Department of Computer Science
Mid Term Assignment
Date: 13/04/2020
Course Details

Course Title: Radar & Satellite Communication **Module:**
Instructor: DR, Naeem Ahmad Jan **Total Marks:** 30

Student Details

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Q1.	(a)	Find and explain Track and Search Radar Range equation	Marks 6
	(b)	Explain working principle of Satellite communications system (GPS), and difference between triangulation & Trilateration?	Marks 4
Q2.	(a)	Draw and Explain Radar Block Diagram	Marks 6
	(b)	Find the escape velocity of satellite?	Marks 4
Q3.	(a)	Find out the orbital speed & Time period of satellite?	Marks 6
	(b)	Explain different types of radar systems	Marks 4

(Q1)

(a) Find and explain Track and search Radar Range equation.

(Ans) Power densit from radiating antenna

$$\frac{P_t}{4\pi R^2}$$

∵ Pt Peak transmitter power

∵ R = distance from radar.

Power density from directive antenna

$$\frac{P_t G_t}{4\pi R^2}$$

∵ Gt transmit gain

Power of reflected signal as target

$$\frac{P_t G_t \sigma}{4\pi R^2}$$

∵ σ = radar cross section units

Power density of reflected signal at the radar

$$\frac{P_t G_t}{4\pi R^2} \frac{\sigma}{4\pi R^2}$$

Power of reflected signal from target and received by radar

$$P_r = \frac{P_t G_t}{4\pi R^2} \frac{\sigma A_e}{4\pi R^2}$$ ∵ P_r Power received

∵ A_e effective area.

Power density by reflected signal is

$$P_r = \left(\frac{P_t G \sigma}{4\pi R^2}\right) \times \frac{1}{4\pi R^2}$$

$$= \frac{P_t G \sigma}{(4\pi R^2)^2}$$

If effective area of antenna A_e, received power.

$$P_r = \frac{P_t G \sigma A_e}{(4\pi R^2)^2}$$

for max range R_{max} received signal

$$P_r = S_{min}$$

$$S_{min} = \frac{P_t G \sigma A_e}{(4\pi)^2 R^4_{max}}$$

$$R_{max} = \left[\frac{P_t G \sigma A_e}{(4\pi)^2 S_{min}}\right]^{1/4}$$

for Parabolic Antenna

$$G = \frac{4\pi Ae}{\lambda^2}$$

Hence

$$\Rightarrow R_{max} = \left[\frac{P_t (4\pi Ae)\, \sigma Ae}{(4\pi)^2 S_{min}}\right]$$

$$R_{max} = \left[\frac{P_t\, Ae\, \sigma}{4\pi \lambda^2 S_{min}}\right]^{1/4}$$

The Noise power at the receiver is given by

$N = K B_n T_s$ ∵ T_s = System Noise Temperature.

K = Boltzman constant

B_n = Noise bandwidth of receiver

* signal Power reflected from target and received by radar.

$$P_r = \frac{P_t G_t}{4\pi R^2} \, \frac{\sigma Ae}{4\pi R^2}$$

* Average Noise Power.

$$N = K T_s B_n.$$

* Signal to Noise Ratio

$$S/N = Pr/N$$

$$S/N = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 R^4 K T_s B_n L}$$

* Track Radar Equation.

$$S/N = \frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^3 R^4 K T_s B_n t}$$

=) when the location of a target is known and the antenna is pointed toward the target

* Search Radar Equation

$$S/N = \frac{P_{av} A_e t_s \sigma}{4\pi \Omega R^4 K}$$

=) when the target location is unknown and the radar has the search a target angular region to find it.

(Q 1)
(b) Explain working principle of satellite communication system (GPS) and difference between triangulation and trilateration?

(Ans) Principle of satellite communication

=> A satellite is a body that moves around another body in a mathematically predicatable path called an orbit.

=> A repeater is a ~~circuit~~ circuit which increase the strength of the signal it receives and retransmits it.

=> The frequency with which is sent into the space is called ~~Downlink~~ uplink frequency.

