TUTORIAL THREE

CPU Scheduling

1. State whether each of the following statements are true or false. Justify your answers.

   (a) A process scheduling discipline is pre-emptive if the CPU cannot be forcibly removed from a process.

   (b) Real-time systems generally use pre-emptive CPU scheduling.

   (c) Time-sharing systems generally use nonpre-emptive CPU scheduling.

2. Consider the following set of processes, with the length of the CPU-burst time given in milliseconds:

Process	Burst Time	Priority
P_1	10	3
P_2	1	1
P_3	2	3
P_4	1	4
P_5	5	2

   The process are assumed to have arrived in the order P_1, P_2, P_3, P_4, P_5, all at time 0.

   (a) Draw four Gantt charts illustrating the execution of these processes using FCFS, SJF, a nonpre-emptive priority (a smaller priority number implies a higher priority), and RR (quantum=1) scheduling.
   (b) What is the turnaround time of each process for each of the scheduling algorithm in part (a)?
   (c) What is the waiting time of each process for each of the scheduling algorithms in part (a)?
   (d) Which of the schedulers in part (a) results in the minimal average waiting time (over all processes)?

3. Measurements of certain system have shown that the average process runs for a time *T* before blocking on I/O. A process switch requires a time *S*, which is effectively wasted (overhead). Define what is meant by CPU efficiency. For round robin scheduling with quantum *Q*, give a formula for the CPU efficiency for each of the following:

   (a) $Q \to \infty$
   (b) $Q > T$
   (c) $S < Q < T$
   (d) $Q = S$
   (e) $Q \to 0$