

ALGORITHM

1. (14%) Write a *quicksort* so that elements of the array need not be moved.
2. (18%) True or False (defend your answer): the following nondeterministic algorithm solves the No Partition Problem in nondeterministic polynomial time.

```
HalfSet:={};  
p:=n;  
repeat  
  count:=choose({0,1})  
  if count=1 then  
    HalfSet:= HalfSetU{p}  
  endif  
  p:=p-1;  
until p=0
```

if

$$\sum_{i \in \text{HalfSet}} c_i \neq \sum_{i \notin \text{HalfSet}} c_i$$

then

success, print("yes")

else

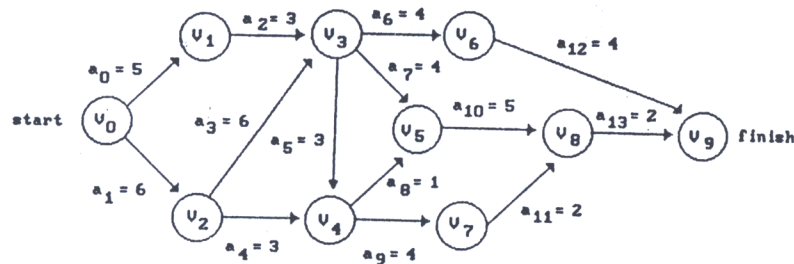
failure, print("no")

endif

3. (18%) Let $A = (a_1, a_2, \dots, a_n)$ and $B = (b_1, b_2, \dots, b_m)$ be two sets. Assume $1 \leq a_i \leq p, 1 \leq i \leq n$ and $1 \leq b_i \leq p, 1 \leq i \leq m$. All a_i s and b_i s are integers. Write an algorithm to determine whether A and B are equal. your algorithm should work in $O(n+m)$ time.

Part II. Data Structure

1. (20%) Answer the following questions.
 - (a) What is an abstract data type?
 - (b) Use physical data types (provided in C or Pascal or Fortran) to represent (define) the following abstract data types.
 - (i) Polynomial
 - (ii) Activity On Edge (AOE) Network
 (an instance of the AOE network is shown below)



(iii) Red-Black Tree

For each type give comments to the defined representation to justify your creation. (You can draw figures to assist your explanation.)

2. (10%) A queue is an ordered list in which all insertions take place at one end and all deletions take place at the opposite end. Write two functions (in C or Pascal or Fortran) that add and delete elements of the queue that is implemented as a circular array. Your algorithm should allow the queue of size n to hold at most n elements.
3. (20%) Answer the following questions.
 - (a) Define 2-3 tree.
 - (b) Draw 2-3 trees sequentially after inserting the values 42, 30, 35, 24, 5, 33, 44, 16, 8, 22, 25, 13 in order.
 - (c) For the 2-3 tree constructed above draw the resulted tree after deleting the value 24.
 - (d) What is the maximum height of a 2-3 tree with n nodes?
 - (e) What is the timing complexity of the search algorithm to search a 2-3 tree with n nodes?