CLO - 1

1. Obtain a unit vector perpendicular to the two vectors $\vec{A} = -1.00\hat{\imath} + 3.00\hat{\jmath} + 5.00\hat{k}$ and $\vec{B} = 2.00\hat{\imath} + 3.00\hat{\jmath} - 1.00\hat{k}$
2. If two vectors $\vec{A} = -1.00\hat{\imath} + 3.00\hat{\jmath} + 5.00\hat{k}$ and $\vec{B} = 2.00\hat{\imath} + 3.00\hat{\jmath} - 1.00\hat{k}$ are lying on the side of parallelogram. Find the area of given parallelogram
3. Find the angle between two forces of equal magnitude such that the magnitude of their resultant is also equal to either of them.
4. For the vector **Ā** =-1.00î+6.00ĵ+3.00k and **B** =-4.00î+2.00ĵ-1.00k, Find the magnitude and direction of **AxB**
5. What is the cross product of two vectors in three-dimensional space? How does it relate to the area of the parallelogram formed by the vectors?
6. How do you project a vector A onto another vector B? What does this projection represent in terms of vector components?
7. Two forces of 20N and 10N are making an angle of 120^0 with each other. Find the single pull that would replace the given forces. (Resultant Force).
8. a) In methane molecule, CH4 each hydrogen atom is at the center of regular tetrahedron with the carbon atom at the center. In coordinates where one C-H bond is in the direction of $\hat{\imath} + \hat{\jmath} + \hat{k}$ and C-H adjacent C-H bond is in the $\hat{\imath} - \hat{\jmath} - \hat{k}$ direction. Calculate angle between two bonds.
   b) Also Find Projection along **B** and **A**
9. Find the resultant of the vectors $\vec{A} = 1.00\hat{\imath} + 2.00\hat{\jmath} - 8.00\hat{k}$, $\vec{B} = 2.00\hat{\imath} + 2.00\hat{\jmath} + 6.00\hat{k}$ and $\vec{C} = 1.00\hat{\imath} + 2.00\hat{\jmath} + 14.00\hat{k}$. Also, calculate the angles which resultant vector makes with the axes x, y and z
10. A car travels 20.0 km due north and then 35.0 km in a direction 60.0° west of north. Find the magnitude and direction of the car's resultant displacement.
11. Can the component of a vector ever be greater than the magnitude of the vector?
12. The polar coordinates of a point are r=5.50 m and angle=240°. What are the cartesian coordinates of this point?
13. Vectors **A** and **B** have equal magnitudes of 5.00. If the sum of **A** and **B** is the vector 6.00**j**, determine the angle between **A** and **B**.
14. Two vectors **A** and **B** have precisely equal magnitudes. For the magnitude of **A+B** to be 100 times greater
15. than the magnitude of **A-B**, what must be the angle between them?

16. Find the angle between two forces of equal magnitude such that the magnitude of their difference is also equal to either of them.
17. Find the resultant of a vector given by the difference of the following two vectors $\vec{A} = 5\sqrt{2}\hat{\imath} + 4\sqrt{2}\hat{\jmath} + 10\hat{k}$ and $\vec{B} = 2\sqrt{2\hat{\imath}} + \sqrt{2}\hat{\jmath} + 2\hat{k}$

CLO. 2

1. The velocity of a particle moving along the x-axis varies in time according to the expression $v=40-5t^2$ m/s, where t is in seconds. (a) Find the average acceleration in the time interval t=0 to t=2.0 s.
2. Consider the following one-dimensional motions: (a) A ball thrown directly upward rises to a highest point and falls back into the thrower's hand. (b) A race car starts from rest and speeds up to 100 m/s. (c) A spacecraft drifts through space at constant velocity. Are there any points in the motion of these objects at which the instantaneous velocity is the same as the average velocity over the entire motion? If so, identify the point.
3. A car is stopped at a traffic light. It then travels along a straight road so that its distance from the light is given by $x(t) = bt^2 - ct^3$, where $b = 2.40$ m/s^2 and $c = 0.120$ m/s^3 (a) calculate the average velocity of the car for the time interval t = 0 s to t = 10 s. (b) Calculate the instantaneous velocity of the car at t = 5 s and t = 10 s. (c) how long after starting from rest is the car again at rest?
4. The acceleration of a bus is given by $a(t) = bt$ where $b = 1.2$ m/s^3 (a) if the bus's velocity at time t = 1 s is 5 m/s what is its velocity at time t = 5 s? (b) If the bus's position at time t = 1 s is 6 m, what is its position at time t = 10 s? (c) Sketch acceleration-time graph, velocity-time graph and position-time graph of the bus. (for at least 10 s)
5. A jet lands on an aircraft carrier at 140 mi/h. (a) What is its acceleration if it stops in 2.0 s? (b) What is the displacement of the plane while it is stopping?
6. A tennis ball is dropped from shoulder height (about 1.5 m) and bounces three times before it is caught. Sketch graphs of its position, velocity, and acceleration as functions of time, with the y direction defined as upward.
7. If the velocity of a particle is nonzero, can its acceleration be zero? Explain.
8. If the velocity of a particle is zero, can its acceleration be nonzero? Explain.
9. Two cars are moving in the same direction in parallel lanes along a highway. At some instant, the velocity of car A exceeds the velocity of car B. Does this mean that the acceleration of car A is greater than that of car B? Explain.

