ENG3014 Tutorial 2

Q1 Electrical filtering is a critical component in communication systems.

(a) State the types of filters used in a Super-heterodyne radio receiver and explain their purpose. [4]

(b) Explain the mathematical method that can be used to calculate the expected time varying output from a filter if you are given a time varying input signal with the function f(t)=A(t) Sin[omega t]. [4]

(c) Explain the difference between synchronous and asynchronous frequency shift keying. Discuss the similarities and differences between these systems and Super-heterodyne radio receivers. [6]

(d) In a digital system, the received radio signal will be sampled when measured. State any requirements that must be met for sampling data and discuss the effect sample time and number of samples has on the frequencies one can measure from sampled data. [4]

(e) Discuss how a synchronous or coherent receiver can be used to create high order modulation formats just as PSK, QPSK or QAM. Using a constellation diagram, with appropriate axes, show an example of each of these modulation formats. [4]

(f) Draw the transmitter and receiver architecture for a communication system implementing one of these modulation formats and explain the mathematical principles that can be used to calculate the function of the key components that enable the system to operate. [6]

Q2 A company is designing a new mobile phone handset. At this company, you are working in the team that is developing the new receiver circuitry to be used in this handset. You are required to determine the appropriate amplifier you require to receive a low error signal from the transmitter.

(a) Name the main sources of channel loss and explain their effect on the signal received at the mobile phone. [6]

(b) The handset is designed to operate in moving vehicles at city street speeds (approximately 30 mph). Calculate and sketch the spectral power density curve for the spectral broadening that you would expect to see for a signal with a carrier frequency of 1200 MHz. [6]

(c) Use the Hata-model to predict the loss that could be expected in a small city at a range of 2km from an 80m high receiver. Please assume an appropriate receiver height. [4]

(d) The transmitter has a power of 30 dBm and -24 dBm in the signal power that is required to successfully decode the signal. Assuming the handset antenna and associated components incur losses of 10dB, what amplifier gain do you need? Beyond channel and electrical system losses, what other parameters do you need to consider when choosing an amplifier? [6]

Q3 You have chosen to join a group of hobbyist radio enthusiasts and you are building up a radio system for voice transmission that is able to communicate with others in the group at a distance of 50km.

(a) Outline three possible radio systems you could make and choose one for the application mentioned above, explaining your choice. [5]

(b) Determine a carrier frequency for your system and the type of antenna you will use, explaining these choices. Estimate the channel loss to achieve the 50km of transmission. [8]

(c) Outline the possible issues in your channel that might lead to errors in the transmitted signal. [4]

(d) Draw a schematic of both the radio transmitter and receiver. Please explain the purpose of each part and why you included it in your design. [10]