=> The frequency with which it is sent by the transponder is called downlink frequency.

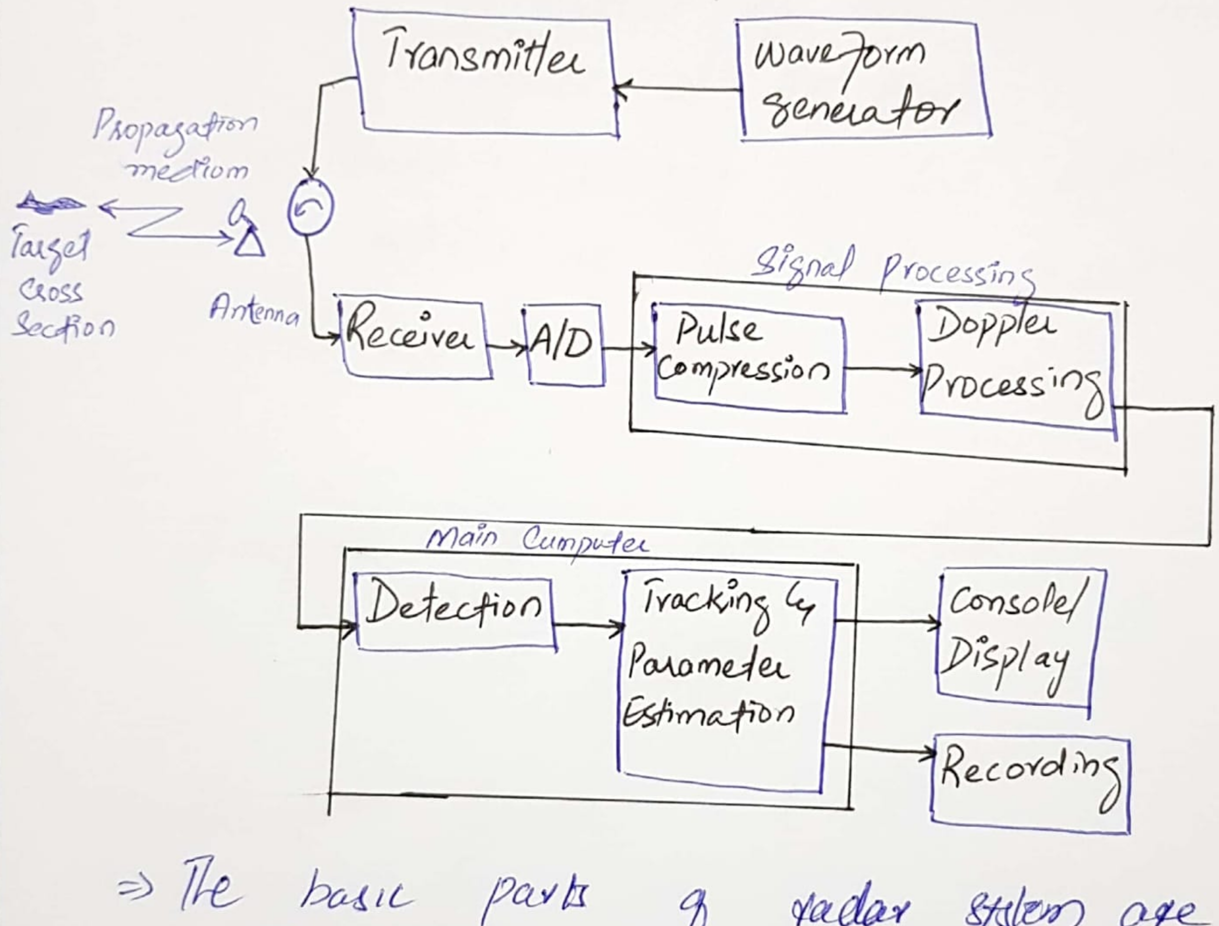
=> GPS satellite circle the earth twice a day in a very precise orbit and transmit signal information to earth.

