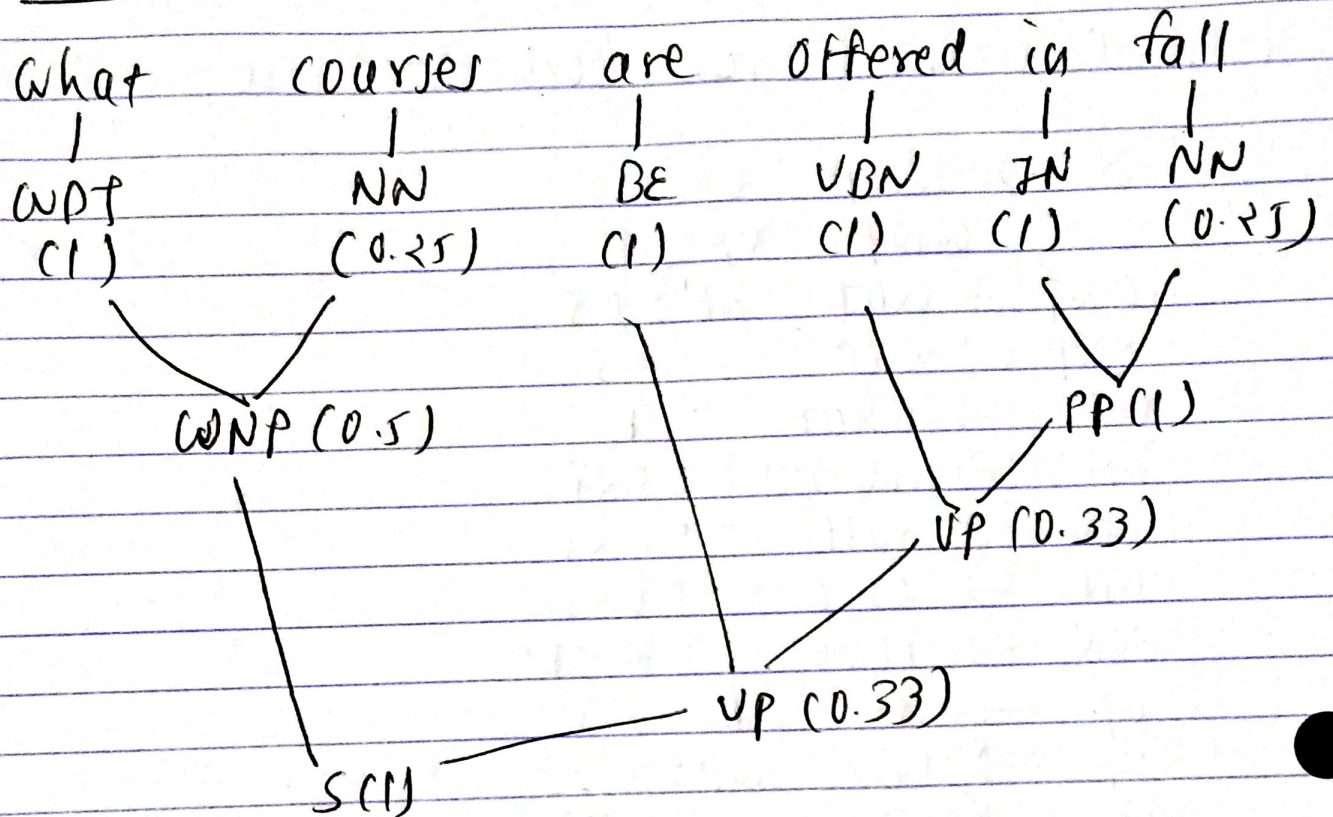Q.5

(a) CFG rules for both trees are
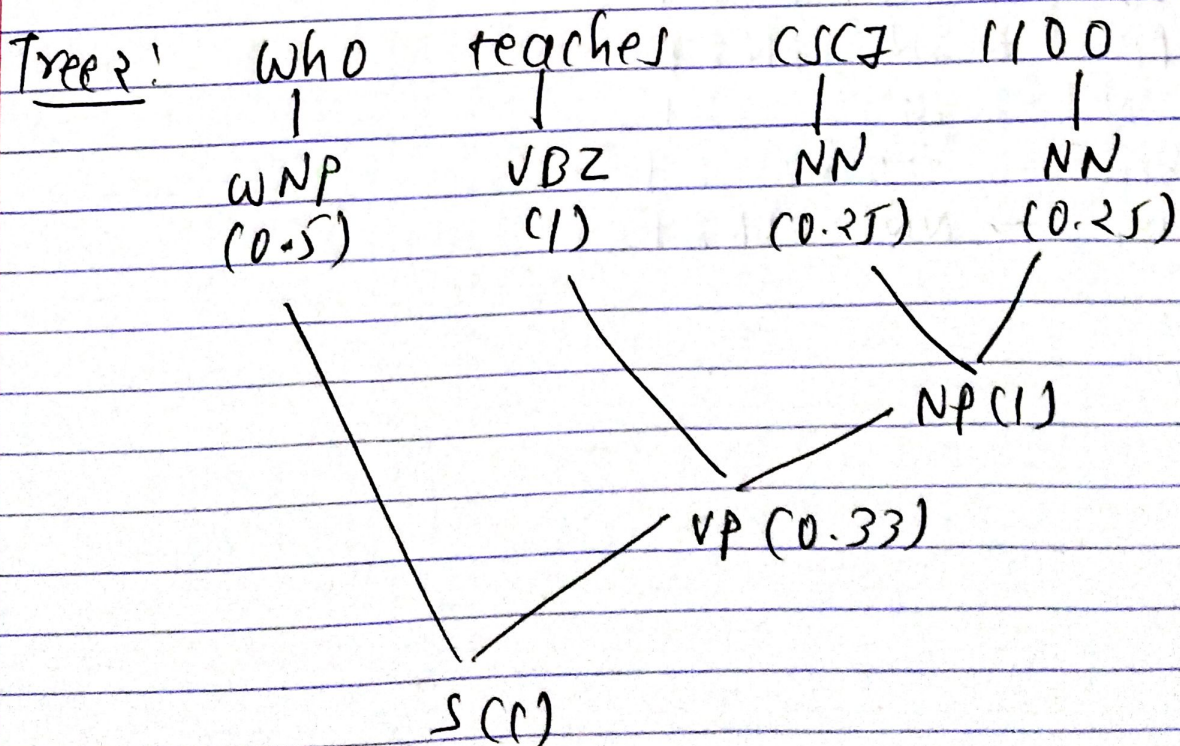
$S \rightarrow WNP \quad VP : 1$
$S \rightarrow WNP \quad VP : 1$
$WNP \rightarrow WDT \quad NN : 0.5$
$WNP \rightarrow who \quad : 0.5$
$WDT \rightarrow what \quad : 1$
$NN \rightarrow courses \quad : 0.25$
$NN \rightarrow fall \quad : 0.25$
$NN \rightarrow CSCI \quad : 0.25$
$NN \rightarrow 1100 \quad : 0.25$
$VP \rightarrow BE \quad VP : 0.33$
$VP \rightarrow VBZ \quad NP : 0.33$
$VP \rightarrow VBN \quad PP : 0.33$
$BE \rightarrow are \quad : 1$
$VBN \rightarrow offered \quad : 1$
$PP \rightarrow IN \quad NN : 1$
$IN \rightarrow in \quad : 1$
$VBZ \rightarrow teacher \quad : 1$
$NP \rightarrow NN \quad NN : 1$

Tree1:

What — WDT (1)

courses — NN (0.25)

are — BE (1)

offered — VBN (1)

in — IN (1)

fall — NN (0.25)

WNP (0.5)

PP (1)

VP (0.33)

VP (0.33)

S (1)

$$\Rightarrow p(\text{tree 1}) = 0.0034$$

Tree2:

who — WNP (0.5)

teaches — VBZ (1)

