ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2017 SESSION

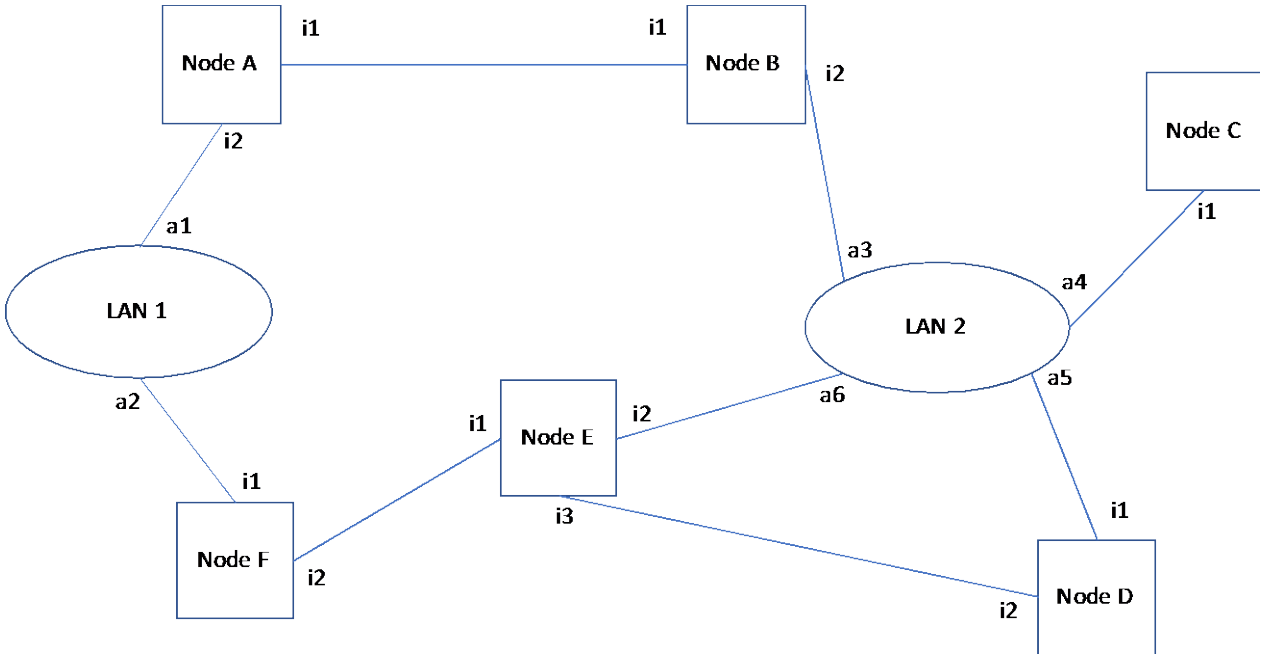
Open-book examination
Non-programmable calculators : only authorized models
Duration : 3 hours

## 14-IF-A7 Computer Communications

1) Encode the following sequence 01010011 with:
   a. NRZI **(5 points)**
   b. Differential Manchester **(10 points)**

2) We consider a 4 Mhz channel.
   a. What is the minimum SNR (Signal to Noise Ratio in dB) necessary to obtain a capacity of 16 Mbps for this channel? **(15 points)**
   b. How many signaling levels are required to achieve this limit? **(10 points)**

3) We consider an interconnected network with 6 nodes, 3 point to point links and 2 local area networks (LAN) represented on the next figure:



Each node has several network interfaces named i1, i2 etc.., each connected to a LAN or a dedicated link, and, if connected to a LAN, appears with an address a1, a2, a3 etc…

a. Show the route of a data packet traveling from Node C to Node F. For each hop indicate the interface used as well as the destination address if relevant. **(10 points)**

b. Complete the routine table in Node B with the following format: **(15 points)**

| Destination node | Interface | Next node | Address (if needed) |
|---|---|---|---|
| Node A | | | |
| Node B | Local | Node B | - |
| Node C | | | |
| Node D | | | |
| Node E | | | |
| Node F | | | |

c. Show the routing table for the Node D with the same format. Explain and justify your choices according to the usual metrics that can be used in network routing. **(15 points)**

4) Considering DS-1 transmission format with 24 voice channels, what is the data rate for the signaling channel associated with each voice channel? **(5 points)**

5) A channel has a bit rate of 1 Mbps and a propagation delay of 200 µS. What is the efficiency of a selective reject ARQ protocol with a window size of 4, 100-bit frames and an error rate of $10^{-2}$? Assume that ACKs and NAKs are never in error. **(15 points)**