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**GARISSA UNIVERSITY**

**UNIVERSITY EXAMINATION 2019/2020 ACADEMIC YEAR TWO**

**SECOND SEMESTER EXAMINATION**

**SCHOOL OF SCHOOL OF PURE AND APPLIED SCIENCES**

**FOR THE DEGREE OF BACHELOR OF EDUCATION**

**COURSE CODE: MAT 215**

**COURSE TITLE: CLASSICAL MECHANICS**

**EXAMINATION DURATION: 2 HOURS**

**DATE: 18/12/2020 TIME: 03.00-05.00 AM**

**INSTRUCTION TO CANDIDATES**

* **The examination has FIVE (5) questions**
* **Question ONE (1) is COMPULSORY**
* **Choose any other TWO (2) questions from the remaining FOUR (4) questions**
* **Use sketch diagrams to illustrate your answer whenever necessary**
* **Do not carry mobile phones or any other written materials in examination room**
* **Do not write on this paper**

**This paper consists of THREE (3) printed pages *please turn over***

**QUESTION ONE (COMPULSORY)**

1. State the three Newton’s laws of motion. (3 Marks)
2. Define the following terms.
3. Inertial mass (2 Marks)
4. Gravitational mass (2 Marks)
5. Free body (2 Marks)
6. State the principle of angular momentum (2 Marks)
7. Write the kinetic energy of rotation of a rigid body w.r.t the principal axes in terms of the Euler angles and obtain the result if I1 = I2  (5 Marks)
8. Find the kinetic energy of rotation of a rigid body with respect to the principal axes in terms of Eulerian angles and interpret the result when *A = B*.(5 Marks)
9. United Airlines ﬂight UA589 from Chicago is 20 km due North of Austin’s Bergstrom airport. Suppose that the plane is ﬂying at 200km/h relative to the air. Suppose, further, that there is a wind blowing due East at 60km/h. Towards which compass bearing must the plane steer in order to land at the airport? (4 Marks)
10. The force required to slowly stretch a spring varies from 0N to 105N as the spring is extended by 13cm from its unstressed length. What is the force constant of the spring? What work is done in stretching the spring? Assume that the spring obeys Hooke’s law. (5 Marks)

**QUESTION TWO (20 Marks)**

1. State the conservation theorem for a linear momentum. (2 Marks)
2. State conservation theorem for total angular momentum of a particle (2 Marks)
3. Consider the vector field $\vec{F}=\left(2xy-z^{3}\right)i+x^{2}j+3xz^{2}$.
4. Is the vector field conservative (3 Marks)
5. Determine the potential energy (4 Marks)
6. Determine the work done in moving the object from $(1,-2,1)$ to $(3,1,4)$ (4 Marks)
7. An electrical circuit contains an inductance *L* and Capacitance *C*. Find the Lagrangian equation of motion when the charge on the capacitor is *q* and the current flowing though it is ***I***. (5 Marks)

**QUESTION THREE (20 Marks)**

1. State the conservation theorem for angular momentum of a particle. (2 Marks)
2. Starting with definition of work derive the kinetic energy as well as the potential energy of a particle. (8 Marks)
3. An inextinsible string of negligible mass hanging over a smooth peg at *A* connects the mass *m* on a frictionless inclined plane of angle θ to another mass *m*2. Use D’Alembert’s principle to prove that the masses will be in equilibrium if 

*m*2*g*

*m*1

B

C

A

θ

 (10 Marks)

**QUESTION FOUR (20 Marks)**

1. State the energy conservation theorem for a linear particle. (2 Marks)
2. Distinguish between external forces and internal forces acting on a particle (4 Marks)
3. A softball of mass m = 0.35kg is pitched at a speed of u = 12m/s. The batter hits the ball directly back to the pitcher at a speed of v = 21m/s. The bat acts on the ball for t = 0.01s. What impulse is imparted by the bat to the ball? What average force is exerted by the bat on the ball? (7 Marks)
4. In a speed trap, two pressure-activated strips are placed 120m apart on a highway on which the speed limit is 85km/h. A driver going 110km/h notices a police car just as he/she activates the ﬁrst strip, and immediately slows down. What deceleration is needed so that the car’s average speed is within the speed limit when the car crosses the second strip? (7 Marks)

**QUESTION FIVE (20 Marks)**

1. Distinguish between holonomic and non-holonomic constraints (4 Marks)
2. Determine the numbers of degrees of freedom for a rigid body
3. Moving freely in space of three dimensions (5 Marks)
4. Having one point fixed (4 Marks)
5. Having two points fixed (3 Marks)
6. Farmer Jones has recently bought a 40 acre ﬁeld and wishes to replace the fence surrounding it. Given that the ﬁeld is square, what length of fencing (in meters) should Farmer Jones purchase? Incidentally, 1 acre equals 43,560 square feet. (4 Marks)