IIT KHARAGPUR

Full marks-50

SMARTPHONE COMPUTING AND APPLICATIONS (CS60009)

MID-SEMESTER EXAMINATION

1. (a) Prove that any online algorithm for scheduling transmissions which minimizes the time spent by a mobile in high power state can be at most 1.28- competetive with the offline adversary. (5)

   (b) Consider the tailEnder algorithm for scheduling transmissions. Consider a set of 6 transmissions T_1, T_2, ...,T_6 with arrival and deadline times represented by $a_1,...,a_6$ and $d_1,...,d_6$ respectively. The values are provided in the table.

	T_1	T_2	T_3	T_4	T_5	T_6
Arrival (a)	6	8	8	15	18	25
Deadline(d)	14	12	16	25	30	36

   Assume tail time is 10 units and the value of parameter *x* is 0.5. Also assume that the mobile moves into idle state after the tail time and needs to ramp up for further transmissions. The ramp up energy is 15 units. Use a chart to show how each task is scheduled and also calculate the total energy consumed. Assume the mobile is initially in idle state. (4)

2. Consider an OFDM carrier consisting of 5 subcarriers ($f_1,...,f_5$). The phases (in degree) of the channel responses of the subcarriers are respectively 60, 80, 85, 90 and 100. The CFRs received cannot be directly used for calibration as any unknown phase β and lag Δt can distort the CFR. The phase of the channel response of subcarrier f (Φ'_f) will be

   $$\Phi'_f = \Phi_f + 2.\pi.f.\Delta t + \beta + z_f$$

   where z is the noise and Φ_f is the genuine channel response. Assuming z_f is very small, how can the responses be sanitized and what should be the value of the post-processed phase. (6)

3. Consider the SAMPLEBYTE algorithm. The sampling period *p* is 8 and the length of the datablock is 32. The size of the minimum redundant string w is 4. Identify the markers in the data block as obtained from the SAMPLEBYTE algorithm.

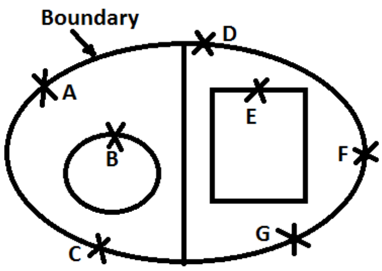
1	4	5	2	3	7	4	3	5	3	4	6	8	1	5	2	9	4	6	9	1	2	5	3	7	5	9	4	5	8	9	1

Data block

1	0
2	1
3	0
4	0
5	1
6	0
7	1
8	1
9	0

SAMPLETABLE (5)

4. Suppose there are 3 cell-towers T_1,T_2 & T_3; each having 3 cells.
Cell-names are given in the following manner: C_{ij} is the name of j^{th} cell belonging to the i^{th} cell-tower. For example, C_{12} is the 2^{nd} cell of cell-tower T_1. Given is a map of the area where war-driving is done.



The following table contains the co-ordinates of 7 locations A,B,C,D,E,F,G and cell strengths (in dBm) of all 9 cells at those locations

Location	X	Y	C_{11}	C_{12}	C_{13}	C_{21}	C_{22}	C_{23}	C_{31}	C_{32}	C_{33}
A	5	15	-65	-50	-40	-30	-35	-40	-60	-55	-60
B	8	10	-70	-60	-39	-20	-25	-25	-55	-50	-50
C	7	2	-90	-80	-45	-25	-20	-20	-60	-60	-50
D	11	18	-70	-55	-42	-35	-40	-40	-35	-25	-40
E	14	13	-80	-70	-45	-35	-40	-40	-30	-20	-35
F	19	7	-100	-85	-50	-40	-50	-45	-35	-40	-35
G	16	3	-100	-85	-51	-40	-50	-45	-40	-45	-35

Assume that the strengths of the cells belonging to same cell-tower, at a particular location may differ by any amount.

