Department of Medical Engineering

UNIVERSITY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MEDICAL ENGINEERING

EBL 4501 : TELE-MEDICINE

END OF SEMESTER EXAMINATION

SUPPLEMENTARY/ SPECIAL PAPER

SERIES: MARCH 2025

TIME:2HOURS

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of FIVE questions; Answer any THREE questions.

Question ONE

(a) i) With the aid of a diagram and appropriate equations describe Amplitude modulation.

ii) Define the term modulation index.

iii) Derive an expression and illustrate for AM bandwidth.

(14 marks)

(b) A sinusoidal message is applied to a transmitter that radiates an AM signal with 10kW power.

i) Compute the carrier power if the modulation index is 0.6.
ii) Determine % of the total power in the carrier.
iii) Calculate the power in each sideband.

(6 marks)

QUESTION TWO

a) i) Explain the meaning of the term **super-heterodyning** as used in modern receivers

ii) Explain any TWO advantages of employing super heterodyning in receivers

(4 marks)

b) Given that the amplitude modulated wave is given by;

$$v_{AM}(t) = V_c(1+m\cos\omega_s t)\cos\omega_c t$$

where V_c is the peak carrier voltage and ω_c is the angular frequency of the carrier, m is the modulation index, ω_s is the modulating signal angular frequency, Show that the ratio of sideband power to the carrier power

$$\frac{P_{sideband}}{P_{carrier}} = \frac{m^2}{2}$$

(5 marks)

c) Draw the circuit of an A.M detector and explain its operation

(6 marks)

d) An AM transmitter has an output of 40kW when modulated to a depth of 75%.

Determine the

i) power of the un-modulated carrier

ii) the power output when after modulation to a depth of 60%

one sideband is suppressed

(5 marks)

Question THREE

(a) With aid of appropriate equations describe the raised Cosine role off filter. **(8 marks)**

(b) i. Derive the expressions and explain using impulse response the operation of Saussion pulse shaping filter. **(2 marks)**

ii. Determine the first zero-crossing RF bandwidth of a rectangular pulse which has $T_s = 41.06\,\mu s$. Compare this to the bandwidth of a raised cosine filter pulse with $T_s = 41.06\,\mu F \wedge \propto = 0.25$. **(10 marks)**

QUESTION FOUR

a) Draw a well labelled simplified block diagram of C band(6GHz/4GHz) communication satellite transponder and briefly explain its operation **(6 marks)**

b) A satellite earth station transmitter has an output power P_T and an aerial gain G_T.The receiving aerial on the satellite distant D meters has a power gain G_R.If the gain of an aerial is $\frac{4\pi}{D^2}$ times its effective aperture, derive an expression for the received power P_R at the satellite. **(4 marks)**

c) A satellite operating at 6GHz at a distance of 40000km from a point on the earth's surface radiates a power of 2W from an antenna with a gain of 17dB.Determine

i) the maximum isotropic radiated power EIRP

ii) Power density at the receiving point

iii) the path loss in dB

iv) the power received by an antenna with effective area of $10m^2$.

(10 marks)

Question FIVE

(a) With the aid of a block diagram explain the operation of a GMSK Transmitter and Receiver. **(14 marks)**

(b) i. Calculate the 3dB bandwidth for a low pass filter used to produce 0.25GMSK with channel data rate of R_b = 270kbs.

ii. Determine 90% power bandwidth in the RF channel and determine parameter α.

(6 marks)