Marking Scheme

Total No. of Questions – [10] Total No. of Printed Pages: 4

G.R. No.	

U118-104NCB(ESE)

DECEMBER 2018 / END-SEM

F. Y. B.TECH. (/ NCB) (SEMESTER - I)

COURSE NAME: Engineering Physics (NCB)

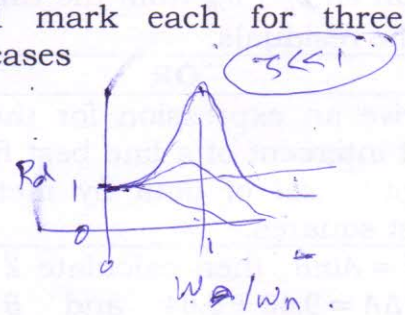
COURSE CODE: ES10184A-NCB

(PATTERN 2018)

Time: [2 Hours] [Max. Marks: 50]

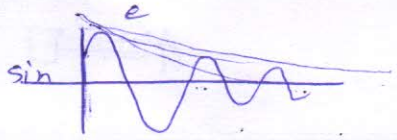
Instructions to candidates:

1) **Attempt Q.1, Q.2, Q.3, Q.4 ORQ.5, Q.6 OR Q.7,Q.8 OR Q.9 and Q.10**
2) **Figures to the right indicate full marks.**
3) **Use of scientific calculator is allowed.**
4) **Use suitable data where ever required.**

Q	Question	Marks	Marking Scheme	Cognitive	Difficulty	CO
Q1 (a)	Draw the displacement of a free damped oscillator as a function of a time for the damping factors $\zeta = 1$, $\zeta > 1$ and $\zeta < 1$ in the same diagram. Compare their behaviours on the basis of damped angular frequency ω_D.	[4]	2M for $\zeta < 1$ 1Mark each for factors $\zeta = 1$, $\zeta > 1$ 	UC	M	1
	OR					
Q1 (b)	Given deformation response factor $R_d = u_0/(u_{st})_0 = \frac{1}{\sqrt{\left[1-\left(\frac{\omega}{\omega_n}\right)^2\right]^2+\left[2\zeta\left(\frac{\omega}{\omega_n}\right)\right]^2}}$, discuss the response of a damped forced oscillator for angular frequency ω of the external force compared to the natural frequency ω_n being $\omega \ll \omega_n, \omega \approx \omega_n$ and $\omega \gg \omega_n$.	[4]	Diagram - 1M 1 mark each for three cases 	UC	M	1
Q2 (a)	What is the minimum thickness that can be detected for a specimen of sapphire if a ultrasonic pulse containing 9 cycles of 50 MHz is used. Given, for sapphire, density = 3980 kg/m^3, Bulk modulus = 25 × 10^{10} N/m^2, Shear modulus = 14.5 × 10^{10} N/m^2.	[4]	$pulse\ width = \frac{9}{50 \times 10^6} = 0.18 \times 10^{-6}\ s$ $v_p = \sqrt{\frac{B + (4/3)S}{\rho}} = 10554\ m/s$ $d_{min} = \frac{0.18 \times 10^{-6} \times 10554}{2}$ $d_{min} = 0.00095m = 0.95mm$	A	M	2
	OR					

Q2 (b)	As a thumb rule, a speaker can be heard clearly if the intensity level of the speaker is 10dB above the noise. What is the power the speaker should generate to be heard by a person at a distance of 6.5m, if the background noise is uniform in the room and its intensity level is 50 dB? Corresponding to this power, what is the intensity level at 1 meter from the speaker?	[4]	$I_L = 10log_{10}\left(\frac{P}{I_0(4\pi r^2)}\right)$ Therefore, $P = I_0(4\pi r^2)10^{\left(\frac{I_L}{10}\right)}$. $P = 10^{-12}(4\pi(6.5)^2)10^6 = 530.9\mu W$ Intensity level at 1 m from the speaker is $I_L = 10log_{10}\left(\frac{530.9\times10^{-6}}{10^{-12}(4\pi(1)^2)}\right) = 76.3dB$	A	M	2
Q3 (a)	Schematically draw the geometry of an X-ray Diffractometer for Debye-Sherrer method and discuss its construction and working.	[6]	Diagram - 2Marks Explanation - 4Marks	U C	H	3
	OR					
Q3 (b)	With the help of a neat diagram explain the principle, construction and working of a compound microscope.	[6]	Diagram - 2Marks Explanation - 4Marks	U C	M	
Q4 (a)	With the help of an example, discuss the concepts of accuracy and precision of a measurement. What do the systematic and random errors lead to - decrease in accuracy or precision?	[6]	Concept - 4Marks Decrease - 2Marks	U C A	M	4
Q4 (b)	If the values of band gap E_g of a semiconductor, measured (in units of eV) by 10 students, are 0.65, 0.73, 0.77, 0.69, 0.60, 0.71, 0.62, 0.81, 0.74 and 0.66, calculate the mean and the standard error in the mean as $\overline{E_g} \pm \sigma_m$ from the rms value of the residuals.	[4]	$\overline{E_g} = 0.698$ $\overline{E_g} \pm \sigma_m = 0.70 \pm 0.07eV$ See on the last page	A	H	4
	OR					
Q5 (a)	Derive an expression for the slope and intercept of a line best fitted to a given set of data by method of least squares.	[6]	Derivation - 6Marks	U C	H	4
Q5 (b)	If $Z = AlnB$, then calculate $Z \pm \Delta Z$ if $A \pm \Delta A = 9.40 \pm 0.04$ and $B \pm \Delta B = 1230 \pm 20$.	[4]	$Z = 66.8788$ $\Delta Z = \left[(\Delta AlnB)^2 + \left(\frac{A}{B}\Delta B\right)^2\right]^{1/2}$ $\Delta Z = \left[(0.04\times7.115)^2 + \left(\frac{9.4}{1230}\times20\right)^2\right]^{1/2}$ $\Delta Z = 0.323$ $Z \pm \Delta Z = 66.9 \pm 0.3$	U A	H	4
Q6 (a)	Discuss three ways in which sensors can be classified.	[6]	2Marks each	U C	L	5
Q6 (b)	Draw a Full Wheatstone bridge and derive the expression for its output	[4]	Diagram - 1Marks Derivation - 3Marks	U C	M	5

