AEEM5063 HW#3

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2.12

$$\vec{V} = -4\hat{i} + 3\hat{j} - 5\hat{k}$$
$$\hat{u_r} = 0.26726\hat{i} + 0.53452\hat{j} + 0.80178\hat{k}$$

(a)

$$v_r = \vec{V} \cdot \hat{u_r} = -4 * 0.26726 + 3 * 0.53452 - 5 * 0.80178$$
$$\boxed{v_r = -3.474\text{km/s}}$$

(b)

$$v = \sqrt{v_r^2 + v_\perp^2} \rightarrow v_\perp = \sqrt{v^2 - v_r^2}$$
$$v = \sqrt{(-4)^2 + 3^2 + (-5)^2} = 50$$
$$v_\perp = \sqrt{50^2 - (-3.474)^2} = \boxed{6.159 \text{ km/s}}$$

(c)

$$\tan\gamma = \frac{v_r}{v_\perp} = \frac{-3.474}{6.159}$$
$$\boxed{\gamma = -29.43^\circ}$$

2.14

$$\vec{V} = 2\hat{i} + 3\hat{j} + 4\hat{k}$$

$$v = \sqrt{2^2 + 3^2 + 4^2} = 5.3852$$

$$u_V = \frac{\vec{V}}{v} = 0.37139\hat{i} + 0.55709\hat{j} + 0.74278\hat{k}$$

$$\epsilon = \frac{v^2}{2} - \frac{\mu}{r} = \frac{5.3852^2}{2} - \frac{398600}{10000} = -25.36$$

$$-25.36 = \frac{0^2}{2} - \frac{398600}{r} \rightarrow r = 15718$$

$$\vec{r} = ru_V = 15718(0.37139\hat{i} + 0.55709\hat{j} + 0.74278\hat{k})$$

$$\boxed{\vec{r} = 5837.4\hat{i} + 8756.1\hat{j} + 11675\hat{k} \text{ km}}$$

2.16

$$\mu = 42828\text{km}^3/\text{s}^2; \quad R = 3396\text{km}$$

$$v = \frac{\mu}{r} = \frac{42828}{3396} = \boxed{3.4511 \text{ km/s}}$$

$$T = \frac{2\pi}{\sqrt{\mu}} r^{3/2} = \frac{2\pi}{\sqrt{42828}}(3396 + 200)^{3/2} = 6547\text{s}$$

$$\boxed{\text{T=1 hr, 49 min, 7s}}$$

2.5

Contents

Initialize

```
clear; clc;
```

Define variables and constants

```
tspan = [0 24*3600];
mu = 398600;
R = 6378;
r0 = [6600 0 0];
v0 = [0 12 0];
ics = [r0'; v0'];
```

Solve non-stiff differential equations, medium order method.

```
[t, y] = ode45(@dstate, tspan, ics);
```

print results

```
fprintf("dist. @ 24hr: %.2f km \n", norm([y(end,1) y(end,2) y(end,3)]));
fprintf("speed @ 24hr: %.2f km/s", norm([y(end,4) y(end,5) y(end,6)]));
```

```
dist. @ 24hr: 463290.13 km
speed @ 24hr: 4.99 km/s
```

Plot results

```
%figure;
%clf;
%plot3(y(:,1), y(:,2), y(:,3));
%grid;
%xlabel('x (m)');
```

```
%ylabel('y (m)');
%zlabel('z (m)');
```

Define derivative function

```
function ddt = dstate(t, yi)
```

define constants

```
    mu = 398600;
```

get state from inputs

```
    x = yi(1);
    y = yi(2);
    z = yi(3);
    vx = yi(4);
    vy = yi(5);
    vz = yi(6);
    r = norm([x y z]);
```

Define derivatives

```
    ax = -mu*x/r^3;
    ay = -mu*y/r^3;
    az = -mu*z/r^3;
```

create output vector

```
    ddt = [vx; vy; vz; ax; ay; az];
```

```
end
```

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