Experimental Competition
27 April 2010

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Question Number 1

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ANSWER SHEET

Exp. I-A、Measuring the resonance frequency

(1) Measure the amplitude A of the oscillating laser beam by tuning the frequency f of the sine wave generator. Record the measured data in the data table.

f	A	

f	A	

ANSWER SHEET

(2) Plot a proper data in the graph paper to determine the resonance frequency f_{RO} and the quality factor Q. Record f_{RO} and Q in the following blank.

f_{RO} = ; Q=

ANSWER SHEET

Exp. I-B、Resonance frequency versus the external force.

(1) Measure and record the measured data z_0 in the data table.

z_0 =

(2) Determine the position z of the top plane of the N-pole of M_C. Calculate the nominal distance d by defining $d = z_0 - z$. Record z and d in the data table.

(3) Determine the resonance frequency f_R for the distance d by tuning the frequency of the sine wave generator until the maximum amplitude is reached. Record the determined resonance frequency f_R in the data table.

(4) Change the vertical position of the magnet M_C and repeat the steps (2) and (3) for a number of measurements of different distance d and the corresponding resonance frequency f_R.

z	d	f_R	Δf_R	$\ln(\Delta f_R)$

(5) Plot a graph of f_R as a function of distance d using a graph paper.

(6) Define $\Delta f_R = f_R - f_{RO}$, and plot $\ln(\Delta f_R)$ as a function of d using another graph paper.

ANSWER SHEET

Exp. I-C、Find the positions and depths of magnets in a black box.

(1) Record z_0 and z_{box} on the answer sheet.

z_0 = ; z_{box} =

(2) Move the black box along the longer line and observe the variation in resonance frequency f_R of the reed to find the position of M_B. Record the measured distances y and their corresponding resonance frequencies f_R in the data table.

y	f_R

y	f_R

ANSWER SHEET

(3) Plot f_R as a function of y on a graph paper to determine the position of magnet M_B. Mark the positions of magnets M_A and M_B on the y-axis of your graph, and write down the value of $\overline{AB}$ on the answer sheet.

$\overline{AB} =$

(4) Determine the depths d_A and d_B of the magnets M_A and M_B from the top surface of the black box using the results in Exp. I-B. Write down the values of d_A and d_B on the answer sheet.

$d_A =$	; $d_B =$

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ANSWER SHEET

Exp. II-A：Light response of the photoconductor

(1) Define θ_P to be the relative angle between polarization axes of P1 and P2. By varying the angle θ_P from $0°$ to $180°$ in step of $5°$. Record the measured PC resistance (R) and θ_P in the data table. Transform the measured R values into conductance (C) values and record them in the data table.

θ_P	R	C		

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(2) Plot the PC conductance values as a function of θ_P on a graph paper.

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ANSWER SHEET

Exp. II-B：The fraction of the linearly polarized laser light

(1) Find the maximum and minimum values of PC resistance (R_{max} and R_{min}) by rotating P1 360 °. Transform R_{max} and R_{min} into the minimum and maximum values of PC conductance C_{min} and C_{max}. Record the data in the data table.

R_{min}	R_{max}	C_{max}	C_{min}		

(2) Utilizing the conductance versus θ_P graph in Exp. II-A-(2) to determine the relative intensities J_{max} and J_{min} corresponding to C_{max} and C_{min}. Write down the result.

$J_{min}=$, $J_{max}=$

ANSWER SHEET

(3) Calculate β and write down the result on the answer sheet.

$\beta =$

ANSWER SHEET

Exp. II-C： The differential quantum efficiency of the collimated laser diode

(1) Control the CLD current (I) and measure the corresponding PC resistance (R) values. Record the data in the data table. Transform your data and plot the PC conductance (C) versus CLD current on a graph paper.

I	R	C		

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(2)Based on the graph of step (1), choose a region (ΔI ~ 3 mA) centered around the maximum slope. By using the conductance versus θ_P graph in Part II-A-(2), transform and record the data of this region in the table of step (1) into the relative light intensity (J). Plot the relative light intensity (J) versus CLD current (I) in a graph paper.

(3) The maximum radiating power of the CLD is assumed to be exactly $P_{\max} = 3$ mW. Extract the maximum slope from the graph in step (3) and transfer it to the value of $G \equiv \left.\frac{\Delta P}{\Delta I}\right|_{Max}$, which is the maximum ratio of the increased amount of radiating power and the increase amount of input ampere. Write down your analysis and the calculated value G on the answer sheet. Estimate the error of G. Do not include the error of the P_{max}. Write down your analysis and the calculated value ΔG on the answer sheet.

$G = \left.\frac{\Delta P}{\Delta I}\right|_{Max} =$, $\Delta G =$

ANSWER SHEET

(4) The **Quantum Efficiency** equals the probability of one photon being generated per electron injected. From a particular bias current of the laser, a small increment of electrons injected would cause a corresponding increment of photons. The **Differential Quantum Efficiency** $\boldsymbol{\eta}$ is defined as the ratio of the increased number of photons and the increased number of injected electrons. Determine $\boldsymbol{\eta}$ of your CLD by using the value of G obtained in step (3). Write down your analysis and the calculated value $\boldsymbol{\eta}$ on the answer sheet. Estimate the error of $\boldsymbol{\eta}$. Write down your analysis and the calculated value $\Delta\boldsymbol{\eta}$ on the answer sheet. (Laser wavelength = 650 nm. Planck's constant = $6.63\times10^{-34}\ J\cdot s$. Light speed $= 3.0\times10^{8}\ m/s$)

η = , $\Delta\eta =$