$B = 512$ bytes → block size

$P = 6$ byte → block pointer size, $RP = 7$ bytes

$r = 30000$ → number of records

---

a) R = size of (Name) + size of (SSN) + size of (Department-Code) + size of (Address) + size of (phone) + size of (BIRTH-date) + size of (Sex) + size of (Job-Code) + size of (salary) + size of (Deletion Marker)

$= 30 + 9 + 9 + 40 + 10 + 8 + 1 + 4 + 4 + 1$

$R = 116$ bytes

---

b) bfr = B (block size) / (R (Record size) + RP)

$= 512 / (116 + 7) = 516 / 123$

$\simeq 4$ bytes

Number of file blocks (b) = r / bfr

$= 30{,}000 / 4 = 7500$ blocks

c)

i) → index entry size = size of SSN + RP = 9 + 7 = 16 bytes

$bfr_i = B / \text{index entry size} = 512 / 16 = 32$

---

ii)

→ Number of first-level index entries = number of unique SSN

= number of Employee records = $r = 30000$

→ Number of first-level index blocks =

number of first-level entries / bfr_i

$= 30000 / 32 \simeq 937.5 \simeq 938$

---

iii) I think this is single-level index so only a one-level primary index is required

---

iv) its a single-level index so the total number of required blocks is equal to number of first-level index blocks $\simeq$ 938 blocks

v) Number of block accesses needed to search for a record using the one-level primary index is 1, because we can directly access the block containing the record using index.

for multilevel index, since this example is a single-level index, I guess still the number of block access is 1.

d)

i) bfr_i = Block size / index Entry size

= 512 / 16 = 32

---

ii)

→ Number of first_level secondary index Entries =

Number of unique SSN = Total number of Employee Records = 30 000

→ Number of first_level secondary index blocks =

number of first_level secondary index Entries / bfr_i (↓ 32)

Number of first_level secondy index bloc will be smaller than 938 (Number of first_level primary index bloc) because secondary index only considers unique SSN values.

iii) Number of levels needed for multilevel index → this is a single-level index, No need for more levels

---

iv) Total number of blocks required by multilevel index → is a single-level index so number of blocks is equal to number of first-level secondary index blocks.

---

v) Number of block access to search is 1.

Primary and secondary have same blocking factor of 32. Number of first-level index blocks in secondary is less than first-level index block in primary. Both have same number of block access needed. Primary provides direct access to any record in a block access, but secondary provides access to unique SSN values.

e)

i) index entry size = size of Department_Code + RP

= 9 + 7 = 16 bytes

bfri = Block size / index entry size

= 512 bytes / 16 bytes = 32

---

ii) Number of blocks needed by the level of indirection :

Number of records per Department_Code value =

Number of Employee records (r) / Number of distinct Department_Code values

= 30 000 / 1000 = 30

↳ number of blocks needed =

number of records per Department_Code value / bfri

= 30 / 32 ≈ 0.937 ≈ 1

---

iii)

number of first_level Index Entries = Number of Distinct Department_Code values = 1000

Number of first-level Index blocks =

number of first_level Index Entries / bfri

$= 1000 / 32 \approx 31.25 \approx 32$

(iv) Number of levels = $\log_{bfri}$ Number of first-level Index blocks

$\approx \log_{32}^{32} \approx 1$

(v) Total number of Blocks required by the multilevel

index = Number of first-level Index blocks ≈ 32

→ Number of blocks used in the extra level of

indirection = 1000

because we need 1 block per distinct Department

-Code valve

(vi) Approximate Number of block Accesses

Needed = Number of Levels + 1

$= 2 + 1 = 3$

f)

i) Index entry size = size of Department_Code + P

= 9 bytes + 6 bytes = 15 bytes

bfri = Block size / Index entry size

= 512 bytes / 15 bytes $\approx$ 34.13 $\approx$ 34

---

ii) Number of first-level index entries = Number of distinct Department_Code values = 1000

Number of first-level index blocks =

Number of first-level index entries / bfri

= 1000 / 34 $\approx$ 29.41 $\approx$ 30

---

iii) Number of levels needed for multilevel index → It's a single-level index, we don't need any additional levels, because each new Department_Code value locates at the beginning

of a new block and we can directly access the block which includes that value.

---

iv) Total number of blocks required by the multilevel index: Because it is a single-level index

↳ Total number of blocks required by the multilevel index = Number of first_level index blocks ≈ 30

---

v) Number of Block Access needed to search for and retrieve all records in the file that have a specific Department_Code value is 1, because each new Department_Code value locates at the beginning of a new block and we can directly access the block which includes that value.