentukan voltan pincang hadapan melawan suhu persimpangan.

[10 marks]

[*10 markah*]

QUESTION 3

SOALAN 3

(a) Explain carrier distribution in p-n homojunctions.

CLO1 *Jelaskan tentang pengagihan pembawa dalam simpang homo p-n.*

[5 marks]

[*5 markah*]

(b) Discuss **TWO (2)** structures of typical LED chip that are used for high power LED packaging.

CLO1

*Bincangkan **DUA (2)** struktur cip LED biasa yang digunakan untuk pembungkusan LED berkuasa tinggi.*

[5 marks]

[*5 markah*]

CLO1 (c) In LEDs with thin top confinement layers, the current is injected into the active region mostly under the top electrode. Examine ways to avoid this problem.

Dalam LED dengan lapisan kurungan atas nipis, arus disuntik ke kawasan aktif kebanyakannya di bawah elektrod atas. Semak cara untuk mengelakkan masalah ini.

[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

GaAs is doped with boron at concentrations of 10^{15} cm^{-3} and 10^{18} cm^{-3} as well as with phosphorus at concentration of 10^{17} cm^{-3}. The undoped GaAs has carrier concentration of 2×10^6 cm^{-3}. Calculate the carrier lifetime in intrinsic GaAs and minority carrier lifetime in all the doping levels. Given the bimolecular recombination coefficient of GaAs is 10^{-10} cm^3/s.

GaAs didopkan dengan boron dengan kepekatan sebanyak 10^{15} cm^{-3} dan 10^{18} cm^{-3} serta dengan fosforus pada kepekatan sebanyak 10^{17} cm^{-3}. GaAs yang tidak didop mempunyai kepekatan pembawa sebanyak 2×10^6 cm^{-3}. Kirakan jangka hayat pembawa dalam intrinsik GaAs dan jangka hayat pembawa minoriti dalam semua aras pendopan. Diberi bahawa pekali penggabungan semula dwimolekul bagi GaAs adalah 10^{-10} cm^3/s.

[20 marks]
[20 *markah*]

QUESTION 2

SOALAN 2

CLO1

The phosphor coating technologies used in white LED is able to reduce the light trapped in LED chip and resultant of increased luminous efficiency. Illustrate **TWO (2)** phosphor coating approaches that are commonly used.

*Teknologi salutan fosforus yang digunakan LED putih untuk mengurangkan cahaya yang terperangkap dalam cip LED dan meningkatkan kecekapan cahaya. Ilustrasikan **DUA (2)** pendekatan salutan fosfor yang biasa digunakan.*

[20 marks]

[*20 markah*]

SOALAN TAMAT

LISTS OF FORMULA

SENARAI FORMULA

1. $R = \beta np$

2. $\tau_{n/p} = \frac{1}{\beta N_{A/D}}$

3. $\tau = \frac{1}{\beta(N_A + N_D)}$

4. $\eta_{int} = \frac{number\ of\ photons\ emmited\ from\ active\ region\ per\ second}{number\ of\ electrons\ injected\ into\ LED\ per\ second}$

5. $\eta_e = \frac{number\ of\ photons\ emmited\ into\ free\ space\ per\ second}{number\ of\ photons\ emmited\ from\ active\ region\ per\ second}$

6. $\eta_{ext} = \frac{number\ of\ photons\ emmited\ into\ free\ space\ per\ second}{number\ of\ electrons\ injected\ into\ LED\ per\ second}$

7. $\eta_{power} = \frac{P}{IV} = \frac{P_{out}}{P_{in}}$

8. $I_{inj} = number\ of\ electrons\ injected\ into\ LED\ per\ second\ \times q$

9. $P_{heat} = P_{in} - P_{out}$

10. $P_{in} = I_{inj} \times V_A$

11. $R_s = \frac{(V_F - V_{th})}{I_{inj}}$

12. $Fraction\ of\ light\ power\ can\ escape = 0.5\ (1 - \cos\theta_C)$

13. $L_{n/p} = \left(D_{n/p}\tau_{n/p}\right)^{\frac{1}{2}}$

14. $D_{n/p} = \frac{kT}{q}\mu_{n/p}$

15. $V_D = \frac{kT}{q}\ln\frac{N_A N_D}{{n_i}^2}$

16. $W_D = \sqrt{\frac{2\varepsilon}{e}(V_D - V)\frac{N_A + N_D}{N_A \times N_D}}$

17. $Tj = Rthjs \times (Vd \times Id) + Ta$

18. $Rthja = \frac{Tjmax - Tamax}{Vd \times Imax}$

19. $Rthsa = Rthja - Rthjs$

20. $\frac{dVf}{dT} = \frac{k}{e}\ln\frac{N_D N_A}{N_c N_v} - \frac{\alpha T(T+2\beta)}{e(T+\beta)^2} - \frac{3k}{e}$