**Engineering Physics I – Fall 2015**
**Instructor: Dr. Marissa Vogt**
**Final Exam information**

The final exam will be cumulative. It will cover material presented in the course throughout the semester during lectures, labs, and in homework, quizzes, and exams. The final exam will give approximately equal weight to material from each midterm (1/3 for each unit).

For the final exam, you are expected to memorize the following equations.

| | | |
|---|---|---|
| $x(t) = x_0 + v_{0,x}t + ½a_xt^2$ | $v_x(t) = v_{0,x} + a_xt$ | if constant $a_x$ |
| $y(t) = y_0 + v_{0,y}t + ½a_yt^2$ | $v_y(t) = v_{0,y} + a_yt$ | if constant $a_y$ |
| $\theta(t) = \theta_0 + \omega_0t + ½\alpha t^2$ | $\omega(t) = \omega + \alpha t$ | if constant $\alpha$ |

Force due to kinetic friction $\mathbf{F} = \mu_k\mathbf{N}$

Force due to static friction $\mathbf{F} \leq \mu_s\mathbf{N}$

$\mathbf{A} \bullet \mathbf{B} = |\mathbf{A}||\mathbf{B}| \cos \theta$
$\mathbf{A} \times \mathbf{B} = |\mathbf{A}||\mathbf{B}| \sin \theta$ (magnitude of the cross product)

$W = \mathbf{F}\cdot\mathbf{s}$ (if force is constant)

$KE = ½ mv^2$ kinetic energy of translational motion
$KE = ½ I \omega^2$ kinetic energy of rotational motion
$U = mgy$ gravitational potential energy

$KE_{1,rotation} + KE_{1,translation} + U_1 + W_{other} = KE_{2,rotation} + KE_{2,translation} + U_2$
(rotational kinetic energy and work done by other forces may not be applicable to every problem)

$\mathbf{p} = m\mathbf{v}$ (linear) momentum

$\mathbf{F} = d\mathbf{p}/dt = m\mathbf{a}$ two expressions of Newton's 2nd law

$\boldsymbol{\tau} = I\boldsymbol{\alpha} = \mathbf{r} \times \mathbf{F}$ torque

$\mathbf{L} = I\boldsymbol{\omega}$ angular momentum

**You will be given the following equations (equations only, not descriptions), plus any other equations you will need:**

| | |
|---|---|
| $W = \Delta KE$ | work-energy theorem |
| $\mathbf{F} = k\mathbf{x}$ | force required to stretch a spring a distance x |
| $s = r\theta$ | linear distance |
| $v_{tangential} = r\omega$ | always holds for a rotating object – how to relate rotational velocity to linear tangential velocity |
| $a_{tangential} = r\alpha$ | always holds for a rotating object – how to relate rotational acceleration to linear tangential acceleration (but remember there is also a centripetal acceleration that is radial!) |
| $a_c = \frac{v^2}{R}$ | centripetal acceleration (radial) |
| $v_{cm} = r\omega$ | requirement for pure roll or motion without slipping |
| $\mathbf{J} = \mathbf{F}\Delta t = \Delta\mathbf{p}$ | Impulse |
| $\mathbf{P}_{\mathbf{total}} = M_{total}\mathbf{V}_{CM}$ | total momentum of a system of particles can be described in terms of the total mass and the motion of the center of mass |
| $r_{cm} = (\Sigma m_i r_i)/M_{total}$ | position of the center of mass of a system of particles |
| $I = \Sigma\, m_i r_i^2$ | (how to calculate the moment of inertia I given a number of discrete masses $m_i$)<br>You will not be required to memorize moments of inertia for specific objects, e.g. that I= 2/5 M $R^2$ for a sphere rotating around an axis at its center. These will be given to you if needed. |
| $I_p = I_o + Md^2$ | parallel axis theorem, given I for an axis at point O, the moment of inertia for an axis at point P $I_p$ can be found from the d, distance from O to P |
| $\boldsymbol{\tau} = d\mathbf{L}/dt$ | condition for conservation of angular momentum |
| $\mathbf{L} = r \times \mathbf{p}$ | angular momentum |
| $T = a^{3/2}$ | Kepler's 2nd law, orbital period of a planet T in years, a is semi-major axis in AU |

$W = \int \boldsymbol{F} \cdot d\boldsymbol{s}$ Work done by a force F if force not constant over **s**

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**Finally, the following equations are all included elsewhere in this document but it may help you to study them in the following way, relating linear motion to rotational motion:**

| Linear/translational motion | Rotational motion analogue |
|---|---|
| $x$ | $\theta$ |
| $v$ | $\omega$ |
| $a$ | $\alpha$ |
| $m$ | $I$ |
| $F = ma$ | $\tau = I\alpha$ |
| $F = dp/dt$ | $\tau = dL/dt$ |
| $p = mv$ | $L = I\omega$ |
| $KE = \frac{1}{2}mv^2$ | $KE_{rot} = \frac{1}{2} I\omega^2$ |

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