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

Subject: Mathematics
Branch: Applied physics branch
Examiner: D. Atheer Ibrahim Abdali

Class: 3ed year
Time: 3 hour
Date: 2017

Note answer Four questions only

Q1\ (a) Solve the P.D.E $3x\frac{\partial u}{\partial y} = 2y\frac{\partial u}{\partial x}$? **[7.5 marks]**

(b) $\int_0^{\frac{\pi}{2}} \sqrt[4]{\mathrm{Sin}(x)}\ dx$? **[5 marks]**

Q2

(a) $Solve\ the\ O.D.E\ \ \frac{d^2y}{dx^2} + x\frac{dy}{dx} + y = 0\ by\ power\ Series$? **[7.5 marks]**

(b) $Evaluate \int_0^{\infty} x^3\, e^{-2x^2} dx$? **[5 marks]**

Q3\ (a) Prove that $\Gamma_{\frac{1}{2}} = \sqrt{\pi}$? **[7.5 marks]**

(b) Evaluate $\int_{-2}^{5} \sqrt{x^2 - 4}\, dx$ by Trapezoidal Methods Take N=7 ?

[5 marks]

Q4\ (a) Is $\mathrm{f(z)} = e^z$? **Analytic function or not** **[5 marks]**

(b) Evaluate $\int_c (2z - 1)dz$ where c is the line from $= 1 - 2i\ \ to\ Z = 2 + i$?

[7.5 marks]

Q5\ (a) Evaluate $\int_0^8 \frac{x}{x^2+4} dx$ by Simpsons $\left(\frac{1}{3}\right) Rule$ Take N=8 Compare your answer with the exact Solution ? **[7.5 marks]**

(b) Prove that $\beta(\mathrm{m,n}) = \beta(\mathrm{n,m})$ **[5 marks]**

Good luck

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

Subject: Laser Principles | **Class: 3rd year**
Branch: Applied Physics | **Time: 3 hours**
Examiner: Dr. Uday M. Nayef | **Date: 12/06/2017**

Note: answer Five questions.

Q.1/ The line width $\Delta v_o^* = 50$ MHz of a low-pressure CO_2 laser is predominantly established by Doppler broadening. The laser is operating with a pump power twice the threshold value. Assuming that one mode coincides with the transition peak and equal losses for all modes, calculate the maximum mirror spacing that still allows single longitudinal mode operation. **(10 mark)**

Q.2/ (a) What is mean that: 1. Normal Population, 2. Three Level Lasers, 3. Population Inversion, 4.Longitudinal (Axial) Modes?

(b) Calculate the Gaussian beam divergence of He-Ne laser (λ=633 nm) which has a confocal cavity with a minimum beam radius (waist) W_o=0.22 mm? **(10 mark)**

Q.3/ (a) Consider the He-Ne laser operating at the 632.8 nm transition, and assume that at room temperature the gain line is Doppler-broadened with a line width (FWHM) $\Delta v_b^* = 1.7$ GHz. If the laser is operated sufficiently far from threshold, and the laser tube has a length of L = 40 cm, what is the expected pulse duration and the pulse repetition rate when the laser is mode-locked by an acousto-optic mode-locker?

(b) Theory of active mode locking? **(10 mark)**

Q.4/ The length of the optical cavity in He-Ne laser is 30 cm. The emitted wavelength is 0.6328 mm. Calculate: **(10 mark)**

1. The difference in frequency between adjacent longitudinal modes?
2. The number of the emitted longitudinal mode at this wavelength?
3. The laser frequency?

Q.5/ (a) Mention the main advantages of diode pumping?

(b) Compute the pulse width Δt_p and the separation between pulses Δt_{spe} for the mode-locked Nd-YAG laser where the fluorescent line width is 1.1×10^{11} Hz and the laser rod of refractive index (1.82 for YAG) is 0.1 mm long. Assume that the laser mirrors are very close to the ends of the rod? **(10 mark)**

Q.6/ Write about population inversion in laser semiconductors? **(10 mark)**

Good Luck

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

Subject: Electronics
Branch: Applied physics
Examiner: Dr.Odai N. Salman

Class: Third class
Time: 3 hours
Date:

Note: answer only **five** questions.