CSC7 — NN (0.25)

1100 — NN (0.25)

NP (1)

VP (0.33)

S (1)

6)

what	csc7	teaches	fall	fall
WDT (1)	NN (0.25)	VBZ (1)	NN (0.25)	NN (0.25)
WNP (0.125)			NP (0.0625)	
			VP (0.021)	
		VP (0.0069)		
	S (0.00086)			
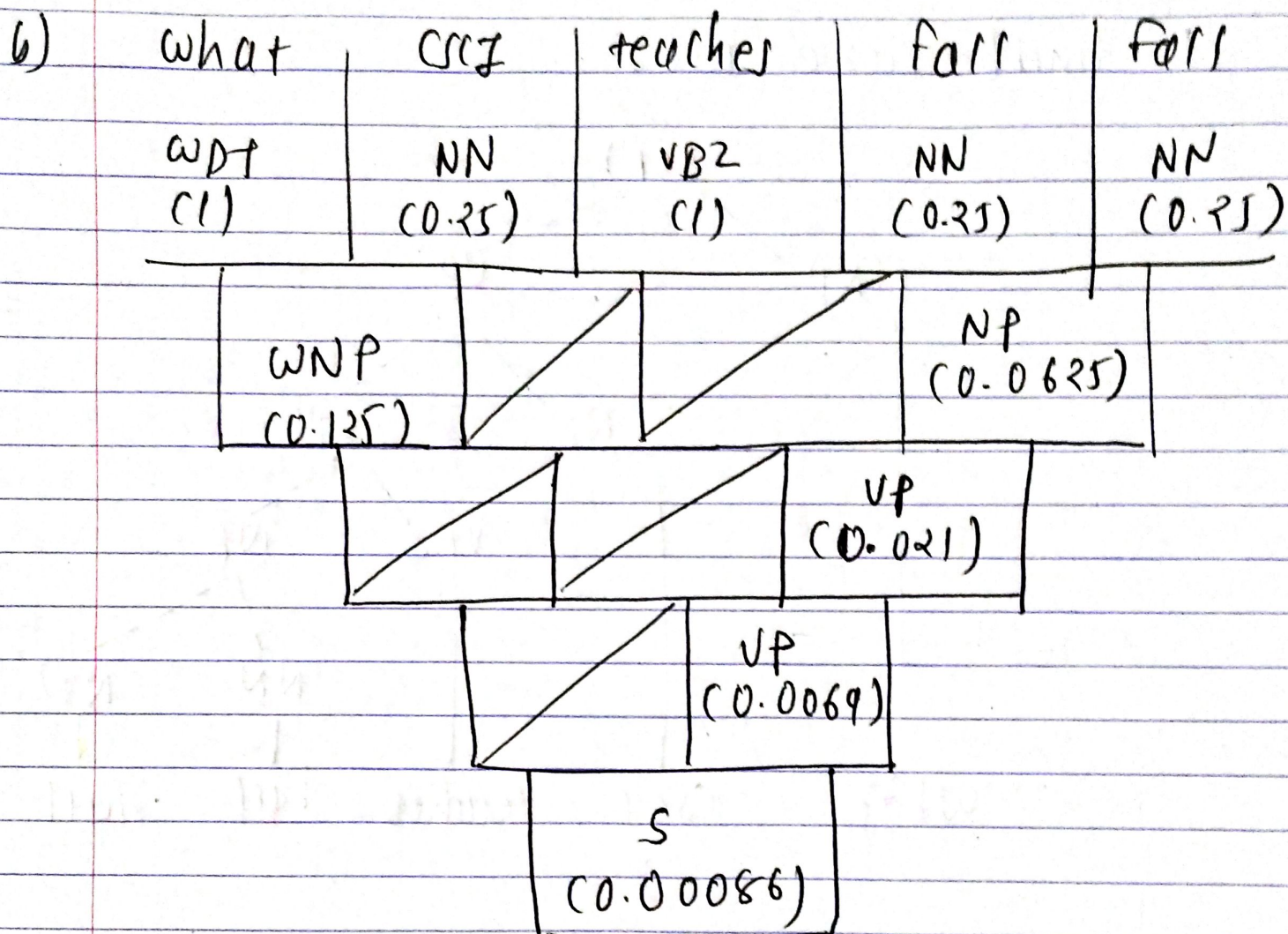
P(what csc7 teaches fall fall) = 0.00086

c) final parse tree:

