## **COMP312 Computer Communications Networks**

Assignment Four (due on 9 Dec) Each question carries 20 marks.

- 1. Consider a host A sends IP packets to a host B, and they are separated by a number of different IP networks. Suppose we know that the path MTU for A to send packets to B is given by P bytes. If host A sends an IP datagram of size D bytes to host B, no fragmentation occurs if  $P \ge D$ .
  - a) If P < D, what is the minimum number of IP fragments as a result of IP fragmentation, in terms of P and D?
  - b) However, the actual number of fragments for this datagram can be larger than the minimum obtained from (a). Give an example to illustrate this claim.
- 2. Answer the following questions concerning IP fragmentation.
  - a) What would be the values of the Fragment Offset and the M bit for an IP packet that has not been fragmented? Explain why.
  - b) If an IP packet, tunneled or not, has been fragmented more than once (multiple fragmentation), how many fragments that arrive at the destination for reassembly would have the M bit set to 0? Explain your answer.
  - c) What is the maximum value of the Fragment Offset, assuming that the MTU value can be very large and why?
- 3. A traceroute program uses ICMP and the TTL field in the IP header to discover the path from a source to a destination. When a router receives an IP datagram with TTL equal to 0 or 1, it will discard the datagram and send back an ICMP "time exceeded" error message to the source. Moreover, a host will send an ICMP "port unreachable" error message back to the source if the destination port is not running any applications. Use pseudo-code to describe how the traceroute program discovers the path.
- 4. (Distance-vector routing) On slide 4-88, the cost of the link between x and y is decreased. Assuming that the routing protocol has converged, similar to the diagram on slides 4-87, draw the evolution of the distance vectors kept by x, y, and z until the routing algorithm converges.
- 5. (Distance-vector routing) On slide 4-89, the cost of the link between x and y is increased. Assuming that the routing protocol has converged, similar to the diagram on slides 4-87, draw the distance vectors kept by x, y, and z for the first 5 iterations and for the converged case.
- 6. (Link-state routing) (Link-state routing) In a link-state routing protocol, a link failure has to be broadcasted to all other routers to update their link-state databases. A COMP312 student, however, claims that it is not necessary to disseminate the link failure update to all routers. Instead, only the routers on the *restoration path* need to be updated. Figure 2 illustrates this student's idea. The link between R1 and R2 fails, and the restoration path for R1-R2 is through R4. Therefore, only R1, R2, and R4 will update the link states for R1 R2 to "unreachable". R3 and R5, on the other hand, are not aware of the link failure.



- a) Use a simple example to illustrate that this scheme will result in a routing loop.b) Use a simple example to illustrate that this scheme will result in a nonshortest path.