TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR DEGREE OF:

BACHELOR OF TECHNOLOGY IN RENEWABLE ENERGY
BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS

APS 4212: WAVE THEORY & TIDAL ENERGY

END OF SEMESTER EXAMINATION
SERIES: APRIL 2015
TIME ALLOWED: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Mathematical tables*
- *Scientific Calculator*

This paper consist of **FIVE** questions
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

Question One (Compulsory)

a) An alternating voltage is given by V = 75sin (200Πє - 0.25) volts. Find:
- **(i)** Amplitude
- **(ii)** The peak-to-peak value
- **(iii)** The r,m.s value
- **(iv)** Periodic time
- **(v)** Frequency and
- **(vi)** The phase angle (in degrees and minutes) relative to 75 sin200Πє **(10 marks)**

b) A complex voltage wave is given by V = 200sin 100 Πє + 8v sin 300 Πє + 40sin 500 Πє volts. Determine:
- **(i)** Which harmonics are present
- **(ii)** The r.m.s value of the fundamental
- **(iii)** The periodic time of the fundamental

(iv) The frequencies of the harmonics **(10 marks)**

c) Briefly explain the following giving TWO examples of each;
(i) Fee oscillations
(ii) Damped oscillations
(iii) Forced oscillations **(9 marks)**

d) Define transverse wave

Question Two

a) An alternating voltage V, has a periodic time of 0.015 and a peak value of 40v. When time t is zero v = -20v. Express the instantaneous voltage in the form v = vm sin (wt ± Q) **(5 marks)**

b) The currents in a.c circuit at any time t seconds is given by I = 1205sin (100 Πє + 0.36) amperes. Find:

(i) Peak value, periodic time, frequency and phase angle relative to 120sin 100 Πє
(ii) The value of the current when t = 8 ms
(iii) The time when the current first reaches 60A
(iv) The time when the current is first a maximum
(v) Discuss ONE method of harvesting tidal energy

Question Three

$$fx = \begin{cases} -k & when, \quad -\pi x < 0 \\ +k & when, \quad 0 < x < \pi \end{cases}$$

a) Obtain the Fourier series for the periodic function f(x) defined
The function is periodic outside of this range with period 2Π **(10 marks)**

b) A circular disc of mass 10kg is suspended by a wire attached to its centre. The wire is twisted by rotating the disc and released. The period of torsional oscillation is found to be 1.5 seconds. if the radius of the disc is 15cm. Calculate the torsional spring constant **(5 marks)**

c) When a grating with 300 lines per mm is illuminated normally with a parallel order principal maximum is observed at 18.9^{o} to the straight through direction. Find the wavelength of the light. **(5 marks)**

Question Four

a) Explain the oscillations of a mall attached to a horizontal spring. Hence deduce an expression for its time period. **(10 marks)**

b) How many principal maxima are produced when a grating with a spacing of 2 x 10^{-6}m is illuminated normally with light at wavelength 6.44 x 10^{-7}m **(5 marks)**

c) A stretched string made of aluminium is vibrating at its fundamental frequency of 512Hz. What is the fundamental frequency of a second string made from the same material which has a diameter and length twice that of the original and which is subjected to three times the force of the original **(5 marks)**

Question Five

a) A complex waveform v comprises of fundamental voltage of 240r.m.s and frequency 50Hz, together with 20g third harmonic which has a phase angle lagging by $3\pi/4$ road at time t = 0:

(i) Write down the expression to represent V **(5 marks)**

(ii) Use harmonic synthesis to sketch the complex waveform representing voltage v one are cycle of the fundamental components **(5 marks)**

b) A block of mass 680g is attached to a horizontal spring whose spring constant is $60Nm^{-1}$/ The block is pulled to a distance of 11cm from the mean position and released from rest. Calculate:

(i) Angular frequency, frequency and time period

(ii) Displacement of the system

(iii) Maximum speed and acceleration of the system **(10 marks)**