Physical Layer Calculations

a) Compute the wavelength of a radio signal having a frequency of 600MHz. In what part of the electromagnetic spectrum does this signal belong i.e. would it correctly be described as UHF, Microwave or Infrared? 5 MARKS

C = λ * f where c is the speed of light in a vacuum = 300 * 10pow6

λ = c / f = 300 * 10 pow 6 / 600 * 10 pow 6

= 0.5m or 50cm

600MHz is UHF

b) What are the key differences between a Digital Signal and an Analog Signal? Suppose we have a communications channel with 30MHz of bandwidth. How many bits/sec can be sent over one of these channels if 1024-level digital signals are used? Assume a noiseless channel. 10 MARKS

Nyquist Theorem -> max data rate = 2B LOGbase2 V where B = bandwidth and V = levels

Max data rate = 2 * 30 * 10pow6 * LOGbase2 1024 = 2300mbps = 2.3gbps

c) Standard WiFi channels are generally 20MHz wide (in terms of bandwidth). What is the minimum signal-to-noise ratio (in dB) required to transmit a 200Mbps data stream through one of these channels? Also, what is the minimum number of signal levels required in the transmitted digital signal to achieve that data rate?
10 MARKS

Shannons Limit -> max data rate = B LOGbase2 (1 + S/N) where S/N is the SNR

200 * 10pow6 = 20 * 10pow6 LOGbase2 (1 + S/N)

10 = LOGbase2 (1 + S/N)

2pow10 = 1 + S/N -> S/N = 1023. Decibels = 10LOGbase10(S/N) =~ 30db

Use Nyquist theorem to get number of signal levels

200 * 10pow6 = 2 * 20 * 10pow6 LOGbase2 V

5 = LOGbase2 V -> V = 2pow5 = 32