Q1: **a)** Compare between Base Bias and Emitter Bias for bipolar junction transistor.

b) Define slew rate and use it to find the power bandwidth of an Operational Amplifier.

(10 marks)

Q2: Figure 1 shows part of a bicycle lighting system. The diodes are Schottky diodes. Use the second approximation to calculate the voltage across the filter capacitor.

(10 marks)

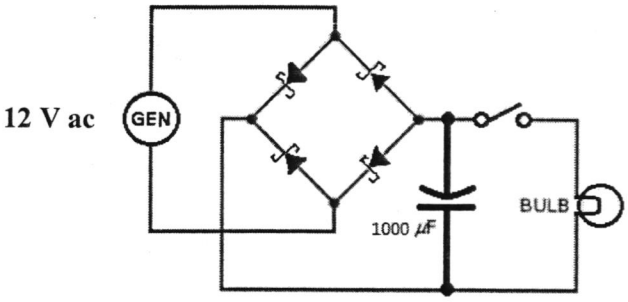


Fig. 1

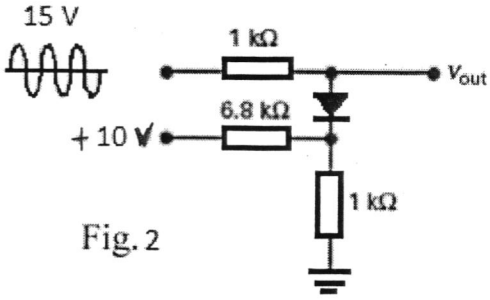


Fig. 2

Q3: In Fig. 2, what is maximum positive output voltage? Maximum negative output voltage? Sketch the output waveform. **(10 marks)**

Q4: What is the ~~LED current~~ Vout in Fig. 3? **(10 marks)**

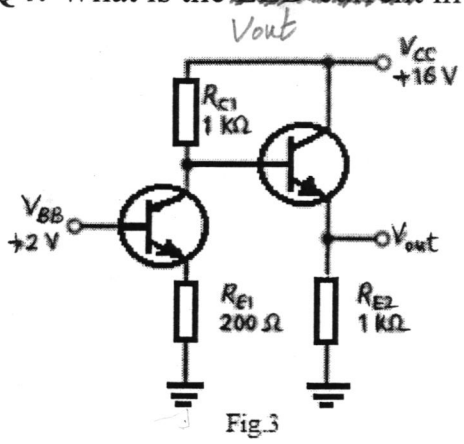


Fig.3

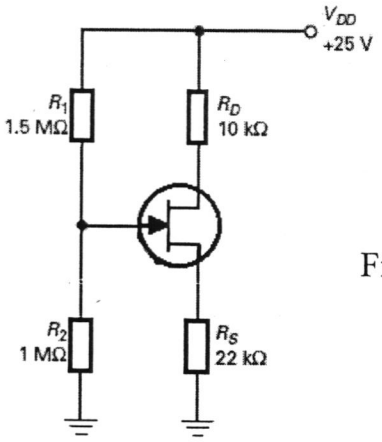


Fig. 4

Q5: Draw the dc load line and Q point for Fig. 4. **(10 marks)**

Q6: If the zener diode of Fig. 5 has a tolerance of ±10 percent and the trigger voltage can be as high as 1.5 V, what is the maximum supply voltage where crowbarring takes place?

(10 marks)

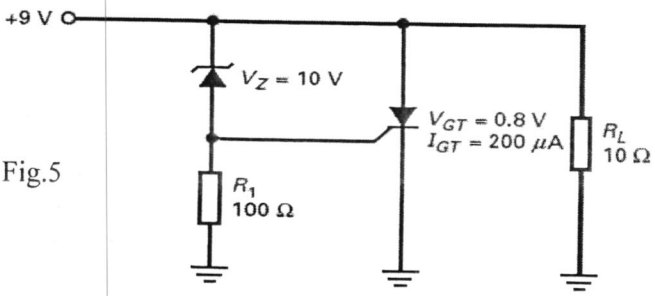


Fig.5

Good luck

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

Branch: Applied Physics
Subject: Quantum Mechanics
Examiner: Dr. Mukhlis M. Ismail

Class : 3rd year
Time : 3 hours
Date :

Note: Answer 7 questions only. (10 points for each question)

Q1/ A) Give the meaning of the following: (6 points)

1) Eign Value Equation, 2) $[x, p] \neq$ zero, 3) $i\hbar \int_{-\infty}^{\infty} \psi_x \frac{d\psi_x}{dt}\, dx$,

4) $\langle \psi_1 | \psi_2 \rangle = 0$, 5) Tunnel Effect 6) Superposition principle.

