SNS COLLEGE OF TECHNOLOGY

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COURSE NAME : 23CST202 – OPERATING SYSTEMS

II YEAR/ IV SEMESTER

UNIT – II PROCESS SCHEDULING AND SYNCHRONIZATION

Topic: Deadlocks

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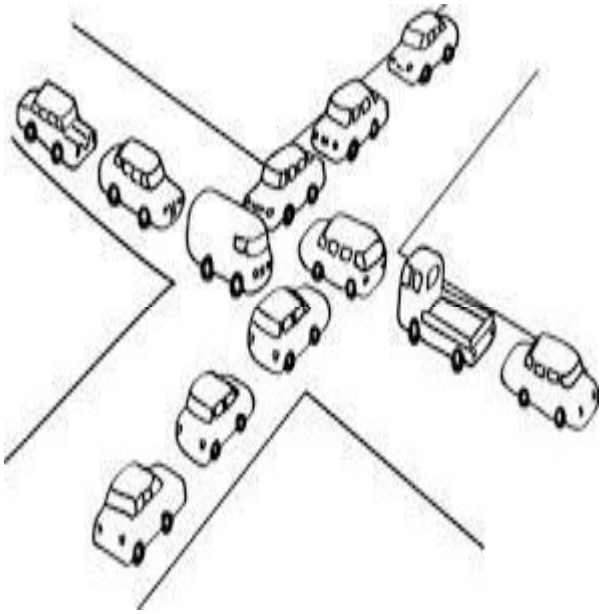
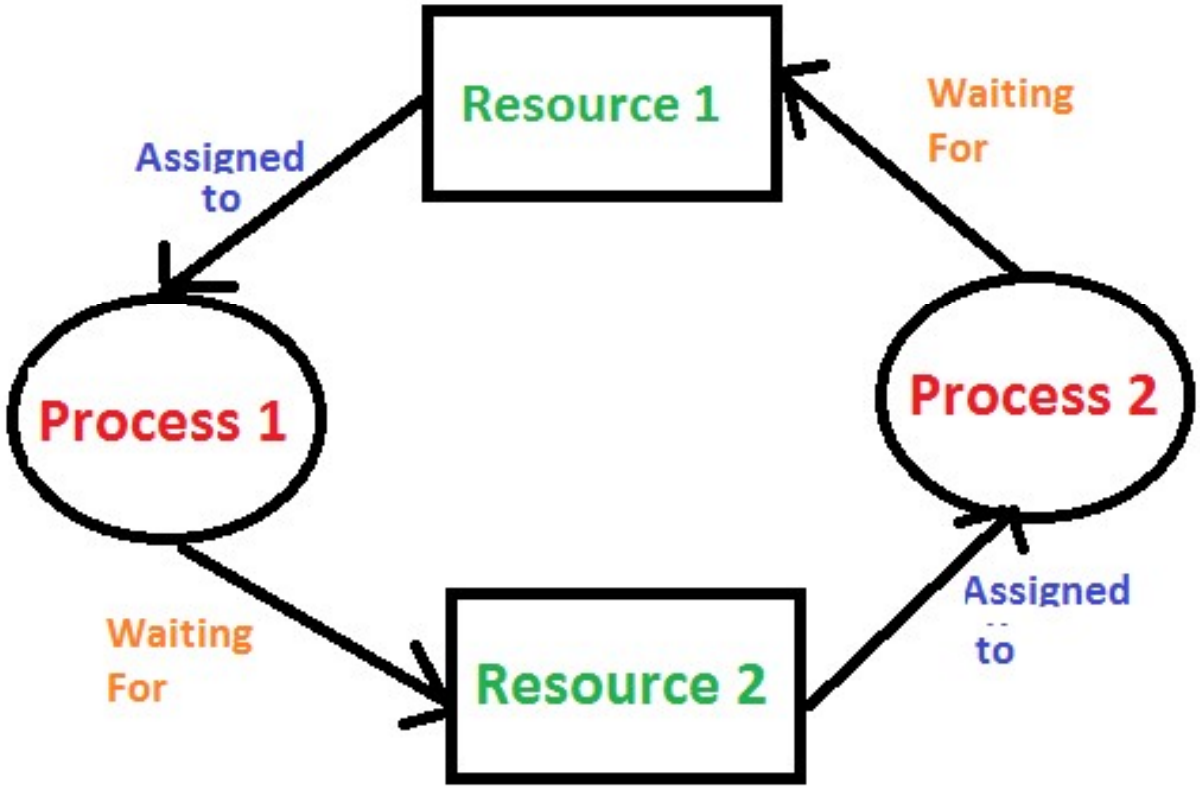
Deadlocks

