
UNIVERSITI SAINS MALAYSIA

KSCP Semester Examination
Academic Session 2007/2008

June 2008

ZKE 323/3 – Electronic and Photonic Devices and Systems
[Peranti dan Sistem Elektronik dan Fotonik]

Duration: 3 hours
[Masa : 3 jam]

Please ensure that this examination paper contains **FIVE** printed pages before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi **LIMA** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

Instruction: Answer all **FIVE** questions. Students are allowed to answer all questions in Bahasa Malaysia or in English.

Arahan: *Jawab semua **LIMA** soalan. Pelajar dibenarkan menjawab semua soalan sama ada dalam Bahasa Malaysia atau Bahasa Inggeris.*

1. (a) Sketch the I-V characteristics of an ideal Zener diode and show its accurate equivalent circuit. State the condition for a proper working of the Zener diode in a circuit.

[Lakarkan ciri-ciri I-V suatu diod Zener unggul dan tunjukkan litar setaranya yang tepat. Nyatakan keadaan bagi diod Zener untuk berfungsi dengan baik dalam suatu litar.]

(20/100)

- (b) The circuit in Figure 1 shows a simple voltage regulator using a Zener diode. Describe how the circuit operates.

[Litar dalam Rajah 1 menunjukkan suatu pengatur voltan mudah menggunakan diod Zener. Perihalkan bagaimana litar tersebut beroperasi.]

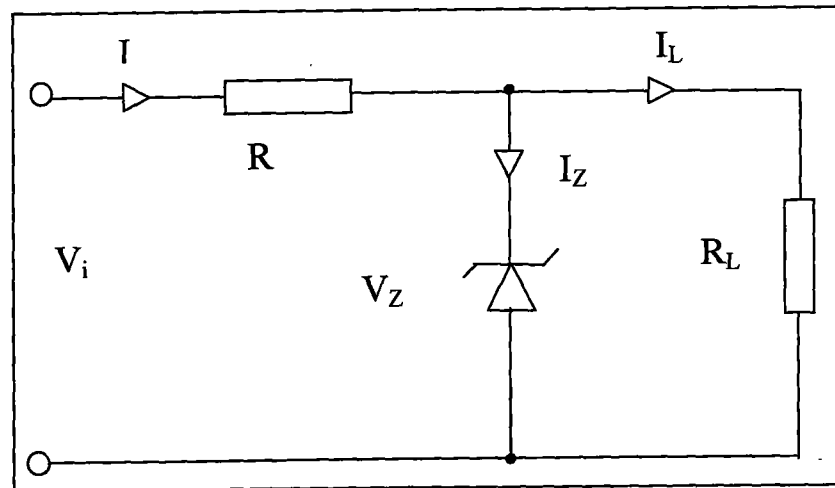


Figure 1 [Rajah 1]

(40/100)

- (c) With reference to an n-channel JFET, show how the device is driven into a saturation and 'off' states.

[Dengan merujuk kepada JFET terusan-n, tunjukkan bagaimana peranti ini dipandu kepada keadaan-keadaan tepu dan 'off'.]

(40/100)

2. (a) With a simple circuit, show how a JFET is employed in an optical fiber communication system which processes signals received from a photodiode. Then, describe in brief how the signal transmission takes place and why JFET is suitable for this application.
[Dengan suatu litar mudah, tunjukkan bagaimana suatu JFET digunakan dalam sistem komunikasi serabut optik yang memproses isyarat diterima dari fotodiod. Seterusnya, jelaskan dengan ringkas bagaimana penghantaran isyarat berlaku dan mengapa JFET sesuai dalam penggunaan ini.]
 (50/100)
- (b) Describe how the operational of LASCR devices is used in AND/ OR logic circuit and in a relay system.
[Perihalkan dengan jelas bagaimana operasi peranti LASCR digunakan dalam litar logik AND/OR dan dalam sistem 'relay'.]
 (50/100)
3. (a) Discuss the process of photon generation in a LED with the help of an energy band diagram and show the I-V output characteristics and the generated power characteristics.
[Bincangkan proses penghasilan foton dari suatu LED dengan bantuan gambarajah jalur tenaga dan tunjukkan ciri output I-V dan ciri kuasa yang dihasilkan.]
 (50/100)
- (b) An LED has a carrier recombination lifetime of $\tau = 38$ ns and a radiative lifetime of $\tau_r = 60$ ns in an active region. If generated light has $\lambda = 0.87$ μm at a drive current of 40 mA, estimate the internal quantum efficiency and the internal optical power of the LED.
[Suatu LED mempunyai masa hayat gabungan pembawa $\tau = 38$ ns dan masa hayat radiatif $\tau_r = 60$ ns dalam kawasan aktif. Jika cahaya yang dihasilkan mempunyai $\lambda = 0.87$ μm pada arus pandu 40 mA, anggarkan kecekapan kuantum dalaman dan kuasa optik dalaman LED.]
 (50/100)
4. (a) Describe the process of laser generation in a p-n junction of semiconductor and show the role of optical cavity for a high efficiency laser.
[Perihalkan proses penghasilan laser dari simpang p-n semikonduktor dan tunjukkan peranan rongga optik bagi kecekapan tinggi laser tersebut.]
 (50/100)

- (b) A laser of GaAs has a device efficiency of 10%. If the voltage used is 2.5 V, determine the external quantum efficiency of the device. Then, estimate the differential external quantum efficiency at a high current injection. Describe the effect on the device external quantum efficiency if the injection current is reduced but still higher than threshold current.
[Suatu laser dari bahan GaAs mempunyai kecekapan peranti sebesar 10%. Jika voltan yang digunakan adalah 2.5 V, kira kecekapan kuantum luaran peranti ini. Seterusnya, anggarkan kecekapan kuantum luaran diferensial pada arus cucukan tinggi. Jelaskan kesan kepada kecekapan kuantum luaran peranti jika arus cucukan dikurangkan tetapi masih lebih besar dari arus ambang.]

(E_g bagi GaAs : 1.43 eV)

[(E_g for GaAs : 1.43 eV)]

(50/100)

5. (a) For a p-n photodiode,
[Bagi suatu fotodiod p-n,]
- (i) describe the operational principle.
[perihalkan prinsip operasi.]
- (ii) determine the cut-off wavelength for the light absorption of a semiconductor with energy gap E_g .
[tentukan panjang gelombang penggal bagi penyerapan cahaya untuk semikonduktor dengan jurang tenaga E_g .]
- (iii) sketch a typical output characteristic.
[lakarkan ciri output tipikal.]
- (50/100)
- (b) (i) State the Pockels effect and the Kerr effect of electro-optic materials.
[Nyatakan kesan Pockels dan kesan Kerr bagi bahan elektro-optik.]
- (ii) Show how a transverse modulator can be built to modulate the phase of optical wave that pass through electro-optic materials.
[Tunjukkan bagaimana suatu modulator melintang dapat dibina bagi memodulasikan fasa gelombang optik yang melalui bahan elektro-optik.]

- (iii) State the principle of a directional optical coupler, sketch the output for power exchange that occurs in the identical coupler (without phase mismatched) and sketch a diagram for the related 3-dB coupler.

[Nyatakan prinsip pengganding optik berarah , lakarkan output bagi tukarganti kuasa yang berlaku dalam pengganding seiras (tanpa taksepadanan fasa) dan lakarkan gambarajah bagi pengganding 3-dB berkaitan.]

(50/100)