

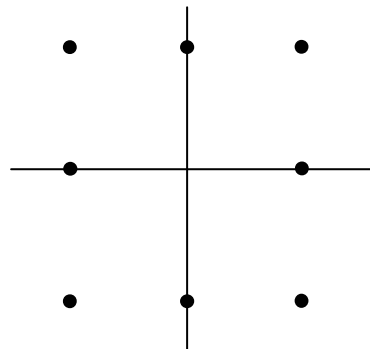
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**The University of Queensland**  
**School of Information Technology and Electrical Engineering**  
**Semester Two, 2009**

**COMS3200/COMS7201 – Tutorial 4**

**Questions**

1. Television channels are 6MHz wide. What's the maximum bit-rate (bps) which can be sent if four-level digital signals are used? Assume a noiseless channel.
2. If a binary signal is sent over a 3kHz bandwidth channel whose signal to noise ratio is 20dB, what is the maximum achievable data rate?
3. Explain how analog signals are converted to digital signals.
4. Two computers communicate via an analog channel using a signal modulated according to the following constellation diagram for phase-amplitude modulation:



Assume the channel is divided into regular time slots each 20 microseconds wide.

- (a) What kind of modulation is used?
  - (b) What is the baud-rate and the bit-rate?
5. Ten signals, each requiring 4000 Hz, are multiplexed on to a single channel using FDM. How much minimum bandwidth is required for the multiplexed channel? Assume that the guard bands are 400 Hz wide.
  6. A cable company decides to provide Internet access over cable in a neighbourhood consisting of 5000 houses. The company uses a coaxial cable and spectrum allocation allowing 100 Mbps downstream bandwidth per cable. To attract customers, the company decides to guarantee at least 2 Mbps downstream bandwidth to each house at any time. Describe what the cable company needs to do to provide this guarantee.
  7. Assume the following parameters for a switching network:  
N = number of hops between two given stations  
L = message length, in bits  
B = data rate, in bps, on all links  
P = packet-size, in bits  
H = overhead (header) bits per packet  
S = call setup time (circuit switching or virtual circuit) in seconds  
D = propagation delay per hop in seconds

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- (a) Derive general expressions for end-to-end delay for the four techniques: circuit switching, message switching, virtual circuit packet switching and datagram packet switching. Assume that there are no acknowledgements. (Note that a diagram for virtual circuit packet switching includes a connection set up phase followed by datagram-like packet switching).
- (b) Using your results in (a), show under what conditions the delays are equal for
- (i) circuit switching vs message switching, and
  - (ii) circuit switching vs (datagram) packet switching.
8. Compare the delay in sending an  $x$ -bit message over a  $k$ -hop path in a circuit-switched network and in a (lightly loaded) packet switch network. The circuit set-up time is  $s$  seconds, the propagation delay is  $d$  seconds per hop, the packet size is  $p$ -bits, and the data rate is  $b$  bps. Under what conditions does the packet network have a lower delay?