	voltage.					
	OR					
Q7 (a)	Discuss the principle of an accelerometer with a neat diagram and explain how strain gauges can be used.	[6]	Diagrams - 2Mark Principle-1Mark Strain gauge - 3Marks	U C	M	5
Q7 (b)	In a differential capacitor sensor, with initial gap between the plates d = 100 μm, what is the displacement Δd if an output voltage V_{out} = 100 mV is observed for a biasing voltage amplitude of V_0 = 5V?	[4]	$V_{out} = 2V_0\left(\frac{\Delta d}{d}\right)$ $\Delta d = \frac{d \times V_{out}}{2V_0} = \frac{100 \times 0.1}{2 \times 5}$ $\Delta d = 1\ \mu m$	A	L	5
Q8 (a)	Explain with the help of neat diagrams, principle, construction and working of a CO_2 laser.	[6]	Diagrams - 2Marks Explanation - 4Marks	U C	M	6
Q8 (b)	What is the diffraction limited beam divergence in degrees of Nd:YAG laser (λ=1.06μm) having an output aperture of 0.8 inch?	[4]	$\theta = 1.22\frac{\lambda}{a} = \frac{1.22 \times 1.06 \times 10^{-6}}{0.8 \times 2.54 \times 10^{-2}}$ $\theta = 6.36 \times 10^{-5} radians = 0.00365°$ $\theta = 1{,}31 seconds$	U A	M	6
	OR					
Q9 (a)	Explain in detail which of the laser characteristics like monochromaticity, coherence, directionality, intensity are useful or not in industrial applications of cutting, drilling and welding.	[6]	1.5 Marks each	U C	M	6
Q9 (b)	Find the intensity of a laser beam of 10^4 W power, having a beam diameter of 1.8 mm. Assume intensity to be uniform across the beam.	[4]	$I = \frac{4P}{\pi d^2} = \frac{4 \times 10^4}{\pi \times (1.8 \times 10^{-3})^2}$ $I = 0.393 \times 10^{10}\ W/m^2$	A	L	6
Q10 (a)	If $Z = \frac{A}{B}$ then $\frac{\Delta Z}{Z}$ is (i) $\frac{\Delta A}{A} + \frac{\Delta B}{B}$ (ii) $\frac{\Delta A}{A} - \frac{\Delta B}{B}$ (iii) $\left(\frac{\Delta A}{A}\right)^2 + \left(\frac{\Delta B}{B}\right)^2$ (iv) $\left(\frac{\Delta A}{A}\right)^2 - \left(\frac{\Delta B}{B}\right)^2$	[1]	(iii)	U C	M	5
Q10 (b)	Zero error is (i) random error (ii) human error (iii) systematic error (iv) all of the above	[1]	(iii)	U C	M	5
Q10 (c)	Johnson noise voltage is related with temperature T as proportional	[1]	(iii)	U C	M	5



	to (i) T (ii)T^2 (iii)$T^{1/2}$ (iv) $T^{-1/2}$					
Q10 (d)	Lasers have high intensity because they are (i) monochromatic (ii) coherent (iii) directional (iv) efficient	[1]	(iii)	U C	M	6
Q10 (e)	The wavelength of CO_2 laser correspond to (i) X-rays (ii) Ultraviolet (iii) visible (iv) Infrared	[1]	(iv)	U C	M	6
Q10 (f)	Which of the following is a necessary condition for lasing action (i) metastable state (ii) pumping (iii) population inversion (iv) all of the above	[1]	(iv)	U C	M	

4(b)

x_i	$d_i = x_i - \bar{x}$	d_i^2		
0.65	**-0.048**	**0.002304**		
0.73	**0.032**	**0.001024**		
0.77	**0.072**	**0.005184**		
0.69	**-0.008**	**0.000064**		
0.60	**-0.098**	**0.009604**		
0.71	**0.012**	**0.000144**		
0.62	**-0.078**	**0.006084**		
0.81	**0.112**	**0.012544**		
0.74	**0.042**	**0.001764**		
0.66	**-0.038**	**0.001444**		
$\bar{x} = 0.698$		$\sum d_i^2$ = 0.04016		

$$s^2 = \frac{1}{n}\sum d_i^2 = 0.004016$$

$$s = 0.2004$$

$$\sigma_m \approx \left(\frac{1}{n-1}\right)^{1/2} s = \left(\frac{1}{10-1}\right)^{1/2} 0.2004 = 0.0668$$

$$\overline{E_g} \pm \sigma_m = 0.70 \pm 0.07 eV$$