Q1. (a) Identify and give a brief explanation of the four main functions performed by Real Time Control Protocol (RTCP).

(12 marks)

(b) Figure Q2 shows how end systems generate streams in an application using Real Time Protocol (RTP).

Q2. A multimedia operating system adopts the SCAN-EDF (SCAN-Earliest deadline First) algorithm as its disk scheduling algorithm.

(i) Name four main goals of disk scheduling in a multimedia system. Which of them is different from that of a traditional non-multimedia system?

(10 marks)

(ii) Figure Q2 shows the order of the arrival of a sequence of disk access requests. Derive the order that the requests are served. You are requested to provide the content of the buffer in your derivation.

(5 marks)

Q3. A sequence of messages are to be served by the CPU and their service requests arrive at the CPU as shown in Fig Q3. Assume that the requests should be periodic and the deadline of serving request $i$ is the time instant that request $(i+1)$ should arrive.

(i) Determine the logical backlog at the time when a particular request arrives.

(10 marks)

(ii) Assume that the logical arrival time of a particular request, say $i$, is the deadline of request $(i-1)$. Determine the guaranteed logical delay of all messages.

(3 marks)

Q4. Fill T/F in the bracket. (2 marks for 1 correct answer. -1 mark for 1 incorrect answer.)

(i) Rate Monotonic scheduling algorithm is a dynamic algorithm. [ ]

(ii) SCAN is a disk scheduling algorithm suitable for a multimedia operating system. [ ]

(iii) To guarantee a reliable service to a new coming task, Rate Monotonic scheduling algorithm requires that the CPU utilization rate of the task is lower than $\frac{1}{2}$. [ ]

(iv) Rate Monotonic scheduling is used for CPU scheduling. [ ]

(v) The current DAB system adopts MPEG layer-3 audio compression standard to encode an audio signal. [ ]

(vi) The number of CSRC included in a RTP header is 256. [ ]

(vii) In a multimedia application, soft deadlines must be met. [ ]
Q2. (a) The RTCP adds additional system-level functionality to its related RTP. In particular, it
- Provides information for a receiving RTP to integrate and synchronize the individual packet streams together
- Provides information for a sending RTP to be informed of the currently-prevailing network QoS.
- Provides participation reports which tell who's in and who's out during a conference call
- Provides participation details which carry the information of each participant

(b) End system SSRC=30
   - ADPCM
   - GSM

End system SSRC=37
   - DPCM
   - GSM
   - Translater

End system SSRC=13
   - Translater

Mixer SSRC=20
   - GSM

Mixer SSRC=10
   - DPCM
   - GSM

(i) Function of a mixer:
   - merge several media streams (of the same types) into one new stream (possible with new encoding)
   - reduce bandwidth of the network

(ii) Time stamp indicates the time reference when the packet was created.
     It can be used to determine the current mean transmission delay, the level of jitter that is being experienced.

     Sequence number indicates the order of packets being sent.
     It can be used for the destination host to detect lost or out-of-sequence packets.

(iii) A video sequence is encoded with a H.263 codec. Suppose each packet carries a frame and GOP is in a form of IBP. Then the time-stamp of the 2nd frame is earlier than the 3rd frame but the 3rd frame is sent before the 2nd frame.

Q2 (i) 4 main goals:
- To reduce the cost of seek operations
- To achieve a high throughput
- To provide fair disk access for every process
- To meet the deadlines of all time-critical tasks.

The last one is different.

(ii) End system SSRC=30
   - ADPCM
   - GSM

End system SSRC=37
   - DPCM
   - GSM
   - Translater

End system SSRC=13
   - Translater

Mixer SSRC=20
   - GSM

Mixer SSRC=10
   - DPCM
   - GSM

(i) Packet header fields

<table>
<thead>
<tr>
<th>Point</th>
<th>CC</th>
<th>Payload type</th>
<th>SSRC</th>
<th>CSRC</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>42</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>98</td>
<td>37</td>
<td>37</td>
</tr>
<tr>
<td>E</td>
<td>2</td>
<td>98</td>
<td>20</td>
<td>30,37</td>
</tr>
<tr>
<td>F</td>
<td>1</td>
<td>27</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>G</td>
<td>3</td>
<td>98</td>
<td>10</td>
<td>13,30,37</td>
</tr>
</tbody>
</table>

(ii) Functions of a mixer:
   - merge several media streams (of the same types) into one new stream (possible with new encoding)
   - reduce bandwidth of the network

(iii) Time stamp indicates the time reference when the packet was created.
     It can be used to determine the current mean transmission delay, the level of jitter that is being experienced.

     Sequence number indicates the order of packets being sent.
     It can be used for the destination host to detect lost or out-of-sequence packets.

Q3. (a) At the time that request i arrives

Logical backlog

(i) 2 3 4 5 6 7 8 9 10

(b) logical delay = period

Q4. (i) F
(ii) F
(iii) F
(iv) T
(v) F
(vi) F
(vii) F