Q	ABET	Max	Earned
Q1	e	20	
Q2	e	20	
Q3	a	15	
Q4	c	16	
Q5	c	20	
Q6		17	
$\sum$		108	

BIRZEIT UNIVERSITY
Electrical and Computer Engineering Department
ENCS339 Operating Systems 2^ed Semester 2017/2018

Midterm Exam Instructors: Dr. Adnan H. Yahya, Dr Ahmad Afaneh Time:90min

Student Number:________________ **Student Name :**________________________

Please answer **all questions** (2 sections) using the exam sheets ONLY and be BRIEF.
Please **show all steps** of your solutions. Max grade is:**108**

Question 1 (20%) A computer system has 16GB of **physical memory (RAM)**. The system has an 16KB **page size** and 32-bit logical address space. CPU generated addresses are 4 bytes each.

(a) Indicate on the diagram below which of the bits of the **logical address** of 46 bits are used for page number (**p**) and for offset (**d**) (4%)

```
0         10                 20            30
|||||||||| |||||||||| |||||||||| ||
```

d: [0-13] 14 bit , p [14 -31] 18 bit

b. How many **frames** are there in the RAM? (4%)

16GB/16KB = $2^{34}/2^{14} = 2^{20}$ Frames

c. Ignoring page table overhead and OS needs, how many **pages** can a process have (max) to be runnable in **contiguous** memory allocation mode? (3%)

Since the max number of pages is less than the max number of frames the answer is the max number of pages 2^{18}

d. What is the minimal number of bits needed for frame numbers of this computer page map tables (PMTs)? In bits_____18______, in Bytes_____3______?(3%)

e. Given a 12GB Process what is the size of the Page Map Table (PMT) in **bytes** and **pages.**
Can the table be placed in a ONE level table? Show why and why not. Show the final diagram of the page map table for such a job. (3%)

12GB/16KB =0.75 X 2^{20} PAGES
PMT size in bytes = 0.75 X 2^{20} x 3 B = 9 x 2^{18} B

PMT size in pages = 9 x 2^{18} B/ 16KB= 9 x 2^{4} =144 pages

f. TLB access time is 5% of RAM access time. RAM access time is 200ns. The TLB hit rate for paging **α** is 98%. Compute the effective access time EAT if only one level of paging for the page map table is used. What is the Max EAT possible in this system and how to achieve it? (3%)

EAT = .98(200+10) + 0.02(2x200+10) = 214 ns

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Question 2 (20%) Consider a computer system involving 5 processes (P1, P2, P3, P4, P5) and 4 different types of resources (R1,R2,R3,R4). The state of the processes and resources is reflected in the tables below.

Currently Available Resources			
R1	**R2**	**R3**	**R4**
3	**2**	**2**	**0**

	Current Allocation				Max Need				Still Needs			
Process	**R1**	**R2**	**R3**	**R4**	**R1**	**R2**	**R3**	**R4**	**R1**	**R2**	**R3**	**R4**
P1	0	0	1	2	0	0	3	2				
P2	2	0	0	0	2	7	5	0				
P3	0	0	3	4	6	6	5	6				
P4	2	3	5	4	4	3	5	6				
P5	0	3	3	2	0	6	5	2				

(a)8% Use Banker's algorithm to check if this system is currently deadlocked, or can any process become deadlocked if it continues working from the current state? Why or why not? If not deadlocked, give an execution order

Deadlocked □YES □ NO

If Not deadlocked: Execution Order is: _________________________

(b)6% If a request from a process P2 asks for the resource vector (0, 1, 2, 0), can the request be immediately granted? Why or why not? If yes, show an execution order. Explain your answer.

(c)6% If instead of (b), process P1 asks for the resource vector (0, 2, 4, 0), can the request be immediately granted? Why or why not? If yes, show an execution order. Explain your answer.

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Q3	**a**	**15**	
Q4	**c**	**16**	
Q5	**c**	**20**	
Q6		**17**	

Question 3 (15%)

a. Match the question with one correct answer.

