Q. 4   (a) We wish to send at a rate of 10Mb/s over a bandpass channel. Assuming that an excess bandwidth of 50% is used, how much bandwidth is needed for each of the following schemes: QPSK, 64-QAM. **(3 marks)**

(b) Repeat part (a) for baseband channel. **(3 marks)**

(c) Assuming that it is desired to transmit information at a rate of R bits/sec. Determine the required transmission bandwidth of each of the following six communication systems (orthogonal BFSK, 8PSK, QPSK, 64-QAM, BPSK, Orthogonal 16-FSK), and arrange them in order of bandwidth efficiency, starting from the most bandwidth efficient and ending at the least bandwidth efficient. **(4 marks)**