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

Course Details

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

Student Details

Name: Javid
Student ID: 13151

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).

(PART. a). Find and explain track and Search Radar equation?

(Ans). Power density from radiating antenna.

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

. Pt = Peak transmitter Power

. R = distance from radar

Power density from directive antenna

$$\frac{Pt\ Gt}{4\pi R^2}$$

. Gt = transmit gain

Power of reflected signal as target

$$\frac{Pt\ Gt\ \sigma}{4\pi R^2}$$

. σ = radar Cross Section units

Power density of reflected signal at the radar

$$\frac{Pt}{4\pi R^2}\ \frac{\sigma}{4\pi R^2}$$

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 desity by reflected Signal is

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

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

If effective area of antenna Ae, received Power

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

For max range Rmax received Signal

$$P_r = S_{min}$$

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

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

For Parabolic Antenna

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

Hence

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

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

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.

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

⇒ Average Noise Power

$$N = K T_s B_n$$

⇒ Signal to noise Ratio

$$S/N = P_r/N$$

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

⇒ Track Radar Equation

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

→ 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 known and the radar has the Search a target angular region to find it.

(Q1).

(PART. b) Explain Working principle of Satelite Communication System (GPS) and difference between triangulation and Trilateration?

(Ans). Principle of Satelite Communication:

- A geostationary Communication Satelite is basically a relay station in Space.
- It receives Signal from one earth station, amplifies it, improves the Signal quality and radiate the Signal back to other earth stations.
- Such a relay System allows us to Communicate with any Corner of the world.
- The use of orbiting Satelites to relay transmission from one Satelite dish to another or multiple dishes.
- GPS Satelile Circle the earth twice a day in a very Precise orbit and transmit Signal information to earth

