National University of Singapore
School of Computing

CS2105 **Tutorial 10** Answer paper

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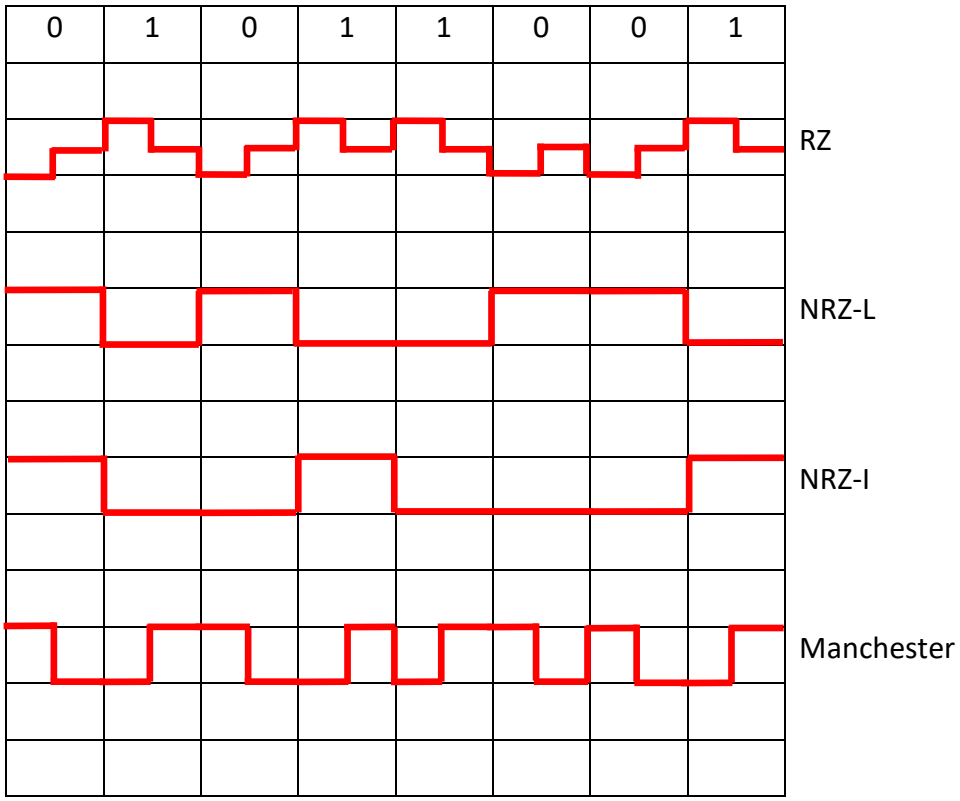
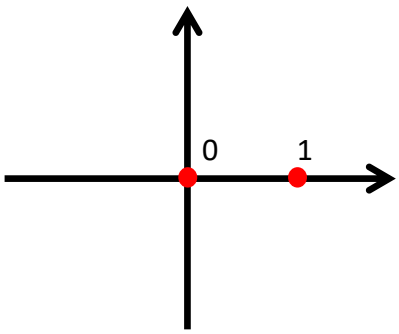
1. For each encoding method below, show how the bit sequence **01011001** is encoded: **RZ**, **NRZ-L**, **NRZ-I**, and **Manchester**.

   Assume for **NRZ**, the signal for the first bit (i.e. **0**) has positive voltage.



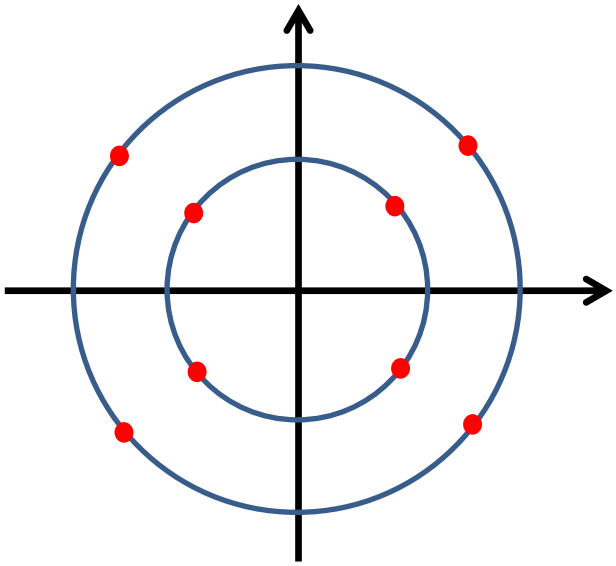
2. A constellation diagram helps us visualize the *amplitude* and *phase* of signal elements. Draw a constellation diagram for ASK illustrated on Lecture 11 notes page 19.



3. A given transmission medium has a SNR of 127 and supports frequency ranging from 1 MHz to 3 MHz. A signal is transmitted using the following modulation scheme:

$$s(t) = \begin{cases} 5\cos(2\pi ft + 45°) & 000 \\ 5\cos(2\pi ft + 135°) & 001 \\ 5\cos(2\pi ft + 225°) & 010 \\ 5\cos(2\pi ft + 315°) & 011 \\ 10\cos(2\pi ft + 45°) & 100 \\ 10\cos(2\pi ft + 135°) & 101 \\ 10\cos(2\pi ft + 225°) & 110 \\ 10\cos(2\pi ft + 315°) & 111 \end{cases}$$

a) Draw the constellation diagram for the modulation scheme above.



b) What is the theoretical maximum bit rate that can be transmitted through the medium?

$2 * 10^6 * log_2(1 + 127)$ = 14 Mbps

4. **[CS2105 Final Exam, April 2013]** 256-QAM modulation is used to transmit data at 256 kbps. What is the baud rate of the signal?

In 256-QAM, a signal level transmits 8 bits of information. Since bit rate is 256 kbps, baud rate is $256*10^3/8 = 32 * 10^3$ baud.

5. Refer to page 29 of Lecture 11 notes. A DHCP discover message is encapsulated in UDP segment, IP datagram, Ethernet frame and then broadcasted in the subnet.

   a) What is the destination MAC address of this frame?

      Broadcast MAC address: FF-FF-FF-FF-FF-FF

   b) What is the destination IP address of the datagram contained in this frame?

      Broadcast IP address: 255.255.255.255

   c) What are the source, destination port numbers of the UDP segment contained in this frame? (Check Lecture 6 notes or search online for answer)

      DHCP server process binds to port 67 and client binds to port 68. So in this DHCP discover message, source port is 68 and destination port is 67.

   d) Why all other nodes on the same subnet will ignore this DHCP query message except DHCP server?

      When UDP receives a segment, it checks destination port number (67 in this case) to decide which process to pass this segment to (i.e. de-multiplexing).

      Only DHCP server runs server process at UDP port # 67. All other hosts will ignore this DHCP query message because there is no app process listening to this port.