10. An apple is dropped from some height above the Earth's surface. Neglecting air resistance, how much does the apple's speed increase each second during its descent?
11. A particle moves according to the equation, $x=10t^2$ where x is in meters and t is in seconds. (a) Find the average velocity for the time interval from 2.0 s to 3.0 s. (b) Find the average velocity for the time interval from 2.0 s to 2.1 s.
12. A person walks first at a constant speed of 5.00 m/s along a straight line from point A to point B and then back along the line from B to A at a constant speed of 3.00 m/s. What are (a) her average speed over the entire trip and (b) her average velocity over the entire trip?
13. A 50.0-g superball traveling at 25.0 m/s bounces off a brick wall and rebounds at 22.0 m/s. A high-speed camera records this event. If the ball is in contact with the wall for 3.50 ms, what is the magnitude of the average acceleration of the ball during this time interval?
14. A particle moves along the x axis according to the equation $x=2.00+3.00t-1.00t^2$ where x is in meters and t is in seconds. At t=3.00 s, find (a) the position of the particle, (b) its velocity, and (c) its acceleration.
15. A certain automobile manufacturer claims that its super deluxe sports car will accelerate from rest to a speed of 42.0 m/s in 8.00 s. Under the (improbable) assumption that the acceleration is constant, (a) determine the acceleration of the car. (b) Find the distance the car travels in the first 8.00 s. (c) What is the speed of the car 10.0 s after it begins its motion, assuming it continues to move with the same acceleration?
16. A truck covers 40.0 m in 8.50 s while smoothly slowing down to a final speed of 2.80 m/s. (a) Find its original speed. (b) Find its acceleration. A jet plane lands with a speed of 100 m/s and can accelerate at a maximum rate of 5.00 m/s^2 as it comes to rest. (a) From the instant the plane touches the runway, what is the minimum time it needs before it can come to rest? (b) Can this plane land at a small tropical island airport where the runway is 0.800 km long?
17. An electron in a cathode-ray tube (CRT) accelerates uniformly from 2.00 $x10^4$ m/s to 6.00 $x10^6$ m/s over 1.50 cm. (a) How long does the electron take to travel this 1.50 cm? (b) What is its acceleration?
18. A motorcycle is moving at 30 m/s when the rider applies the brakes, giving the motorcycle a constant deceleration. During the 3.0 s interval immediately after braking begins, the speed decreases to 15 m/s. What distance does the motorcycle travel from the instant braking begins until the motorcycle stops?
19. Is it possible for an object (a) to be slowing down while its acceleration is increasing in magnitude (b) to be speeding up while its acceleration is decreasing? In each case, explain your reasoning.

CLO. 3

1. A long-jumper leaves the ground at an angle of 20.0° above the horizontal and at a speed of 11.0 m/s. (a) How far does he jump in the horizontal direction?
2. A tennis player standing 12.6 m from the net hits the ball at 3.00° above the horizontal. To clear the net, the ball must rise at least 0.330 m. If the ball just clears the net at the apex of its trajectory, how fast was the ball moving when it left the racket?
3. In a projectile motion:
   (i) Which velocity component retains its initial value throughout the flight and why?
   (ii) At what point in the path of a projectile is the speed a minimum? Show this point by drawing a projectile path.
4. (i) Show that for a projectile motion the maximum range covered is equal to four times of its maximum height attained.
   (ii) Why is a launch angle of 45° considered optimal for achieving the maximum range in a vacuum?
5. A ball thrown vertically upward is caught by the thrower after 20.0 s. Find (a) the initial velocity of the ball and (b) the maximum height it reaches.
6. A ball is thrown vertically upward from the ground with an initial speed of 15.0 m/s. (a) How long does it take the ball to reach its maximum altitude? (b) What is its maximum altitude? (c) Determine the velocity and acceleration of the ball at t=2.00 s.
7. At t=0, a particle moving in the xy plane with constant acceleration has a velocity of v_i=3**i**-4**j** when it is at the origin. At t=3.00 s, the particle's velocity is v=(9.00i +7.00j) m/s. Find (a) the acceleration of the particle and (b) its coordinates at any time t.
8. In a local bar, a customer slides an empty beer mug down the counter for a refill. The bartender is momentarily distracted and does not see the mug, which slides off the counter and strikes the floor at distance d from the base of the counter. If the height of the counter is h, (a) with what velocity did the mug leave the counter and (b) what was the direction of the mug's velocity just before it hit the floor?
9. An artillery shell is fired with an initial velocity of 300 m/s at 55.0° above the horizontal. It explodes on a mountainside 42.0 s after firing. What are the x and y coordinates of the shell where it explodes, relative to its firing point?
10. A cannon with a muzzle speed of 1 000 m/s is used to start an avalanche on a mountain slope. The target is 2000 m from the cannon horizontally and 800 m above the cannon. At what angle, above the horizontal, should the cannon be fired?

11. A soccer player kicks a rock horizontally off a cliff 40.0 m high into a pool of water. If the player hears the sound of the splash 3.00 s later, what was the initial speed given to the rock? Assume the speed of sound in air to be 343 m/s.
12. A tire 0.500 m in radius rotates at a constant rate of 200 rev/min. Find the speed and acceleration of a small stone lodged in the tread of the tire (on its outer edge).
13. A soccer ball is kicked from the ground with an initial speed of 19.5 m/s at an upward angle of 45°. A player 55 m away in the direction of the kick starts running to meet the ball at that instant. What must be his average speed if he is to meet the ball just before it hits the ground?
14. A centripetal-acceleration addict rides in uniform circular motion with radius r = 3.00 m. At one instant his acceleration is.

$$\vec{a} = (6.00\ \text{m/s}^2)\text{i} + (-4.00\ \text{m/s}^2)\text{j}.$$

At that instant, what are the values of (a) v. a and (b) r x a?