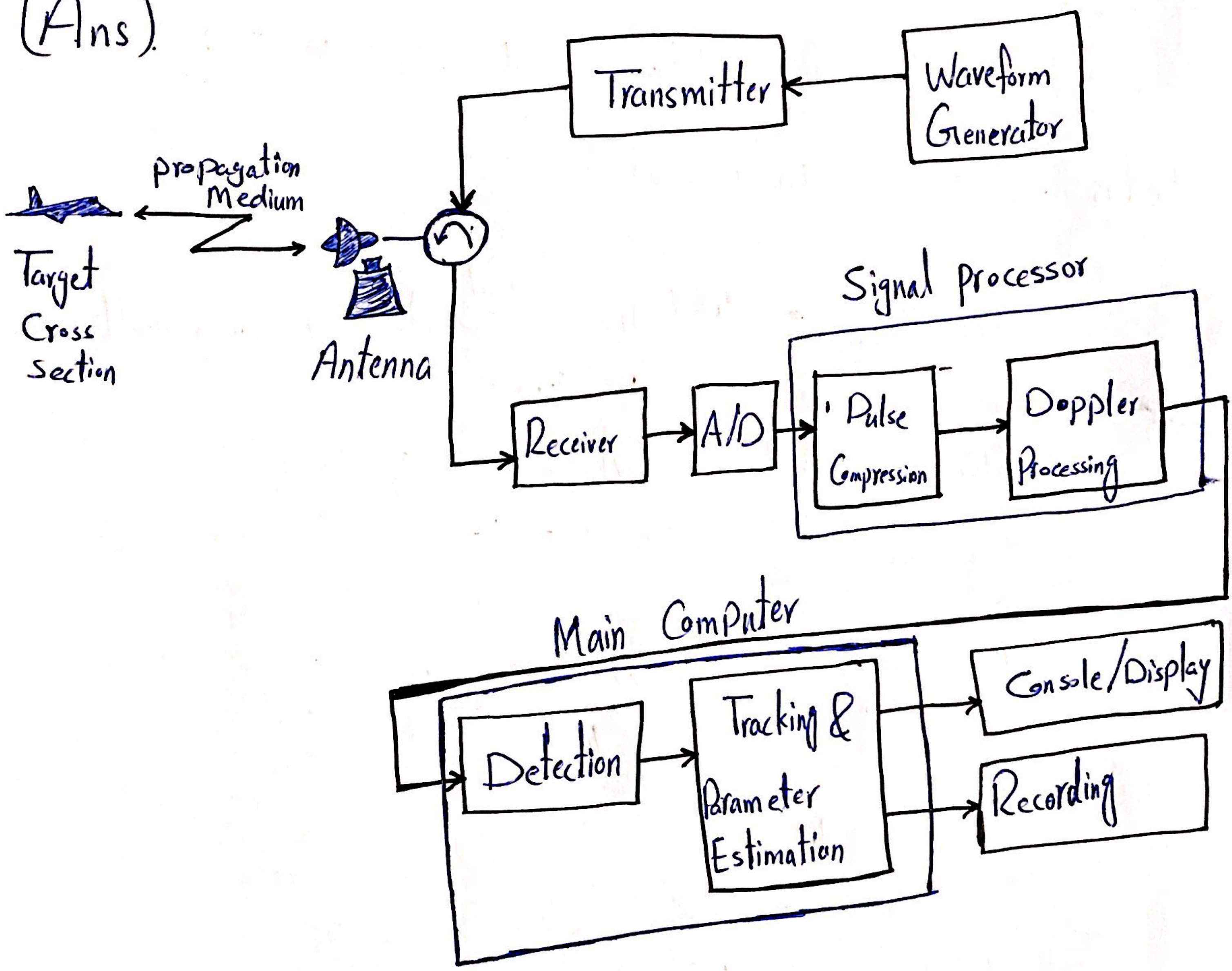
Triangulation Vs. Trilateration

Triangulation	Trilateration
1. All angles are measured in triangulation.	1. All sides are measured in trilateration
2. Distance of baseline is measured to control scale error.	2. Azimuth of the initial lines is measured.
3. Intervisibility between stations is essential.	3. Some check angles are measured to control azimuth error.
4. Some check base lines are also measured to control scale error.	4. For small areas it is possible to measure distances without intervisibility.
5. There are more internal checks in the same geometric figure.	5. There are less internal checks in comparison with triangulation in the same geometric figure.
6. The side lengths are computed on the basis of measured angles applying sine law.	6. The angles are computed on the basis of measured side lengths applying cosine law.

(Q2).

PART(a). Draw and Explain Radar Block Diagram?

(Ans)



Explaination: Basic Radar System Block Diagram Concists of a transmitter and a receiver, each Connected to a directional antenna.

The transmitter is capable of Sending out a large UHF or microware power through the antenna.

The receiver Collects as much energy as possible from the echoes reflected in its direction by the target and then processes and displays this information in Suitable way.

The receiving antenna is very often the Same as the transmitting antenna.

(Q2).

PART (b). Find the escape Velocity of Satelite ?

(Ans).

Consider a body of mass 'm' Which is at rest on the Surface of the earth.

Let M be the mass of the earth and R be the radius of the earth.

Then the binding energy of the body on the Surface of the earth is given by.

$$B.E. = \frac{GMm}{R}$$

Where G is Universal gravitational Constant.

Therefore, KE of statelite = BE

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

- Therefore, $\frac{1}{2} m v_c^2 = \left(\frac{GMm}{R}\right)$

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

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

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

Here, $G = 6.67 \times 10^{-11}$, $M = 5.97 \times 10^{24}$

$R = 6378000$

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

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

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

$$= \sqrt{124992160}$$

$$= 1118 \text{ m/s or } 11.2 \text{ km/s}$$

(Q3).

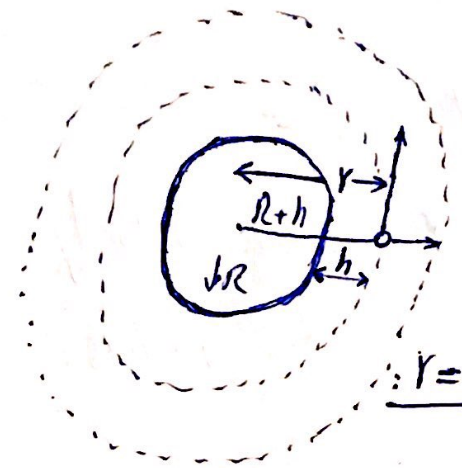
PART (a). Find out the orbital Speed & Time Period of Satelite ?

(Ans). Orbital Speed :
It is the minimum Speed required to put Satelite in given orbit around earth.

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

Where, $g = 9.8 \, m/s$ and Re = radius of earth.
The value for orbital velocity was found to be $7.9 \, km/s$.

$$V = R\sqrt{g/R+h}$$



Satelite is close to earth

$$R + h \approx R$$

$$\therefore r = R + h$$

$$V = R\sqrt{g/R}$$

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

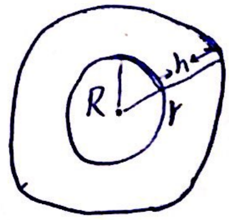
$$V = 7.92 \times 10^3 \, m/s.$$

Time Periode of Satelite:

Time taken by Satelite for one Complete revolution around earth.

$$T = \frac{\text{Distance travelled in one revolution}}{\text{Orbital speed}} = \frac{2\pi r}{V} = \frac{2\pi r}{R\sqrt{g/r}}$$

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



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

$$V = \sqrt{\frac{g}{r}}$$

it is independent of mass of Satelite.

