CS2410

UNIVERSITY OF WARWICK

Second Year Examinations: January 2015

Operating Systems and Computer Networks

Time Allowed: 3 hours.

Answer **TWO** questions from **Section A** and **TWO** questions from **Section B.**

Use one answer book for your Section A answers and a separate answer book for your Section B answers.

Read carefully the instructions on the answer book and make sure the particulars required are entered on each answer book.

Approved calculators may be used.

Section A Answer **TWO** questions from this section.

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1. (a) Explain why tasks are assumed to be independent in the Rate Monotonic Scheduling Algorithm (RMA). [3]

   (b) Consider the following task set, where each task is represented as (execution time; period): T1 = (10; 50); T2 = (20; 75); T3 = (10; 100)

      (i) Calculate the utilization of the task set, assuming all tasks are released at t = 0. [5]

      (ii) Derive the set of conditions to determine whether the task set is RMA-schedulable. [7]

   (c) Given the following task set: T1 = (10; 40); T2 = (20; 75); T3 = (35; 100); T4 = (15,150), determine whether there is any task that misses its deadline. Justify your answer and develop a schedule to illustrate this. [10]

Continued

2. Three tasks, labelled T1; T2; T3, exist in a computer system. They enter the system at times t = 3ms; 2ms; 0ms respectively. The execution profile of each process is as follows:

- Task T1 executes normal code for 1ms, followed by the execution of a critical section for 3ms. After exiting the critical section, it executes for another 1ms. The deadline is 9ms.
- Task T2 executes normal code for 5ms. The deadline is 13ms.
- Task T3 executes normal code for 1ms, followed by the execution of a critical section for 2ms. The deadline is 15ms.
- The critical sections of tasks T1 and T3 are protected by a semaphore, S.
- The priority of the tasks is as follows: Priority(T1) > Priority(T2) > Priority(T3).

(a) Develop a schedule for the task set using a generic priority-based scheduling algorithm. Is there any task that misses its deadline? If so, which? [10]

(b) Develop a schedule for the task set using a generic priority-based scheduling algorithm extended with priority inheritance. Is there any task that misses its deadline? If so, which? [10]

(c) Using an appropriate example, explain one weakness of priority inheritance. [5]

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3. (a) Explain, using appropriate pseudo-code, how the bounded waiting property of the critical section problem can be guaranteed. [5]

(b) Using a two-process system, develop an example to illustrate the nature of the problem that arises if the test and set primitive to ensure mutual exclusion is not executed atomically. [5]

(c) Explain when a page fault occurs in a virtual memory system and how such a fault is handled. [5]

(d) You are given the following reference string for referenced page numbers:

7, 1, 0, 2, 3, 4, 0, 1, 3, 2, 0, 2, 7, 4, 0, 1, 5, 4, 0, 3

Assume that a process can have up to 4 pages in memory at any time and that memory is initially empty. By clearly showing your working, calculate the hit ratio when the following page replacement policies are used:

(i) First In First Out (FIFO). [5]

(ii) Least Recently Used (LRU). [5]

Continued

Section B Answer **TWO** questions from this section.

4. (a) Explain the purpose of the *physical* and *data link* layers in the OSI reference model. [4]

(b) (i) Consider a communication channel of bandwidth 2MHz and signal to noise ratio (S/N) of 251 (24dB). How many signal levels are required for 50% of the maximum possible data rate to be achieved? [4]

(ii) Explain the difference between *quadrature phase shift keying* (QPSK) and *quadrature amplitude modulation* (QAM). [4]

(iii) What is the maximum transmission rate in bits per second (bps) that a modem can achieve if the baud rate is 9600 and (1) QPSK, and (2) QAM-64, signalling methods are used? [4]

(iv) A modem constellation diagram has data points at (0,1) and (0,2). What type of modulation does the modem use? [2]

(c) (i) Four stations have the following bi-level chip sequences (Walsh codes):

A = (-1 +1 -1 -1 -1 -1 +1 -1) B = (-1 +1 -1 +1 +1 +1 -1 -1)
C = (-1 -1 +1 -1 +1 +1 +1 -1) D = (+1 +1 -1 +1 -1 -1 -1 +1)

A CDMA receiver obtains the following bi-level chip sequence:
S = (-1 +1 -3 +1 -1 -3 +1 +1). Which of the four stations transmitted, and which bits did each one send? [4]

(ii) Most 3G mobile phone systems use a form of Wideband Code Division Multiple Access (WCDMA). It is impossible for all phones to be synchronised such that the chip sequences transmitted are exactly orthogonal. How is this problem overcome in practice? [3]

5. (a) (i) Describe the operation of the Go-Back-N sliding window data link protocol. Do not give details of all the possible error scenarios. [7]

(ii) What advantage and what disadvantage does the Go-Back-N protocol have over a simple Stop-and-Wait protocol? [2]

(iii) The following data fragment occurs in a data stream to which a (data-link) byte-stuffing algorithm is to be applied:

A B ESC C ESC FLAG FLAG D.

What is the output after stuffing? [2]

(b) (i) List the essential function(s) of the Internet Protocol (IP) and state the ISO OSI level at which it operates. [3]

(ii) In IP, the checksum covers only the header and not the data. Why do you suppose this design was chosen? [3]

(iii) A network on the Internet has a subnet mask of 255.255.240.0. What is the maximum number of hosts it can handle? [2]

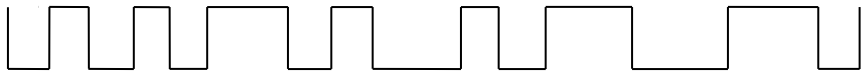
(c) (i) List the essential function(s) of the Transmission Control Protocol (TCP) and state the ISO OSI level at which it operates. [3]

(ii) A client sends a 125-byte request to a server located 100 km away over a 1 Gbps optical fibre. The speed of signal propagation in the optical fibre is 2×10^8 m/s. What is the efficiency of the line during the remote procedure call? [3]

Continued

6. (a) (i) Explain the operation of the *binary exponential back-off algorithm* as used in the CSMA/CD protocol employed by Ethernet. [4]

(ii) The encoded bit stream shown below is detected on an Ethernet LAN.



Decode the information if: (1) Manchester Coding, and (2) Differential Manchester Coding, is used. [4]

(iii) A 100 Mbps CSMA/CD local area network (not Ethernet) has equally spaced nodes and a total length of 1.5 km. The signal propagation speed in the cable is 2 x 10^8 m/s. There are no repeaters. What is the minimum frame length (in bits) that is required for correct operation of the CSMA/CD protocol? [3]

(b) Four stations, A, B, C and D exist within in an IEEE 802.11 wireless network. A is within range of B and C, but not D. D is within range of B and C, but not A.

(i) Explain what is meant by the *hidden station problem* [2]

(ii) Station A wishes to send to C using the 'Multiple Access with Collision Avoidance for Wireless' (MACAW) protocol that features 'virtual channel sensing'. With the aid of a timing diagram (for A, B, C and D) explain the operation of the protocol. [7]

(iii) Why may the successful throughput of a frame in this type of network be increased by fragmenting the frame into smaller parts? [2]

(iv) How is collision avoidance maintained if other stations set a network allocation vector (NAV) only for transmission of the first of a number of fragments and its corresponding ACK frame? [3]

End