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KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2016/2017 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

SUPPLEMENTARY/SPECIAL EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE) AND BSC (PHYSICS)

COURSE CODE: SPH 312

COURSE TITLE: CLASSICAL MECHANICS II

DURATION: 2 HOURS

DATE: 12/09/2017 **TIME:** 11:30AM – 12:30 PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **3** printed pages. Please Turn Over

[useful constants: Earth-sun distance= $1.5x10^{11}$m, earth-moon distance= 384400 km, mass of moon= 7.35X10 ^{22}kg, mass of sun =$2x10^{30}$kg, mass of Earth= $6x10^{24}$kg, radius of sun =6.9x 10^{8}m, radius of Earth= $6.37x10^{6}$m, universal gravitational constant G= $6.67x10^{-11}$ Nm^2/kg^2, Earth's gravity g= 9.81N/kg,, Moon's gravity =1.64 N/kg]

QUESTION ONE (30marks)

(a). Give two distinct differences between classical(Newtonian) mechanics and relativistic mechanics ? (4 marks)

(b). Generate the Hamiltonian for a 1-D harmonic oscillator. (8 marks)

(c). From the constants given in this question paper, estimate the position of the centre of mass of the Earth- moon system. (6 marks)

(d). State the work- energy theorem. (2 marks)

(e). What is escape velocity? Estimate this value for a 5000kg rocket launched from the surface of the Earth and the k.e it must have to escape. (4 marks)

(f). Distinguish between inertial and gravitational mass. (2 marks)

(g). Clearly explain the advantages of Langragian mechanics over Newtonian mechanics. (4 marks)

QUESTION TWO (20MARKS)

(a). What is a conservative field? (2 marks)

(b). State the important properties of a central force field. (4 marks)

(c). A force is given by $\mathbf{F}= (2xy+z^3)i +x^2j+3xz^2k$

i. Is the force conservative? Determine the associated potential. (4 marks)

ii. determine the work done by the force in moving a particle from (1,-2,1) to (3,1,4). (4 marks)

(d). Given that change in potential energy of a system is given by $\Delta U = -\int_{x_1}^{x_2} F(x)\,dx$, compute the change in potential energy of a body when a force $F = b + cx^2$acts on it raising it from ground level to height h=x.(b and c are constants).(6 marks)

QUESTIONTHREE(20 MARKS)

a.) Enunciate Keplers laws of planetary motion. (6 marks)

b.) Proof Keplers law of harmonicity. (6 marks)

c.) A proposed communication sattelite would revolve round the earth in a circular orbit in the equatorial plane, at the height of 35880 km above the earths surface. Find the period of revolution of the sattelite in hours and comment on the result. (8 marks)

QUESTION FOUR(20 MARKS)

a.) Differentiate between holonomic and non holonomic constraints. (4 marks)

b.) Obtain the equation of motion, hence an expression for period, of a simple pendulum using Lagrangian formulation.? (6 marks)

c.) Given the following Langrangians, compute the equations of motion they represent

i. $L=0.5\ ml^2\ (\dot{\theta})^2 + mlr\omega^2\sin(\theta-\omega t) + mgl\cos\theta$, r and l = constants.

ii. $L = 0.5m\ \dot{y}^2 + 0.5\ (\frac{k1k2}{k1+k2})\ y^2$ (10 marks)

QUESTION FIVE (20 MARKS)

(a). State the important properties of central force fields. Give an example of a central force field. (4 marks)

(b). Show that the gravitational potential energy of a particle of mass, m, in the field is given by $U(r) = -GmM/r$ (4 marks)

(c). A sattelite of mass 1000kg moves in a circular orbit of radius 7.0 Mm round the earth. At this height, g= 8.2 N/kg calculate,

i. the k.e of the sattelite
ii. its linear speed
iii. the work done by the earths pull per revolution. (6 marks)

(d). Deduce an expression for moment of inertia of a uniform rigid rod of lenght L and mass M about an axis perpendicular to the rod and passing through its center of mass. (6 marks)