Answer	**Questions**	**#**	**Answers**
4	Under what conditions does FIFO scheduling result in the shortest possible average response time?	1	If the job lengths are all the same, and much greater than the time slice length.
3	Under what conditions does round robin scheduling behave identically to FIFO?	2	Always when all jobs arrive at the same time.
1	Under what conditions does round robin scheduling perform poorly compared to FIFO?	3	If the job lengths are no longer than the length of the time slice.
5	Under what conditions does shortest job first perform much worse than round robin have the same order of job completion?	4	If the jobs happen to arrive in the ready queue with the shortest completion times first.
2	Under what conditions does shortest job first and shortest remaining time first perform the same?	5	This is never the case.

b. Match the question with as many correct answers as possible. Partitions are dynamic and the size of the partition is the same as the job size.

Answer	Questions		Answers
1,5	First Fit for hole selection is partitioned memory management	1	**Is the same as best fit if holes are ordered in the increasing size (largest last).**
4,5	Best Fit for hole selection is partitioned memory management	2	**Is the same as best fit if holes are ordered in the Decreasing size (largest first).**
3,5	Worst Fit for hole selection is partitioned memory management	3	**Has worst external fragmentation**
3,5	Random Fit for hole selection is partitioned memory management (selection is random)	4	**Has best external fragmentations**
6	Paging for memory management	5	**Has no internal fragmentation**
		6	**Has no external fragmentation**

c. Suppose two threads execute the following C code concurrently, accessing shared variables **a, b,** and **c**:

Initialization `int a = 4; int b = 0; int c = 0;`

Thread 1
```
if (a < 0){
     c = b - a;
} else { c = b + a; }
```

Thread 2
```
b = 10;
a = -3;
```

What are the **possible values** for **c** after both threads complete? You can assume that **reads** and **writes** of the variables are atomic, and that the order of statements **within each thread** is preserved in the code generated by the C compiler. Switching between threads can take place after any instruction.

T1 starts: c=0+4=4; T1 starts: then T2 b=10 then c=10+4=14; T1 starts: then T2 b=10, a=-3 then c=10+3=13;
T2 starts: b=10, then T1 b=10, Then T2 a=-3 then c=103=7; T2 starts: b=10, a=-3, Then T1 then c=10-3=7;

Answer:**c=___4,7,13,14,~~-3~~**

What is happening here that causes this behavior: ____**Race**_________

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Question 4 (16%) Consider a dynamic partitioning system in which the (free) memory consists of the following list of **holes** (free partitions), sorted by increasing **memory address** (all sizes are in Megabytes):

7 → 4 → 23 → 9 → 7 → 12 → 16 → 15

↑ Pointer to the first hole (Head_Free)

Suppose a new process P1 requiring 10 MB arrives, followed by a process P2 needing 11MB of memory. Show the list of holes **after both of** these processes are placed in memory for each of the following algorithms (start with the original list of holes for each algorithm).

i) First Fit-5%:

7 → 4 → ~~23~~ ~~13~~ 2 → 9 → 7 → 12 → 16 → 15

ii) Worst Fit -5%:

7 → 4 → ~~23~~ 13 → 9 → 7 → 12 → ~~16~~ 5 → 15

iii) Best Fit-5%:

7 → 4 → 23 → 9 → 7 → ~~12~~ 2 → 16 → ~~15~~ 4

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Question 5 (20%) Show the scheduling order for these processes under 4 policies: First Come First Serve (FCFS), Shortest-Remaining-Time-First (SRTF), Round-Robin (RR) with timeslice quantum = 1 and Priority, by filling in the Gantt chart with ID of the process currently running in each time quantum. *Assume that context switch overhead is 0 and that new RR processes are added to the* ***head*** *of the queue and new FCFS processes are added to the* ***tail*** *of the queue.*

For each of the algorithms: Priority, First Come First Served, RR and Shortest remaining time first compute the Finish time, TA time and Weighted Turnaround (W) time and the averages.