- System Model
- Deadlock Characterization
- Methods for Handling Deadlocks
- Deadlock Prevention
- Deadlock Avoidance
- Deadlock Detection
- Recovery from Deadlock

Deadlock



Deadlock


Resource 1
Assigned to
Waiting For
Process 1
Process 2
Waiting For
Resource 2
Assigned to

System Model

- System consists of resources
- Resource types $R_1, R_2, \ldots, R_m$

  CPU cycles, memory space, I/O devices
- Each resource type R_i has W_i instances.
- Each process utilizes a resource as follows:
  - **request**
  - **use**
  - **release**

Deadlock Characterization

Deadlock can arise if four conditions hold simultaneously.

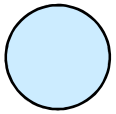
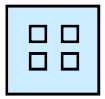
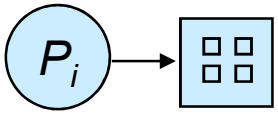
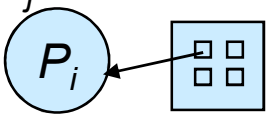
- **Mutual exclusion**: only **one process** at a time can use a resource
- **Hold and wait**: a process holding at least one resource and waiting to acquire additional resources held by other processes
- **No preemption**: a resource can be released only **voluntarily** by the process holding it, after that process has completed its task
- **Circular wait**: there exists a set $\{P_0, P_1, \ldots, P_n\}$ of waiting processes such that P_0 is waiting for a resource that is held by P_1, P_1 is waiting for a resource that is held by P_2, …, P_{n-1} is waiting for a resource that is held by P_n, and P_n is waiting for a resource that is held by P_0.

Resource-Allocation Graph

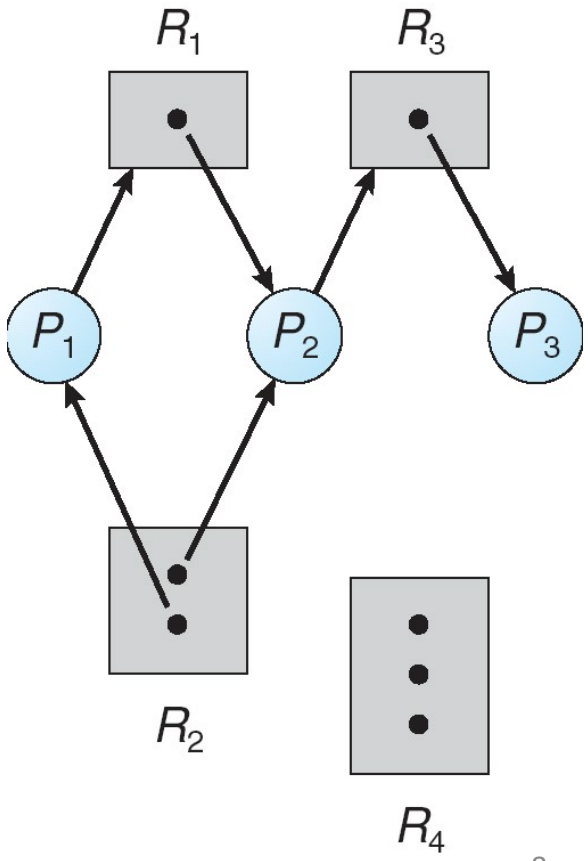
A set of vertices V and a set of edges E.

- V is partitioned into two types:
  - $P = \{P_1, P_2, \ldots, P_n\}$, the set consisting of all the **processes** in the system
  - $R = \{R_1, R_2, \ldots, R_m\}$, the set consisting of all **resource** types in the system
- **request edge** – directed edge $P_i \rightarrow R_j$
- **assignment edge** – directed edge $R_j \rightarrow P_i$

