Code: A-15 **Subject: COMMUNICATION ENGINEERING**
Time: 3 Hours **June 2006** **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x10)

a. If the resistance value is doubled and temperature maintained constant, the available thermal noise power per unit bandwidth will

(A) increase four-fold. **(B)** increase two-fold.
(C) remain unchanged. **(D)** decrease to half of its original value.

b. A product modulator yields

(A) a full AM signal. **(B)** a DSB-SC signal.
(C) a VSB signal. **(D)** an SSB signal.

c. An AM signal can be demodulated by using

(A) an LPF. **(B)** a PLL.
(C) a discriminator. **(D)** an average detector.

d. Flat top sampling leads to

(A) aperture effect. **(B)** aliasing.
(C) loss of signal. **(D)** loss of higher frequency components.

e. The modulating signal frequency in commercial FM systems is usually limited to

(A) 75 kHz. **(B)** 15 kHz.
(C) 5 kHz. **(D)** 3.4 kHz.

f. A sinusoidal, 400 Hz modulating signal of 2 V amplitude phase modulates a carrier and produces 2.5 kHz maximum deviation. The index of phase modulation is

(A) 20. **(B)** 12.5.

(C) 6.25. **(D)** 3.125.

g. The impulse response of a filter matched to data pulses $\pm g(t)$ with $0 \le t \le T$ is

(A) $\delta^*(t)$. **(B)** $g^*(t)$.
(C) $g^*(t-T)$. **(D)** $g^*(T-t)$.

h. A CW radar operating at 5 GHz aims at a target moving with a 108 kmph radial speed. The observed Doppler shift will be

(A) 180 Hz. **(B)** 500 Hz.
(C) 927 Hz. **(D)** 1000 Hz.

i. A single bit parity check code can

(A) only detect a single bit error. **(B)** correct a single bit error.
(C) only detect two-bit errors. **(D)** correct upto two-bit errors.

j. A DM system with a pulse amplitude S and pulse rate f_s will not suffer from slope overload distortion with a sinusoidal modulating signal $A \sin 2\pi f_m t$ if

(A) $A < \frac{Sf_s}{f_m}$. **(B)** $A < \frac{Sf_s}{2\pi f_m}$.
(C) $A < \frac{Sf_m}{f_s}$. **(D)** $A < \frac{Sf_m}{2\pi f_s}$.

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. Explain the operation of an envelope detector for AM signals. Clearly explain diagonal clipping in such detectors. **(8)**

b. Derive a condition on the RC time constant in an envelope detector so that there is no diagonal clipping when the AM signal has a sinusoidal modulation to a depth m. **(8)**

Q.3 a. Discuss the parameter variation method for generation of FM signals. **(8)**

b. Describe an ADM system and explain how it overcomes some of the shortcomings of a simple delta modulation system. **(8)**

Q.4 Consider an FM signal v(t) given by

$v(t) = 10\cos\left(2\pi 10^7 t + 2.405 \sin 2\pi 10^3 t\right) \text{Volt}$

with t in seconds. This signal appears across a 75 Ω resistor. Find

(i) The expression for the modulating signal. **(4)**
(ii) The index of frequency modulation. **(2)**
(iii) The bandwidth of the FM signal by Carson's rule. **(2)**
(iv) The power in the carrier component. **(4)**
(v) The total power in all the sidebands. **(4)**

Q.5 Describe an integrate-and-dump filter receiver for binary data pulses represented by positive and negative rectangular pulses of amplitude V and duration T. Derive an expression for the probability of error. **(16)**

Q.6 a. State and prove sampling theorem for low pass signals. **(8)**

b. Give the merits and shortcomings of VSB signals. Describe the transmitter filter and the receiver filter responses vis-à-vis the demodulator output as relevant to a television picture signal. **(8)**

Q.7 Find the maximum tracking range of a deep space radar that operates at a frequency of 2.5 GHz, and has a peak pulse power of 500 kW. Its receiver noise figure is 1.1 and it uses a parabolic reflector of 64 m diameter. The corresponding figures for the beacon are: frequency = 2.5 GHz; peak pulse power = 50 W; noise figure = 13 dB and diameter of the parabolic reflector = 1.0 m. **(16)**

Q.8 A message source generates ten messages,

$m_1, m_2, m_3, m_4, m_5, m_6, m_7, m_8, m_9$ and m_{10}

with a-priori probabilities of

0.25, 0.17, 0.10, 0.22, 0.06, 0.05, 0.08, 0.01, 0.02 and 0.04, respectively, at a rate of 400 messages/ second.

(i) Find the entropy of the source. **(2)**
(ii) Find the information transmission rate. **(1)**
(iii) Design the Huffman codes for the messages. **(5)**
(iv) Find the average length of the code words. **(1)**
(v) Find the code redundancy and code efficiency. **(2)**
(vi) Are the codes uniquely decidable? Justify your answer. **(2)**
(vii) What can be the maximum entropy of the source if the occurrence probabilities of the messages become controllable? **(3)**

Q.9 Write notes on any **TWO** of the following:

(i) Phased array radars.
(ii) Colour television receivers.

(iii) Multiplexing techniques.
(iv) Narrowband noise. **(2 x 8)**