Note that weighted TA for a process equals TA didvided by CPU burst: **W= TA/CPU_Time**

Process ID	**Arrival time**	**CPU burst time**	**Priority**	**FCFS**			**SRTF**			**RR, slice=1**			**Priority/P**		
				F	**TA**	**W**	**F**	**TA**	**W**	**F**	**TA**	**W**	**F**	**TA**	**W**
A	0.0	2	2	2	2	1	2	2	1	3	3	3/2= 1.5	2	2	1
B	1.0	6	1	8	7	7/6= 1.16	9	8	8/6= 1.33	13	12	12/6 =2	16	15	15/6 =2.5
C	4.0	1	5	9	5	5	5	1	1	5	1	1	5	1	1
D	7.0	4	3	13	6	6/4= 1.5	16	9	9/4= 2.25	16	9	9/4= 2.25	14	7	7/4= 1.75
E	8.0	3	4	16	8	8/3= 2.67	12	4	4/3= 1.33	15	7	7/3= 2.33	11	3	1
Avge		16/5=3.2			28/5 =5.6	11.34/ 5=2.3		4.8	6.74= 1.35		32/5 =6.4	9.08/5 =1.82		28/5= 5.6	7.25/5 =1.45

(a) FIFO/FCFS(First Come First Served):

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Process	**A**	**A**	**B**	**B**	**B**	**B**	**B**	**B**	**C**	**D**	**D**	**D**	**D**	**E**	**E**	**E**			

(b) SRTF (Shortest Remaining Time First).

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Process	**A**	**A**	**B**	**B**	**C**	**B**	**B**	**B**	**B**	**E**	**E**	**E**	**D**	**D**	**D**	**D**			

(c) Round Robin.

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Process	**A**	**B**	**A**	**B**	**C**	**B**	**B**	**D**	**E**	**B**	**D**	**E**	**B**	**D**	**E**	**D**			

(d) Priority (higher priority value, better)

Time	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Process	**A**	**A**	**B**	**B**	**C**	**B**	**B**	**D**	**E**	**E**	**E**	**D**	**D**	**D**	**B**	**B**			

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Question 6 (17%) True or false and give ONE SENTENCE EXPLANATION. Then copy answers to the table at the end. Sample true false only, no explanations (though needed in exam).

1. **□True □False:** A Cycle in resource allocation graph indicates a deadlock when we have only one (single) instance of each resource.
2. **□True □False:** Aging is used as a mechanism to solve the deadlock problem.
3. **□True □False:** Signal() primitive usually results in resources made available while wait() usually reduces the number of available resources.
4. **□True □False:** Compaction is a costly process in memory management.
5. **□True □False:** Starvation happens when the system doesn't have the resource a process needs and thus the process cannot progress.
6. **□True □False:** Races happen in programs when the final results are affected by the execution order of process instructions.
7. **□True □False:** Shortest-job-first scheduling is optimal in the sense that no other scheduling results in better throughput for a collection of processes.
8. **□True □False:** Given a constant number of bits in a virtual address, the size of a linear page table decreases with larger pages (page size).
9. **□True □False:** In real time systems the process with the earliest deadline has always to start immediately after the previous process finishes and can never be forced to wait.
10. **□True □False:** In a multiprocessor system with multiple cores a process gets assigned to a given processor (affinity) to reduce cache misses.
11. **□True □False:** Threads that are part of the same process share the same stack.
12. **□True □False:** A process can move form a **ready** state to the **waiting** state, say if it consumes all of its time quantum.
13. **□True □False:** With kernel-level threads, multiple threads from the same process can be scheduled on multiple CPUs (cores) simultaneously.
14. **□True □False: I**n a symmetric multiprocessor, threads can not always be run on any processor.
15. **□True □False:** Locks prevent the OS scheduler from performing a context switch during a critical section.
16. **□True □False:** Last Come First Served scheduling algorithm can lead to starvation.
17. **□True □False:** A Job can have several processes and a process can have several threads.

Please make sure to copy your answers to the following table (-3 points if not copied).

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
□True OR □False	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**	**□T □F**