College of Science.
Department of Physics & Astronomy

كلية العلوم
قسم الفيزياء والفلك

Final Exam
Academic Year 1442-1443 Hijri- 1st Semester

Exam Information معلومات الامتحان			
Course name	**Classical Mechanics 2**		اسم المقرر
Course Code	**Phys. 312**		رمز المقرر
Exam Date	**2022-01-04**	**1443-06-01**	تاريخ الامتحان
Exam Time	**08: 00 AM – 11:00 AM**		وقت الامتحان
Exam Duration	**3 hours**		مدة الامتحان
Classroom No.			رقم قاعة الاختبار
Instructor Name	**Dr. Rabia Qindeel, Dr. Abdelhay Salah**		اسم استاذ المقرر

Student Information معلومات الطالب		
Student's Name		اسم الطالب
ID number		الرقم الجامعي
Section No.	**26751, 31855**	رقم الشعبة
Serial Number		الرقم التسلسلي

General Instructions:

- Your Exam consists of **4** PAGES (except this paper)
- Keep your mobile and smart watch out of the classroom.

تعليمات عامة:

- عدد صفحات الامتحان **4** صفحة. (بإستثناء هذه الورقة)
- يجب إبقاء الهواتف والساعات الذكية خارج قاعة الامتحان.

هذا الجزء خاص بأستاذ المادة

This section is ONLY for instructor

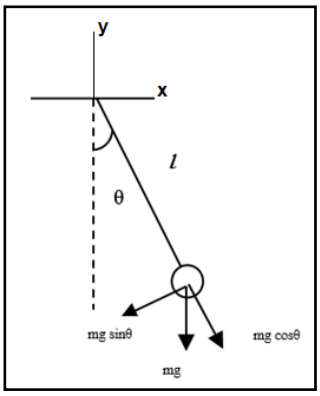
#	Course Learning Outcomes (CLOs)	Related Question (s)	Points	Final Score
1	CLO 1.1	Part 1	10	
2	CLO 1.2	Part 2	10	
3	CLO 1.2	Part 3	10	
4	CLO 2.1	Part 4	10	
				40

EXAM COVER PAGE

Solve all parts. All the parts carry equal marks

Part 1: [10 Marks]

Question 1: Consider a simple pendulum that oscillates with a small angle. Derive the equation of motion using: **[4+4 = 8 Marks]**



a) Lagrangian mechanics
b) Hamiltonian mechanics

Question 2: In two-body central force problem, reduced mass is; **[1 Mark]**

a. $\mu = \dfrac{m_1 - m_2}{m_1 + m_2}$

b. $\mu = \dfrac{m_1 m_2}{m_1 - m_2}$

c. $\mu = \dfrac{m_1 m_2}{m_1 + m_2}$

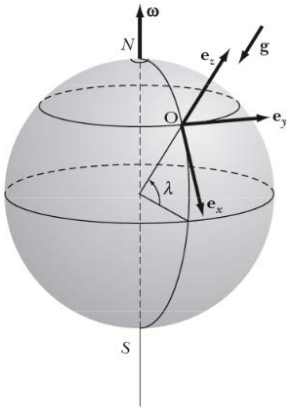
d. $\mu = \dfrac{m_1 + m_2}{m_1 m_2}$

Question 3: In an inertial reference frame, the homogeneity of space implies that …….. of a closed system is constant in time. **[1 Mark]**

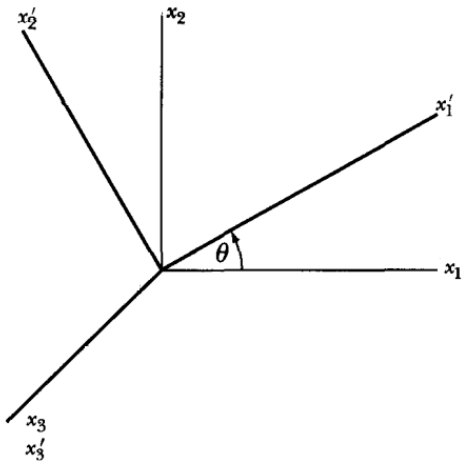
a. Total energy **E**
b. Linear momentum **P**
c. Angular momentum **L**
d. Linear displacement **r**

Part 2: [10Marks]

Question 1: Find the horizontal deflection caused by the Coriolis force acting on a ***free-falling*** particle in the earth's effective gravitational field from a height ***h*(<<*R*)** above its surface. **[5 Marks]**



Question 2: Derive the three-dimensional transformation matrix that rotates a ***frame1*** *(x_1, x_2, x_3)* to a ***frame2*** *(x_1', x_2', x_3')* around ***x_3-axis*** by an angle ***θ*.** **[5 Marks]**



Part 3 [10 Marks]

Question 1: The Lagrangian is describing the motion of a particle of mass ***m*** as mentioned below:

$$L = \frac{1}{2}md^2\left(\dot{\theta}^2 + \dot{\varphi}^2 cos^2\theta\right) + mgdcos\theta$$

Where ***d*** is constant. **[2+1+2 = 5 Marks]**

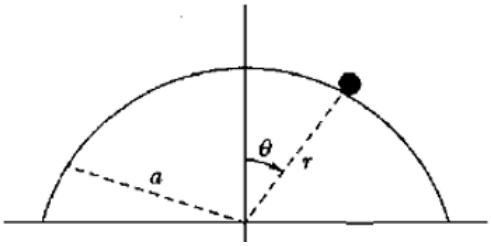
a) Find the momenta p_θ and p_φ

b) Find the Hamiltonian of the system

c) Write down the Hamilton's Equations of motion.

Question 2: A particle of mass ***m*** starts at rest on top of a smooth fixed hemisphere of radius ***a***.

[2+2+1= 5 Marks]



a) Find the Lagrange equations for the particle.

b) Find the force of constraint $\boldsymbol{\lambda}$.

c) Determine the angle $\boldsymbol{\theta_o}$ at which the particle leaves the hemisphere.

Part 4: [10Marks]

Question 1: A particle moves in a logarithmic spiral orbit has radius, $\boldsymbol{r = ke^{a\theta}}$, (where $\boldsymbol{k}$ is constant).

The ***Kinetic energy*** of the particle is; $K.E = \frac{1}{2}\mu\dot{r}^2 + \frac{1}{2}\frac{l^2}{\mu r^2}$ where $l \equiv \mu r^2 \dot{\theta} = cost.$)

and ***Potential energy*** of the particle is; $U(\boldsymbol{r}) = -\int \boldsymbol{F}(r) \,.\, \boldsymbol{dr}$: **[2+4+2 = 8 Marks].**

a) Find the ***Force law F(r)*** for a central force field.
b) Determine ***r(t)*** and ***θ(t)*** of the particle motion.
c) What is the ***total energy*** of the particle?

Question 2: If the force on a body is always towards a fixed point, it is called a: **[1 Mark]**

a. Newton's Force
b. Gravitational Force
c. Centrifugal Force
d. Central Force

Question 3: A planet's speed is maximum: **[1 Mark]**

a. when it is nearest the Sun
b. when it is farthest from the Sun
c. when it is beside the Sun
d. when it is middle the Sun