S(r)
├── WNP
│   └── what
└── VP
    ├── NN
    │   └── CSC7
    └── VP
        ├── VBZ
        │   └── teaches
        └── NP
            ├── NN
            │   └── fall
            └── NN
                └── fall
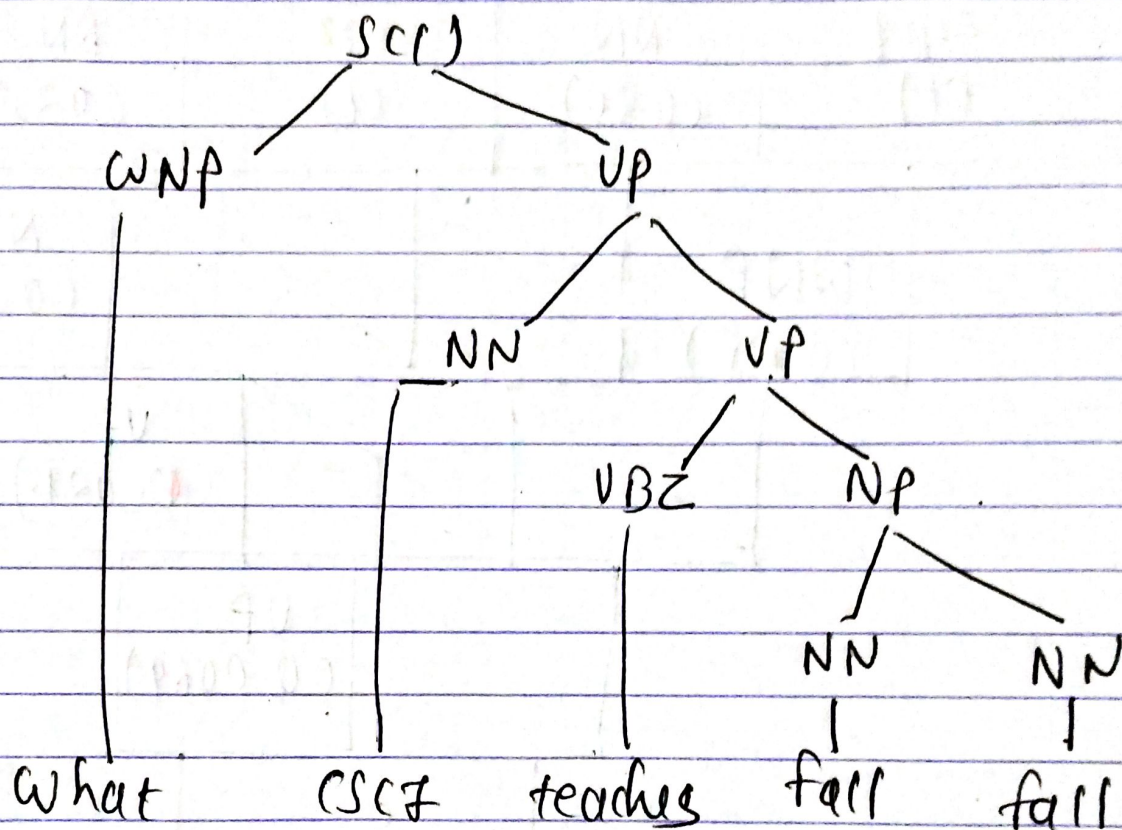
⟹ considering probabilities of Part B.

Probability (final parse tree) =

$$= 1.521 \times 10^{-11}$$

⟹ considering probabilities of part A

Probability (final parse tree) =

$$= 0.00085$$