Please be sure to show all your work and write down any assumptions you make.

1. (a) In a system with \( n \) processes and \( m \) resources of the same type, assume that the sum of all maximum needs is less than \( m + n \) and that the maximum need of each process is between 1 and \( m \) resources. Resources are requested and released by processes only one at a time. Prove that this system cannot deadlock.

(b) Consider a system with 10 units of a single resource. There are four processes in the system, named [A,B,C,D], each of which have a maximum resource requirement that can be specified by the vector [6,5,4,7] units, where each element indicates the maximum needs of the corresponding process. If the processes currently hold [1,2,2,4] resource units, is the system in a safe state (i.e., is deadlock possible given the maximum needs of each process)?

2. Consider a single-CPU system with only CPU-bound tasks and assume CPU scheduling is always non-preemptive. Also assume each task’s runtime is known in advance, no two tasks have the same runtime, and that all tasks are ready at system start. Show that shortest-job-first (SJF) scheduling is the sole optimal scheduling order in terms of mean task turnaround time (where turnaround time is defined as the elapsed time from when the task enters the system to the moment the task finishes).