

UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2006/2007

April 2007

ZAE 384/4 - Laser and Their Applications
[Laser dan Penggunaannya]

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 English only.

[Arahan: Jawab kesemua LIMA soalan. Pelajar dibenarkan menjawab semua soalan dalam Bahasa Inggeris sahaja.]

1. (a) Calculate the wavelength of emission when an atom de-excites from an energy state at 12.74 eV and 12.09 eV to one at 10.2 eV above the ground state and 13.6 eV, 12.74 eV, 10.2 eV to one at ground state. In which part of spectrum are these happening?
Use the energy diagram of hydrogen to assist in your calculation.
[Hitungkan jarak gelombang pemancaran bila suatu atom menyahaja dari keadaan tenaga 12.74 eV dan 12.09 eV ke keadaan tenaga 10.2 eV di atas keadaan asas dan dari keadaan tenaga 13.6 eV, 12.74 eV, 10.2 eV ke keadaan tenaga keadaan asas. Bahagian spektrum yang manakah nyahaja ini berlaku?]
Gunakan gambarajah tenaga hidrogen bagi membantu pengiraan anda.]
(35/100)
- (b) Explain the important requirements of LIDAR, with diagrams. Define the LIDAR and RADAR.
[Berbantuan rajah, terangkan keperluan-keperluan penting LIDAR. Takrifkan LIDAR dan RADAR.]
(25/100)
- (c) The decay occurs in two ways within laser action. Explain this decay.
[Reputan berlaku dalam dua cara di dalam tindakan pelaseran. Terangkan reputan tersebut.]
(20/100)
- (d) How to excite the active medium in the Argon laser?
[Bagaimanakah medium aktif diujakan di dalam laser Argon?]
(20/100)
2. (a) Calculate the energy of a photon in eV of 514 nm wavelength. In which part of the spectrum would this photon be emitted?
[Hitungkan tenaga foton berjarak gelombang 514 nm dalam eV. Di bahagian spektrum manakah photon ini bersinar?]
(25/100)
- (b) How is a hologram made?
[Bagaimanakah hologram diperbuat?]
(25/100)
- (c) Explain the basic requirements of any laser system, with diagram.
[Berbantuan rajah, terangkan keperluan-keperluan asas sebarang sistem laser]
(25/100)

- (d) How to achieve laser action in semiconductor laser?
[Bagaimanakah tindakan pelaseran di dalam laser semikonduktor?]
 (25/100)
3. (a) What are the properties of stimulated photons? Explain with diagrams.
[Apakah sifat-sifat foton terangsang? Jelaskan jawapan anda dengan menggunakan gambarajah]
 (25/100)
- (b) Estimate the power density of a 15 mW laser beam with a diameter of 1.5 mm? You have to note the irradiance of sunlight on the earth.
[Anggarkan ketumpatan kuasa 15 mW alur laser berdiameter 1.5 mm. Anda perlu mengambil kira kesinaran cahaya suria pada permukaan bumi.]
 (25/100)
- (c) Why did you think that the Ozone (O₃) layer is important? Mention the reasons.
[Mengapa anda anggap lapisan Ozon (O₃) itu penting? Nyatakan sebab-sebabnya.]
 (25/100)
- (d) On what does the spectral distribution of radiation depend?
[Taburan spektrum itu bergantung kepada apa?]
 (25/100)
4. (a) The bandwidth of a line in the visible region, $\lambda = 6000 \text{ \AA}$, is 1000 \AA and the temperature is 1000 K, proved the following?
[Lebar jalur suatu garis dalam bahagian nampakkan, $\lambda = 6000 \text{ \AA}$, ialah 1000 \AA dan suhu adalah 1000 K, buktikan persamaan yang berikut.]
 (35/100)
- $$d\omega = \frac{2\pi}{12} \times 10^{15}$$
- (b) Using the Ideal Gas Law, what are the relationships between the LIDAR-Photocounts and the Temperature?
[Menggunakan Hukum Gas unggul, apakah hubungan di antara fotobilang LIDAR dan suhu?]
 (25/100)
- (c) What are the main types of holograms?
[Apakah jenis-jenis hologram utama?]
 (20/100)

- (d) What are the characteristics of lasers? Explain with diagrams
 [Apakah ciri-ciri laser? Terangkan dengan menggunakan gambarajah.]
 (20/100)

5. Answer (**True or False**) the following and correct the wrong sentences.
 [Jawab sama ada **Benar** atau **Salah** kenyataan berikut dan betulkan kenyataan yang salah.]

- (i) The emission of light during wave propagation is called attenuation.
 [Pancaran cahaya semasa perambatan gelombang dipanggil atenuasi.]
 (10/100)
- (ii) A population inversion can be achieved with just two levels because the probability for absorption and for spontaneous emission is exactly the same.
 [Sonsangan populasi boleh dicapai dengan hanya dua aras kerana kebarangkalian untuk penyerapan dan pancaran spontan adalah sebenarnya sama.]
 (10/100)
- (iii) The laser beam is an eye hazard if one looks indirectly into it or a reflection of it from a shiny object.
 [Alur laser membahayakan mata jika seseorang melihatnya secara tak langsung atau pantulannya daripada suatu objek berkilat.]
 (10/100)
- (iv) The color or wavelength of light being emitted depends on the type of lasing material being used.
 [Warna atau jarak gelombang cahaya yang terpancar adalah bergantung kepada jenis bahan pelaseran yang digunakan.]
 (10/100)
- (v) A lasing medium must have at least two excited (metastable) states where electrons can be trapped long enough (microseconds to milliseconds) for a population inversion to occur.
 [Medium pelaseran mestilah mempunyai sekurang-kurangnya dua keadaan teruja (metastabil) yang mana elektron-elektron dapat diperangkapkan cukup lama (mikrosaat hingga milisaat) untuk sonsangan populasi berlaku.]
 (10/100)

- (vi) A Q-switch in the optical path is a method of providing laser pulses of extremely short time duration.
[Suis Q dalam lintasan optik adalah suatu kaedah menghasilkan denyutan laser tempoh masa.]
 (10/100)
- (vii) Free electron lasers have the ability to generate wavelengths from the infrared to the ultraviolet region.
[Laser elektron bebas mempunyai keupayaan menjanakan jarak gelombang dalam bahagian inframerah hingga ultralembayung.]
 (10/100)
- (viii) When light energy from the flash lamp is added to the atoms of the lasing material, the minority of the electrons are excited to a higher energy level, this phenomenon known as population inversion.
[Bila tenaga cahaya daripada lampu kilat ditambahkan kepada atom-atom bahan pelesenan, elektron-elektron minoriti adalah teruja ke aras tenaga lebih tinggi. Fenomenon ini dikenali sebagai sonsangan populasi.]
 (10/100)
- (ix) When radiation is absorbed, the effect on the absorbing biological tissue is photochemical, thermal or mechanical:
[Bila sinaran diserapkan, kesan ke atas tisu biologi menyerap adalah fotokimia, terma atau mekanikal:]
- In the ultraviolet region, the action is thermal.
[Dalam bahagian ultralembayung, tindakannya adalah terma.]
 - In the infrared region, the action is photochemical.
[Dalam bahagian inframerah, tindakannya adalah fotokimia.]
 - In the visible region, the action is mechanical.
[Dalam bahagian nampakkan, tindakannya adalah mekanikal.]
 (10/100)
- (x) LASER is defined as *Light Amplification by Spontaneous Emission of Radiation*.
[LASER ditakrifkan sebagai Amplifikasi Cahaya dengan Pancaran Spontan Sinaran.]
 (10/100)