



Name :

Roll No. :

Invigilator's Signature :

CS/M.Tech(ECE)/SEM-1/MCE-105D/2012-13

2012

MICROWAVE APPLICATIONS

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

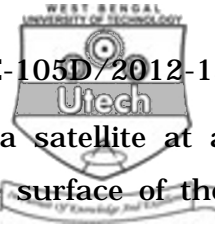
(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :
 $10 \times 1 = 10$

- i) Geostationary satellites are generally placed in
- a) Equatorial orbit b) Polar orbit
- c) Inclined orbit d) None of these.
- ii) The earth coverage angle for a geostationary satellite at an altitude of 42000 Km from the centre of the earth for a 0° earth station elevation would be (Assume earth's radius = 6370 Km)
- a) $2 \tan^{-1} 0.15$ b) $\cos^{-1} 0.15$
- c) $2 \sin^{-1} 0.15$ d) $\sin^{-1} 0.15$.



- iii) The available bandwidth of a transponder in 6/4 GHz band is
- a) 500 MHz b) 600 MHz
- c) 550 MHz d) 1000 MHz.
- iv) Telemetry data are transmitted as a frequency or phase shift keying using
- a) Time division technique
- b) Frequency division technique
- c) any of the two
- d) none of these.
- v) The type of antenna commonly used in fire control radars is
- a) Parasitic arrays b) Driven arrays
- c) Horn antenna d) Yagi-Uda antenna.
- vi) A satellite earth station antenna has a gain of 10^6 and a noise temperature of 100 K. The earth station G/T in dB/K is
- a) 40 dB/K b) 80 dB/K
- c) Zero d) none of these.
- vii) An amplifier has a quoted noise figure of 2.5 dB. The equivalent noise temperature is (Take reference temperature as 290 K)
- a) 230 K b) 226 K
- c) 240 K d) 250 K.



- viii) A 10 GHz signal was beamed up for a satellite at a distance of about 40,000 Km from the surface of the earth. The signal undergoes a free space loss of about
- a) 10 dB b) 50 dB
- c) 204 dB d) 385 dB.
- ix) Probability density function of thermal noise is
- a) Binomial b) Gaussian
- c) Poisson d) None of these.
- x) The multiple satellite access technique suitable only for digital transmission is
- a) CDMA b) TDMA
- c) FDMA d) both (b) and (c).
- xi) The earth subtends an angle of 17° when viewed from geostationary orbit. For global coverage at 4GHz, the diameter of antenna should be about
- a) 0.25 m b) 0.33 m
- c) 0.53 m d) 0.66 m.
- xii) Forward error correction (FEC) technique is meant for
- a) only detection of errors
- b) only correction of errors
- c) both detection and correction of errors
- d) none of these.



xiii) For pulse width $1\mu s$, two equal size targets can be resolved when the distance of separation between them is

- a) 150 m b) 125 m
c) 100 m d) 75 m.

xiv) When the average time between false alarms is 15 min, the probability for false alarm for 1 MHz bandwidth is

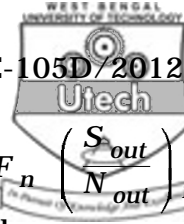
- a) 1.21×10^{-9} b) 1.31×10^{-9}
c) 1.11×10^{-9} d) 1.41×10^{-9} .

GROUP - B

(Short Answer Type Questions)

Answer any *three* of the following. $3 \times 5 = 15$

2. With the help of block diagram, explain telemetry, tracking, command and monitoring (TTC & M) subsystem of a satellite.
3. Derive the relation between $\frac{C}{N}$ and $\frac{G}{T}$ ratio. In this context, develop the complete link design taking care of interfering signal.
4. Prove that for an FM signal $\left(\frac{S}{N} \right)_0 = \left(\frac{C}{N} \right)_1 \cdot 3 (1 + m) m^2$, where 'm' is the modulation index.
5. Illustrate error detection on satellite link and its correction.
6. a) Derive the simple form of radar equation. 3
b) What should be the pulse repetition frequency of radar in order to achieve a maximum unambiguous range of 60 nmi ? 2



7. a) Develop the relation $(S_{in})_{min} = kT_0BF_n \left(\frac{S_{out}}{N_{out}} \right)_{min}$ where, S , N and F_n represent signal power, noise power and noise figure respectively with k , T_0 and B denoting Boltzmann constant, reference temperature (290 K) and IF bandwidth respectively. 3
- b) Find out duty cycle of radar for a pulse wave form having peak power 1MW, pulse width $1\mu s$ and repetition period 1ms and also find the energy of the pulse. 2

GROUP - C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

8. a) Make a comparative study between LEO, MEO and HEO types of satellite. 4
- b) A satellite is in an elliptical orbit with a Perigee height of 1000 km and Apogee height of 4800 km. Find time period of the satellite in hours, minutes and seconds and also the eccentricity of the orbit. (Take $G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{Kg}^2$; $M = 5.98 \times 10^{24} \text{ Kg}$). 4
- c) Find the range and antenna elevation angle from the following data. Determine also the round trip delay for an earth station.
- Earth station is located at 6378 km distance from the centre of the earth.
 - The satellite is moving at 35786 km above the surface of the earth.
 - Given $\gamma = 36.2^\circ$, the notation carries its usual meaning. 4
 - Derive the necessary working formula. 3



9. a) What is a transponder ? With the help of the figure, describe the action of a typical single conversion transponder for 6/4 GHz. 1 + 4
- b) What kind of antenna systems are being used in satellite communication subsystem ? State and explain the factors on which the selection on an antenna depends. 2 + 4
- c) A geostationary satellite is located at a distance of 3000 km with an operating frequency 14.25 GHz. The gain of transmitting and receiving antenna are 15 and 20 respectively. If the transmitter power is 200kW, calculate the power received by the receiving antenna. 4
10. a) With a neat circuit diagram, explain the generation of FM signals for analog communication. 3
- b) Write down some of advantages of FM over AM. 2
- c) Mention analytically the methods of improvement of signal to noise ratio $\frac{S}{N}$ of an analog TV link through a satellite. 4
- d) Write down the basic differences between a small earth station and a large earth station. 3
- e) What do you understand by redundancy ? Why is it required at an earth station. 3



11. a) Assuming Gaussian pulse being sent through IF filter, formulate the relation between average time between crossing of threshold (when only noise is present), the IF bandwidth mean square value of noise voltage. 5
- b) Writing down the probability density function of the envelope of the video output, how do you find probability of detection of the signal ? Through the concerned integral cannot be evaluated analytically how one can conclude that a relation involving probability of detection probability of false alarm and signal to noise ratio can be established. 5
- c) With help of Albersheim empirical formula, find signal to noise ratio. (given, probability of detection = 0.99; av. time between false alarm = 30 min; bandwidth of IF amplifier = 0.4 MHz). 5
12. a) Drawing the block diagram of simple CW Doppler radar along with its frequency response curve, illustrate its operation. Describe also the action of Pulse radar in this connection. 8
- b) Derive the frequency response function of the single MTI delay time canceller. Quantify the blind speed and state how it imposes constraint in respect of functioning of MTI radar. 7

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