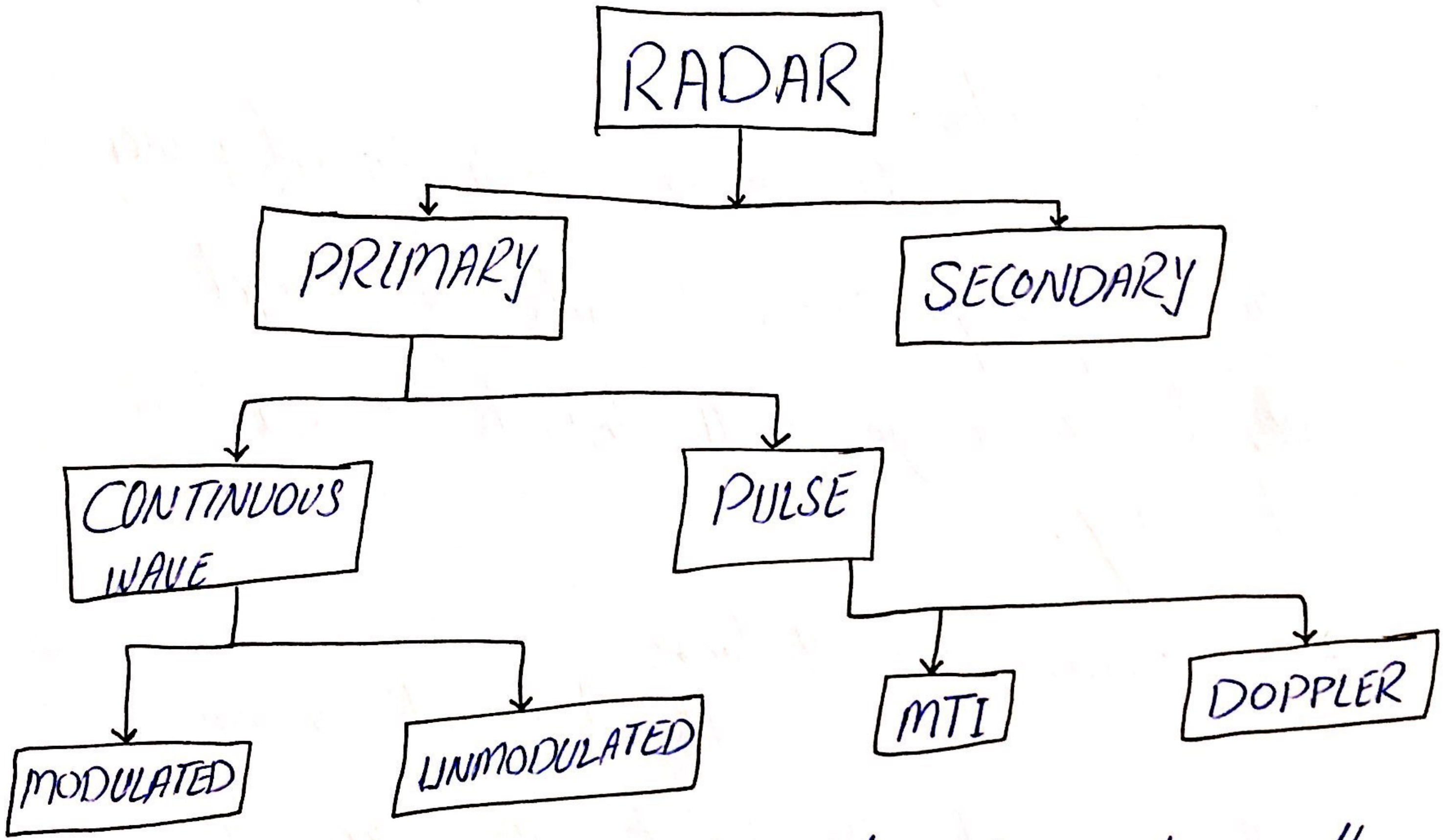
$$V \propto \frac{1}{\sqrt{r}}$$

orbital velocity decrease with increase in orbital radius.

(Q3).

PART (b). Explain different types of radar Systems?

(Ans). TYPES OF RADAR



Primary Radar:- primary radar relies solely on the energy that it has generated and radiated, being reflected back from the target.
i.e echo.

Secondary Radar:- It has Some Co-operation from the target the target generates its own 'em' radiation.

There for Primary Radar has following types:-

1). Pulse Radar:- It ~~Ba~~ sends high ~~Speed~~ power and frequency Pulses towards the target object. The range will depends on 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.