B) Prove that $-i\hbar \frac{\partial}{\partial x}$ is a Hermitian operator. (4 points)

Q2/ A) Given wave functions $\psi_1, \psi_2, \ldots\ldots\ldots, \psi_n$ are solutions of Schrodinger Equation, and $\Psi = \sum_{i=1}^{n} c_i \psi_i$ where $c_1, c_2, \ldots\ldots\ldots, c_n$ are constants. Prove that Ψ is a solution of Schrodinger Equation.

Q3/ Given the wave function: $\psi(x) = Ae^{-\frac{x^2}{2\pi}}$, Find the normalization constant.

(using: $\int_{-\infty}^{\infty} e^{-ax^2} dx = \sqrt{\frac{\pi}{a}}$).

Q4/ A) Drive the time dependent Schrodinger Equation.

Q5/ Given the laddar operator $a_{\mp} = \frac{1}{\sqrt{2\hbar m\omega}}(\pm ip + m\omega x)$ to find first excited state wave function for harmonic oscillator.

Q6/ Prove that the ground state wave function of harmonic oscillator is a solution of Schrodinger equation.

Q7/ A) Determine the $\psi_{nx,ny,nz}$ and the degree of degeneracy of the energy level $(13h^2/(4ma^2))$ for particle in cubical potential box of side a. (5 points)

B) Calculate the energy difference between the $n_x=3$, $n_y=2$, $n_z=1$ and the next level for free electron in solid cube of side 5 mm. ($m_e=9.1\times10^{-31}$ kg, $\hbar=1.05\times10^{-34}$ J. sec.) (5 points)

Q8/ Find the commutator between Hamiltonian and position operator, then find $\frac{d\langle x\rangle}{dt}$ using Ehrenfest Theorem and compare your result with classical.

Subject: Matlab
Stage: Third Class
Lecturer: L . Eman

Final Examination

2016-2017

University of Technology
Department of Applied Sciences
Branches : Physics

Notes: (Answer **four** questions only)

Q1: A) Create a matrix A using matlab program:

$$\text{Where } A = \begin{bmatrix} 1 & 1 & 1 & 1 & 5 \\ 1 & 1 & 1 & 4 & 1 \\ 1 & 1 & 3 & 1 & 1 \\ 1 & 2 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{bmatrix}_{5x\,5}$$

B) if $f(x,y,z)= |z|+e^{x+y}\,(x^2/y!)+\sin(y)$, Find: 1) $\frac{\partial^2 f}{\partial y^2}$, 2) $\frac{\partial^3 f}{\partial x^3}$, 3) $\frac{\partial f}{\partial z}$

Q2:A) Write a program to compute the following where x=[1 5 7 9], y=[3 6 8 12]

Find: 1) $W_1 = \sum_{i=1}^{4} x_i y_i$ 2) $W_2 = \sum_{i=1}^{4} \frac{x_i}{y_i}$

B) For the following functions:

$y_1=e^x+2x^2$, $y_2=|x|+2^x+x^2$ where $x = [1\ \ -2\ \ 3\ \ -4]$

1) plot y_1 and y_2 on the same y-axis.

2) Plot y_1 and y_2 on different graph on the same figure window.

Q3:A) Evaluate $\int_0^2 \frac{1}{x^2-2x+10}\,dx$ using matlab program.