★ Difference Triangulation Vs Trilateration

Triagulation	Trilateeration
(1) All angles are measured in triangulation.	(1) All sides are measured in trilateration
2) Distance of basedline is measured	2) Azimuth of the initial line is measured
(3) Multiple bearing on an unknown target.	(3) Multiple distance determination to an unknown target.
4) Reading taken from unknown location	(4) Reading taken from known location.
(5) The size length are computed on the basis of measured angle applying sine	(5) The angle are computed on the basis of measured side lengths applying cosine.

Q2
(a) Draw and explain Radar Block Diagram?

Radar Block Diagram:



⇒ The basic parts of radar system are illustrated in the simple Block diagram of Fig. The radar ~~say~~ Signal usually a repetitive train of Short pulses. is generated by the transmitter and radiated into the space by the antenna. If the output of the radar receiver is sufficently large detection of a target is said to occur.

Q2

(b) Find the escape velocity of satellite?

(Ans) Escape velocity of Satellite:-

⇒ Consider a satellite of mass m, stationary on the surface of the Earth.

⇒ The binding energy of the satellite, on the surface of the Earth, is given by

$$BE = \left(\frac{GMm}{R}\right)$$

Therefore KE of satellite = BE

$$KE = \left(\frac{GMm}{R}\right)$$

Therefore. $\frac{1}{2} m V_c^2 = \left(\frac{GMm}{R}\right)$

$$V_c^2 = \frac{2GM}{R}$$

$$V_c = \sqrt{\frac{2GM}{R}} \rightarrow (1)$$

Where $G = 6.67 \times 10^{-11}$

$M = 5.97 \times 10^{24}$

$R = 6.378 \times 10^{6}$

Pull all values in eq (1)

$$V_c = \sqrt{\frac{2(6.67 \times 10^{-11})(5.97 \times 10^{24})}{6378000}}$$

$$V_c = \sqrt{\frac{2 \times 6.67 \times 5.97 \times 10^{24-11}}{6378000}}$$

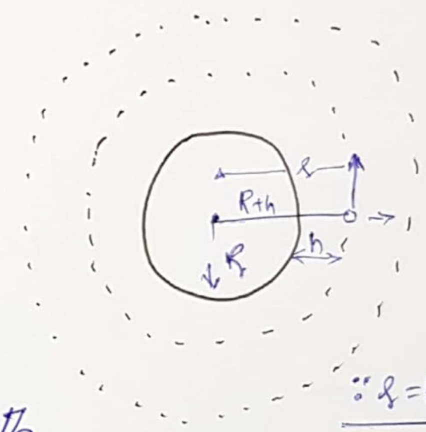
$$V_c = \sqrt{\frac{79.72 \times 10^{13}}{6378000}}$$

$$V_c = \sqrt{124992160}$$

$V_c = 1118$ m/s or 11.2 Km/s

Q3
(a) Find out the orbital speed and Time Period of satellite?

Ans **Orbital Speed:-** It is the minimum speed required to put satellite in given orbit around earth.



$$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{gR^2}{r}}$$

$\because r = R+h$

Where $g = 9.8 m/s$

R_E = radius of earth.

The value for orbital velocity was found to be 7.92K/s

$$v = R\sqrt{g/_{R+h}}$$

Satellite is close to earth.

$$R+h \approx R$$

$$v = R\sqrt{g/_R}$$

$$v = \sqrt{g \times R} = \sqrt{gR}$$

$$\boxed{v = 7.92 \times 10^3 m/s}$$

* Time Period of Satellite

Time taken by satellite for one complete revolution around earth.

