KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
Physics Department

PHYS 301
First Major Exam (March 24, 2001) – Term 002

Instructor's Name: Dr. A. Mekki

Student's Name: Key

I.D. No: _____

Exam Time: 90 minutes
Show the details of your work

Problem #	Grade
1	/10
2	/10
3	/10
4	/10
5	/10
Total:	/50

Q.1

(a) Prove the following vectorial relation: $\vec{\nabla} \times (\vec{\nabla} \times \vec{A}) = \vec{\nabla}(\vec{\nabla} \cdot \vec{A}) - \vec{\nabla}^2 \vec{A}$

(b) Consider the following matrices

$$A = \begin{pmatrix} 1 & 2 & -1 \\ 0 & 3 & 1 \\ 2 & 0 & 1 \end{pmatrix} \qquad B = \begin{pmatrix} 2 & 1 & 0 \\ 0 & -1 & 2 \\ 1 & 1 & 3 \end{pmatrix}$$

calculate:

(i) $|AB|$

(ii) $AB - B^t A^t$

Q.2

Consider the following force $\vec{F} = 2xz\,\hat{i} + 2yz\,\hat{j} + (x^2 + y^2)\,\hat{k}$.

(a) Calculate $\vec{\nabla} \times \vec{F}$

(b) Find potential energy, U(x,y,z), associated with this force.

Q.3

A particle of mass m is acted upon by a force whose potential energy is given by $U(x) = ax^2 - bx^3$, where a and b are positive constants.

(a) Find the force F producing this potential.

(b) Find the equilibrium positions, and state whether they are stable or unstable.

(c) Sketch the potential energy curve.

(d) Discuss the motion if $E_1 = 2E_0$, $E_2 = \frac{E_0}{2}$ and $E_3 = -E_0$ where $E_0 = \frac{4a^3}{27b^2}$

Q.4

Consider a particle of mass m whose motion starts from rest in a constant gravitational field. If a resisting force proportional to the square of the velocity (mkv^2) is acting along the y-direction, find the distance the particle falls while accelerating from $v = 0$ to $v = 0.5\ v_t$ where v_t is the terminal velocity of the particle.

↑ mkv^2

Q.5

A rocket traveling through the atmosphere experiences ONLY a linear air resistance force given by $-kv$. Find the final speed of the rocket in terms of the u (the exhaust speed), m (the final mass), m_0 (the initial mass) and α (a constant given by $\frac{dm}{dt} = -k\alpha$).