B) Use while statement to find z

$$z = \begin{cases} \sin(x) & x \text{ is even} \\ e^x + x^2 & x \text{ is odd} \end{cases} \quad \text{where } x=1,2,\ldots,10$$

Q4:A) compute the value of S where $S = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} \ldots + \frac{x^n}{n!}$

B) Solve the system using Matlab (by **<u>two</u>** ways)

$4x_1 - 3x_2 = 7$

$5x_1 + 2x_2 = 3$

Q5: Consider the following two polynomials:

$a(x) = x^5 + 2x^4 + 3x^2 + 1$

$b(x) = x^2 + 2x + 3$

Find using Matlab:

1) The roots of a and b , **2)** Multiply a by b , **3)** Derive the polynomial a ,

4) a(x) + b(x) , **5)** Divide a by b , **6)** Evaluate b(x) at x=4

…… **Best Wishes**……

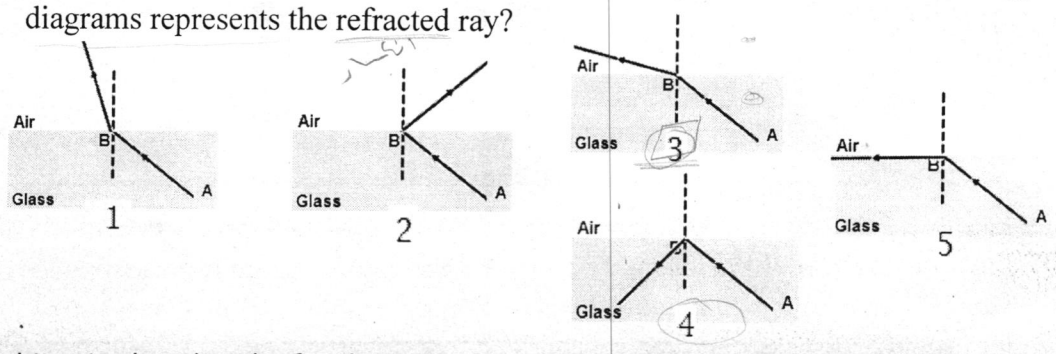
University of Technology
Department of Applied Sciences
Final examination 2016/2017

Subject : mechanics | **Class : 3**
Branch : Applied physics | **Time : 3 hours**
Examiner :Dr. Esam A. Tawfiq | **Date : / / 2017**

NOT: ANSWER FIVE QUESTIONS ONLY

Q1(a) choose the correct answer:-

1-A light ray AB passes from glass into air at the critical angle. Which of the following diagrams represents the refracted ray?



2- An object is placed at the focal point in front of a concave mirror. The image is located at :

(A) The distance d>R
(B) The distance d<F
(C) The distance F<d<R
(D) The focal point
(E) No image is formed

3- An object is placed in front of a converging lens at a distance greater than 2F. The image produced by the lens is:

(A)Real, inverted and demagnified
(B)Real, inverted and magnified
(C) Virtual, upright and magnified
(D) Virtual, upright and demagnified
(E) Virtual, inverted and magnified

(b) A light ray travels from glass to air at an angle of incidence $\theta_1 = 35^\circ$. The ray partially reflected from the glass-air boundary at the angle θ_2 and partially refracted at the angle θ_3. The index of refraction of the glass is 1.6.

(A)What is the speed of light in glass?
(B)What is the angle of reflection θ_2?
(C)What is the angle of refraction θ_3?

Q2(a) Rays from a light source that is very far from a concave mirror are brought to a focus 12.5 cm from the front of the mirror.

(A) What is the focal length
(B) What is the radius of curvature of the mirror?

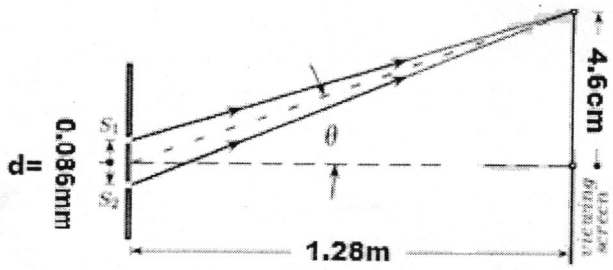
(b) 4.95cm tall object is placed 44.3 cm from a spherical mirror producing a virtual image 6.25 cm from the mirror.

(A) What type of mirror is this?

(B) What is the height of the image produced?