$$T = \frac{\text{Distance travelled in one revolution}}{\text{orbital speed}}$$

$$T = \frac{2\pi r}{V} = \frac{2\pi r}{R\sqrt{g/r}}$$

$$T = \frac{2\pi r}{R}\sqrt{\frac{r}{g}} = \frac{2\pi}{R}\sqrt{\frac{r^3}{g}}$$

$$T = \frac{2\pi}{R\sqrt{g}}\sqrt{r^3}$$

$$\boxed{T = \frac{2\pi}{R\sqrt{g}} \sqrt{(R+h)^3}}$$

$$v = R\sqrt{g/r}$$

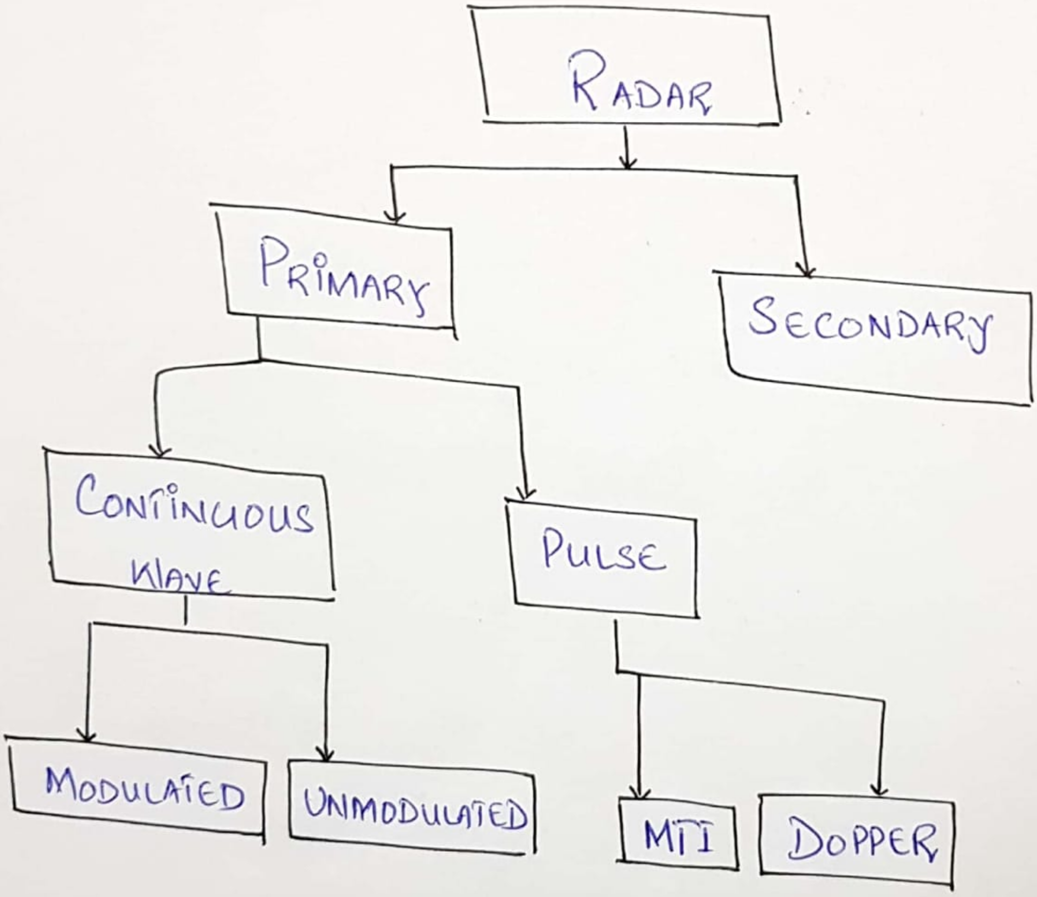
It is independent of mass of satellite

$$v \propto \frac{1}{\sqrt{r}}$$

Orbital velocity decrease with increase in orbital radius.

(Q3)
b. Explain different types of Radar system?

(Ans) **Types of Radar**



(a) **Primary Radar**:-

Primary Radary Radar relies solely on the energy that it has generated and radiated. being reflected back from the target. i.e echo.

(b) **Secondary Radar:-**

It has some co-operation from the target- the target generates its own 'em' radiation.

Therefore Primary Radar has following types.

1) **Pulse Radar:-** It sends high power and frequency pulses towords the target object. The range will depends on pulse repetition frequency.

(2) **Continuous Wave Radar:-**

It does not measure the range of the target but rather the rate of change of range by measuring the doppler shift of the return signals.