浙江大学 2023–2024 学年春夏季学期

《数据库系统》课程课堂测试四

(Quiz 4 for Database Systems)
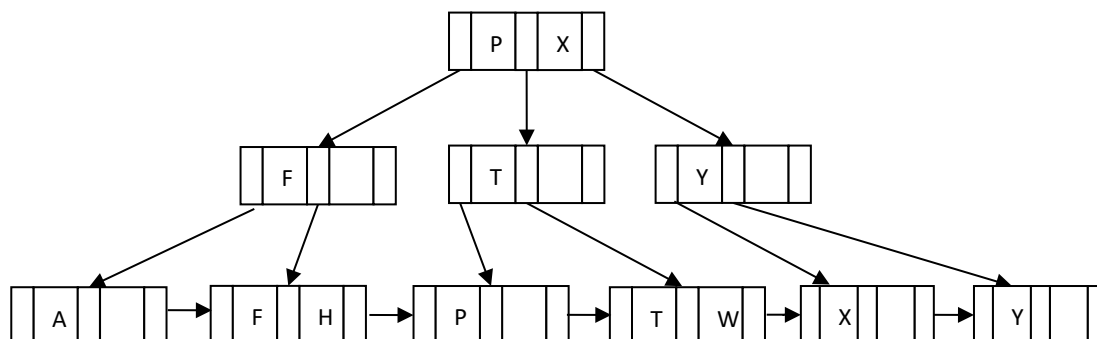
考生姓名：＿＿＿＿＿　学号：＿＿＿＿＿　专业：＿＿＿＿＿　得分：＿＿＿＿＿

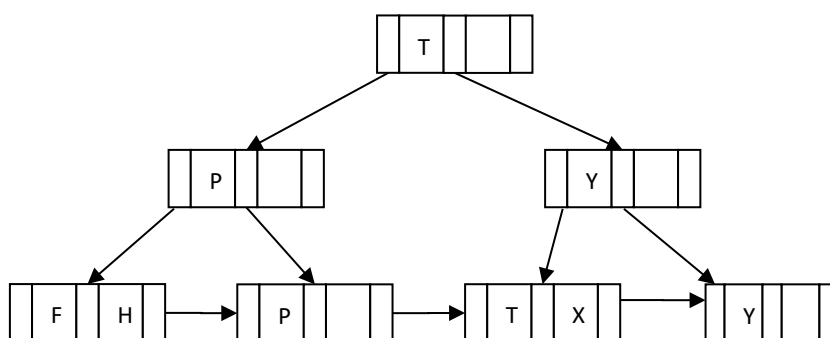**Problem 1.** For the following B+ tree (n=3):
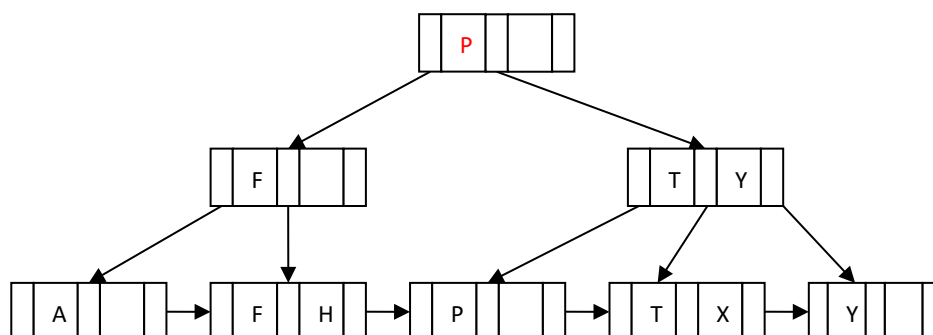
(1) Draw the B+ tree after insert an index item with key 'W' to the given tree.
Solution:

(2) Draw the B+ tree after delete an index item with key 'A' from the original tree.
Solution:

(3) Assume that the B+ tree contains 1000 index items, please estimate the height of the B+ tree.

$$\left\lceil log_3 \frac{1000}{2} \right\rceil + 1 \leq \text{height} \leq \left\lceil log_{\lceil \frac{3}{2} \rceil} 1000 \right\rceil + 1$$

$$8 \leq \text{height} \leq 11$$

Or

$$7 \leq \text{height} \leq 10$$

(4) Assume that the B+ tree contains 1000 index items, please estimate the size (i.e. the number of nodes) of the B+ tree.

$$\text{size} \geq 500 + 167 + 56 + 19 + 7 + 3 + 1 = 753$$
$$\text{size} \leq 1000 + 500 + 250 + 125 + 62 + 31 + 15 + 7 + 3 + 1 = 1994$$
$$753 \leq \text{size} \leq 1994$$

Problem 2. Consider the following relational schema and SQL query:

product(pid: char(10), name: char(20), producer: char(20), price: integer)
customer(cid: integer, name: char(20), age: integer; city: char(20))
order(cid: integer, pid: char(10))

select customer.name, product.name
from customer, order, product
where customer.cid= order.cid and product.pid = order.pid
customer.city ='Hangzhou' and product.price>=200;

(1) Identify a relational algebra tree (or a relational algebra expression if you prefer) that reflects the order of operations that a decent query optimizer would choose.

$$\prod_{customer.name, product.name} (\sigma_{city='Hangzhou'}(customer) \bowtie Order \bowtie \sigma_{price \geq 200}(product))$$

(2) What indexes might be of help in processing this query? Explain briefly.

Since the pid (in product and order) and cid (in customer and order) is crux of the join, it's helpful to create B+tree indexes in these attributes. (Different answer is OK if it makes sense.)