(C) is the image upright or inverted?

Q3(a) The second-order bright fringe (m = 2) is 4.6 cm from the center line. Determine the wavelength of the light. Be sure to use the small angle approximation,



(b) If the focal length of the lens is 15.5 cm and the 3.2 the height object is placed 22 cm from the lens .Find(A)the image distance.(B) the magnification.(C)the image height.

Q4(a) What is the position of the fourth maximum for a double-slit apparatus with slits 0.05 centimeters apart and a screen 1.5 meters distant when performed with monochromatic red light of frequency 384×10^{12} Hz?

(b) In an arrangement to demonstrate double-slit interference, $\lambda = 730$ nm, $\theta = 0.815^{\circ}$ and d = 0.134 mm.For light from the two slits interfering at this angle, what is the path difference in millimeters?

Q5(a) an oil film (n = 1.5) on top of water (n = 1.3). Light of $\lambda = 600$ nm is normally incident. Which value of thickness corresponds to destructive interference?

(b)A certain double convex lens has an index of refraction of 1.45.If the radius of curvature of the front and back surfaces is 23cm.(A) Find the focal length of the lens. (B) Find the image distance if the object is placed 120cm to the left.

Q6(a) Suppose in the double-slit arrangement, d = 0.150mm, L =120cm, $\lambda = 833$nm, and $y_m = 2.00$cm . (a) What is the path difference for the rays from the two slits arriving at point P(on the screen)? (b) Express this path difference in terms of λ . (c) Does point P correspond to a maximum or a minimum,(explain why)?

(b) Coherent light of wavelength 633 nm from a He-Ne laser falls on a double slit with a slit separation of 0.103 mm. An interference pattern is produced on a screen 2.56 m from the slits. Calculate the separation on the screen of the two fourth-order bright fringes on either side of the central image.

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

Subject: Electromagnetic
Branch: Applied physics branch
Examiner: Dr. Rabeah Q.Nafil

Class: 3 year
Time: 3 hour
Date: 1st Attempt

Answer **only four** questions

Q1- A / Prove that the potential at any point due to a point charge Q located at the origin is

$$V = \frac{Q}{4\pi\varepsilon_o r} = -\int_{\infty}^{r} \vec{E}.dl$$

(12.5 degrees)

B / Give the physical meaning of the following relation $\vec{\nabla}.\vec{J} = -\frac{\partial \rho_v}{\partial t}$

(5 degrees)

Q2- A/ Classify dielectric materials depending on their permittivity.

(12.5 degrees)

B/ Two pint charges of equal mass m , charge Q are suspended at a common pint by two threads of negligible mass and length L. show that at equilibrium the inclination angle α of each thread to the vertical is given by: $Q^2 = 16\pi\varepsilon_o mgL^2 \sin^2\alpha \tan\alpha$

(5 degree)

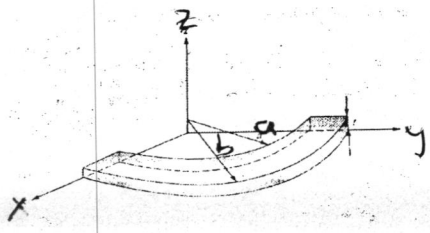
Q3- A/ Use Ampere's circuit law to drive an expression for magnetic field intensity ($\vec{H}$) in an infinite sheet current.

(12.5 degrees)

B/ Give the four Maxwell's equations in their differential and integral form for static electromagnetic fields.

(5 degrees)

Q4- A/ A metal bar of conductivity δ is bent to form a flat 90° sector of inner radius *a,* outer radius *b,* and thickness *t* as shown in Figure. Show that the resistance of the bar between the vertical curved surfaces at $\rho = a$ and $\rho = b$ is:



$$R = \frac{2\ln\frac{a}{b}}{\sigma\pi t}$$

(17.5 degrees)

Q5- Prove that the electric field intensity due to electric dipole is given by:

$$\vec{E} = \frac{p}{4\pi\varepsilon_o r^3}(2\cos\theta\,\vec{a}_r + \sin\theta\,\vec{a}_\theta)$$

(17.5 degrees)

Good luck