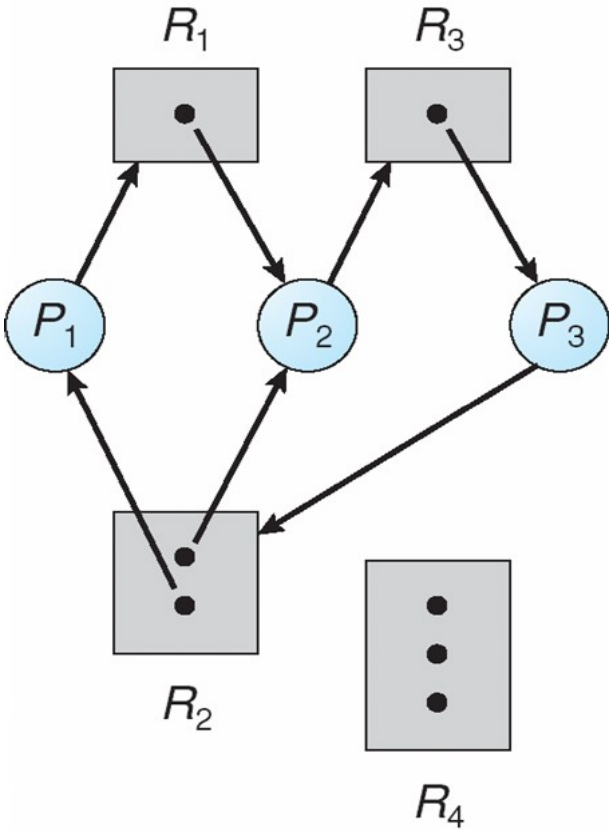
Resource-Allocation Graph (Cont.)

- Process 
- Resource Type with 4 instances 
- P_i requests instance of R_j 
- P_i is holding an instance of R_j 

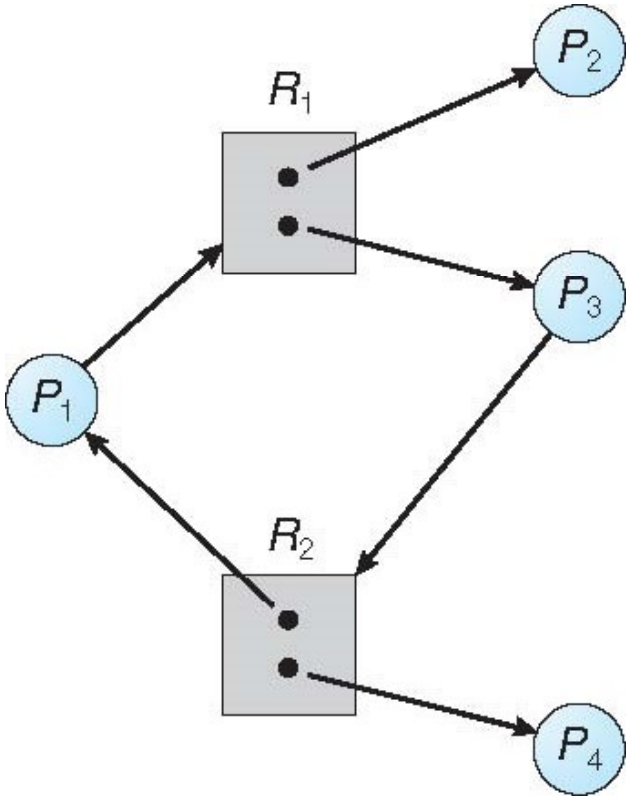
Example



Resource Allocation Graph With A Deadlock



Graph With A Cycle But No Deadlock



Deadlock - Characteristics

- If the graph contains **no cycles** ⇒ **no deadlock**
- If the graph contains a **cycle** ⇒
  - if only **one instance per resource type**, then deadlock
  - if several instances per resource type, possibility of deadlock

REFERENCES

TEXT BOOKS:

T1 Silberschatz, Galvin, and Gagne, “Operating System Concepts”, Ninth Edition, Wiley India Pvt Ltd, 2009.)

T2. Andrew S. Tanenbaum, “Modern Operating Systems”, Fourth Edition, Pearson Education, 2010

REFERENCES:

R1 Gary Nutt, “Operating Systems”, Third Edition, Pearson Education, 2004.

R2 Harvey M. Deitel, “Operating Systems”, Third Edition, Pearson Education, 2004.

R3 Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, “Operating System Concepts”, 9th Edition, John Wiley and Sons Inc., 2012.

R4. William Stallings, “Operating Systems – Internals and Design Principles”, 7th Edition, Prentice Hall, 2011