University of Technology
Department of Applied Sciences
Final Examination 2016/2017

Subject: laser applications, **Class: 4th year**
Branch: Laser Physics **Time: 3 hours**
Examiner: Walid K. Hamoudi **Date:**

ANSWER 5 QUESTIONS ONLY

Q1: A diffraction-limited continuous 500 Watt, 2 mm diameter Gaussian Nd: YAG laser was selected to cut a steel sheet. If half of the incident power is reflected out of the steel surface, use the given data to specify if the cutting is possible. **(12 marks)**

Q2: 60 nm spectral width LED drives a 10 Km single mode fiber and having a material dispersion of (-100 ps/Km^{-1}nm^{-1}) for the wavelength centered at (λ = 800 nm).

(A). If the LED is pulsed on and off in 5 ns, work out the pulse length when it arrives at the end of the waveguide. **(6 marks)**
(B). Find the maximum practical pulse rate for this system, if the received pulses are to be distinguished from one another. **(6 marks)**

Q3: Write the scientific principle behind each of the following applications: **(12 marks)**
(1) Laser hair removal, (2) Single mode fiber transmission, (3) Laser angular rotation measurement, (4) Laser dental photoablation, (5) Laser acne treatment, (6) Laser communications, (7) Sun screen protection, (8) Laser hardening, (9) Laser car's wheel alignment and balance, (10) Laser surgery.

Q4-A: Calculate the frequency shift corresponding to a rotation rate of 4.85 x 10^{-7} rad/s when a He-Ne laser (λ = 633 nm) based 10cm side length gyroscope was used. **(6 marks)**

Q4-B: Work out the temperature of a 0.05 mm thick glass slide inside a thermal coating chamber, employing a 633 nm He-Ne laser [Room temperature = 27 ^{o}C, number of cycles on chart = 5, incidence angle = 60^{o}, and (K) the linear expansion coefficient of glass = 9x10^{-6}]. **(6 marks)**

Q5: Skin wrinkles are to be treated by 2ms duration, 2Jpulse energy, and 2mm diameter diode laser; operating at 980 nm. Work out:
(A). Thermal relaxation time. **(4 marks)**
(B). Irradiation time required before damaging the epidermal layer. **(4 marks)**
(C). Rise in temperature (Δ**T**) of the skin layer. **(4 marks)**

Q6-A: 5 Joule, 0. 5 ms Nd: YAG laser pulses, and a focusing lens, were used to drill a steel sheet. If the laser spot area on the steel surface is 0.0025 cm^2 and 40% of the incident energy is reflected, work out the laser intensity at the surface. Is this intensity enough to drill the hole? **(8 marks)**

Q6-B: Explain the principle of photothrmolysis in laser medical applications. **(4 marks)**

[**For steel:** thermal conductivity = 0.2 W/cm. K, thermal diffusivity= 0.05 cm^2/s, boiling point = 1520 ^{o}C, density = 8 g/cm^3, specific heat = 0.45 W.s/g. K].

[**For epidermal skin layer:** thermal conductivity, **k** = 0.4 W/m. K, thermal diffusivity, **N** = 1.2 x 10^7 (m^2/s), density, ρ = 1040 Kg/m^3, specific heat, **c** = 4000 J/Kg. K, and absorption coefficient of epidermal layer, μ**a** = 0.24].