Assignments

Assignment 1 - due Friday 10/2 Vector Identities - 1.16(b) 1.19, & $\nabla\left(\overrightarrow{A}\cdot\left(\overrightarrow{B}\times\overrightarrow{r}\right)\right)=\overrightarrow{A}\times\overrightarrow{B}$ when $\overrightarrow{A}$ and $\overrightarrow{B}$ are constant vectors, 1.23, 1.32, 1.39, 1.40, 1.45, 2.11*, 2.12, 2.13 *In 2.11(c) include the leading order term due to drag.

Assignment 2 - due Friday 10/9 2.19, 2.39, 2.41*, 2.42, 2.49(a), 2.55*(a-c), 3.4, 3.11, 3.13, 3.22, & Analogous to the dumbbell discussed in class, consider a uniform rod of mass m and length l lying on a frictionless table. The rod is struck on one end by a force F whose direction is perpendicular to the rod. Find the velocity of both ends of the rod immediately after the impulse in terms of the velocity of the center of mass. The moment of inertia of the rod about its center of mass is $I = ml^2/12$.

*Problem 2.55 will be discussed a bit during the discussion session. In problem 2.41 merely perform the necessary integral to determine $y_{\max}(v_0)$.

Assignment 3 - due Friday 10/16 3.27, 3.32, 3.35, 4.3, 4.4, 4.7(a&c), 4.18, 4.19, 4.23, 4.34

Assignment 4 - due Friday 10/23

4.35, 4.36, 4.37, 4.39, 4.46, 4.47, 5.4, 5.13, Prove the Virial Theorem for two particles, $\langle T\rangle = (n/2)\left\langle U^{int}\right\rangle$, where T is the total kinetic energy of both particles and U^{int} is the potential for a central conservative force between the two particles of the form $U^{int} = kr^n$. Here r is the relative distance between the two particles and there are no external forces. Hint, for problem 4.39 (a) use the substitution $\sin(\phi/2) = Au$ where $A = \sin(\Phi/2)$ and Φ is the maximum amplitude of oscillation. If you get stuck on 4.39 omit it, but try to complete the rest of the assignment particularly 4.37.

Assignment 5 - Due Friday 10/30 5.11, 5.18, 5.23, 5.27, 5.44, 6.9, 6.11, 6.15 Find the particular solution for the example of a mass being released from a critically damped spring, basically problem 5.28 in the text, using the Green's function

$$G(t-t') = (t-t')\, e^{-\beta(t-t')}\theta(t-t')\,.$$

Here $\theta(t-t')$ is the Heaviside step function defined so that $\theta(t-t') = 1$ when $t > t'$ and $\theta(t-t') = 0$ when $t < t'$. Additionally the first derivative of $\theta(t-t')$ satisfies $d\theta(t-t')/dt = \delta(t-t')$ where $\delta(t-t')$ is the Dirac delta function.

Performing the required integral is more difficult than simply noting the solution via observation as was done in class, but this exercise demonstrates the power of the concept.

Hint for problem 5.11, think about the conservation of energy.

Hint for problem 5.44, do problem 5.23 first.

Assignment 6 - Due Friday 11/6 6.16, 6.18, 6.22, 6.25, 7.3, 7.8, 7.10, 7.14, Assume that we have an integral I of the form

$$I = \int_1^2 f\left(y, y', y'', x\right) dx,$$

for which you want to find the path $y\left(x\right)$ along which the integral is stationary. Derive the Euler-Lagrange equations for $f\left(y, y', y'', x\right)$ that determines the stationary path given that the small deviations from the stationary path satisfy the constraints $\eta(x_1) = \eta(x_2) = \eta'(x_1) = \eta'(x_2) = 0$.

Hint, for problem 6.25 express the integrand that you obtain in the beginning of the problem via;

$$\frac{\sqrt{1-\cos\theta}}{\sqrt{\cos\theta_0 - \cos\theta}} = \frac{\sqrt{1-\cos\theta}}{\sqrt{1+\cos\theta_0 - (1+\cos\theta)}} = \frac{\sin\theta/2}{\sqrt{\cos^2\theta_0/2 - \cos^2\theta/2}}.$$

Assignment 7 - due Friday 11/13 7.16, 7.19, 7.20, 7.22, 7.27, 7.29, 7.30, 7.33, 7.35, 7.37

Assignment 8 - due Friday 11/20 7.38*, 7.41**, 7.47 (a,b,c), 7.50, 7.51 (a), Using the method of Lagrange multipliers, find the maximum area above the x axis under a string of length l that is fastened to the origin at one end and has its other end attached to the x axis. That is, find the path for which the integral $A = \int y dx$ is stationary subject to the constraint $l = \int \sqrt{1+y'^2}dx$. Express the area as a function of l. 8.3†, 8.9 (a,c), 8.12, 8.14††

*Assume in problem 7.38 and 7.41 that the systems reside in a uniform gravitational field g. ** In 7.41 only consider the equilibrium position at $\rho = 0$. † Given the initial conditions in 8.3 only solve for Y and y, the center of mass and relative coordinates (not required to find y_1 and y_2). †† In problem 8.14 no sketches required. Be sure and comment on how the result in part (c) impacts your solution for 8.12.

Assignment 9 - due Monday 11/30 Verify the relations in (8.52), 8.19, 8.20, 8.21, 8.23, 8.29, 8.35, 11.5, 11.9

Assignment 10 - due Friday 12/4 11.17*, 11.19, 11.27**, 11.32***

*For 11.17 add a part (c) in which you find the normal coordinates. Show that by using these coordinates the Lagrangian separates into two independent Lagrangians. **For problem 11.27 assume that $m_1 \neq m_2$. Additionally add a part (d) in which you verify that the zero frequency normal coordinate is (or at least proportional to) the CM coordinate and that the finite frequency normal coordinate is (or at least proportional to) the relative coordinate. *** In 11.32 assume that all masses are equal, $M = m$.