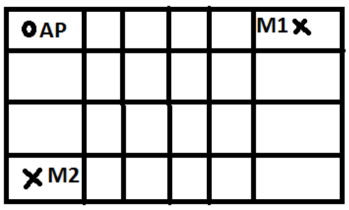
i) Find the location of cell C_{22} and C_{32} using "strongest RSS" and "weighted centroid" methods. (1+1)+(2+2)

ii) Use RSS Thresholding (assuming threshold -60dBm) to identify which cells can be out of the marked boundary. (1.5)

iii) Use Boundary Filtering to identify which cells can be out of the marked boundary. (1.5)

iv) Use Tower-based Regrouping (using above two results) to identify whether any of the cell-towers is outside the marked boundary of the area and justify. (1)

5. Use the Seidel & Rappaport's formulae to estimate the signal strength of WiFi access-point AP at mobile receivers M1 and M2. All black lines are walls.



M1 is at a distance of 50 meters from AP and M2 is at 40 meters distance from AP. At 1 meter distance (d_0) from the AP, it's strength is -20dBm ($P(d_0)$). Wall Attenuation factor (WAF)= 3.1 dBm. The rate at which power attenuates with distance (n) is 1.5. The maximum number of walls up to which attenuation factor makes a difference is 3 (C).

i) Write the Wall Attenuation formulae in terms of $P(d_0)$,n,WAF and C. Note that the formulae gives weightage to both the distance from the AP and the number of obstructions between the AP and the receiver. (1.5)

ii) Calculate signal strengths at M1 and M2 (3.5)

6. Consider a hypothetical activity/wellness tracking application that seeks to detect an episode where an individual "Runs for 10 minutes, while being exposed to an ambient temperature greater than 80 Degree F (over a 10 minutes window), while exhibiting an AVERAGE pulse rate (over a 5 minutes window) of > 75 beats/min".
Assume that this application uses an external wrist-worn device, equipped with accelerometer (sensor S1, sampling at 100 samples/sec), temperature sensor (S2,

sampling at 1 sample/sec) rate and pulse rate (S3, sampling at 10 sample/sec) sensors. The probabilities of each event to be true: P(S1)=0.55, P(S2)=0.2 and P(S3)=0.15 Furthermore, given the potentially different sample sizes and transmission rates for each sensor, assume that the acquisition energy costs, denoted by E(Si) are as follows: E(S1) = 0.2 nJ/sample; E(S2) = 0.05 nJ/sample and E(S3) = 0.3 nJ/sample.

Find the best acquisition sequence based on 'normalized acquisition cost' (NAC) for each event.

(5)

7.

a) Consider a linear workflow consisting of a set of n tasks, with every odd numbered task being a native one to be executed on a connectivity-enabled mobile phone with a single processor. You have an option of executing a non-native task on the mobile phone or on the cloud. The energy expenditure for computing any task locally on the mobile device is much greater than the energy needed to offload its input data set, which is in turn is more than the energy needed to download the resulting output. Assume that the energy expenditure for a task executing on the cloud is zero and the network conditions are steady and fault-free. Also, if two consecutive tasks are executed at the same location, there is no network transfer necessary.

   Formulate the task partitioning problem in the MCC context as above with energy expenditure minimization as the primary objective. You may assume there is no constraint on the time taken to finish the task set. Can you give some insights on how the optimal solution would be? (3)

b) Consider the same setting as above, with a 2-state channel, which is either good or bad. In the case of a good channel, the time taken to execute any task locally on the mobile device is considerably more than the time taken to get it executed remotely on the cloud (this includes the time taken to upload its inputs received from its predecessor, get it executed on the cloud and download the resulting state). In the case of a bad channel, however, the time taken to execute locally is less than the cumulative time for the corresponding remote execution.

   Formulate the task partitioning problem in this setting with an objective of minimizing the overall completion time, with no constraint on the energy expenditure.

   (4)

c) Assume now that you are given the task to look for a solution which is good, in terms of both completion time and energy with the channel being unpredictable. Can you show an example scenario with some value of n, where the time and energy objectives may yield different optimal solutions?

   (3)