5) a) (S (WNP (WDT What)
(NN courses))
(VP (BE are)
(VP (VBN offered)
(PP (IN in)
(NN fall))))

~~(S (WNP who)
(VP (VBN offered)
(PP (~~

(S (WNP who)
(VP (VBZ teaches)
(NP (NN CSCE)
(NN 1100))))

CFG induced from parse tree

Post tree =>

S → WNP VP
WNP → WDT NN
WDT → what
NN → courses
VP → BE VP
BE → are
VP → VBN PP
VBN → offered

PP → IN NN

IN → in

NN → fall

second tree (not including ones in first)

VP → VBZ NP

VBZ → teaches

NP → NN NN

NN → CSCI

NN → 1100

WNP → who.

CFG with probabilities.

S → WNP VP / 1

WNP → WDT NN / 0.5

WNP → who / 0.5

WDT → what / 1

NN → courses / 0.25

NN → fall / 0.25

NN → CSCI / 0.25

NN → 1100 / 0.25

VP → BE VP / 0.33

VP → VBN PP / 0.33

VP → VBZ NP / 0.33.

BE → are / 1

VBN → offered / 1

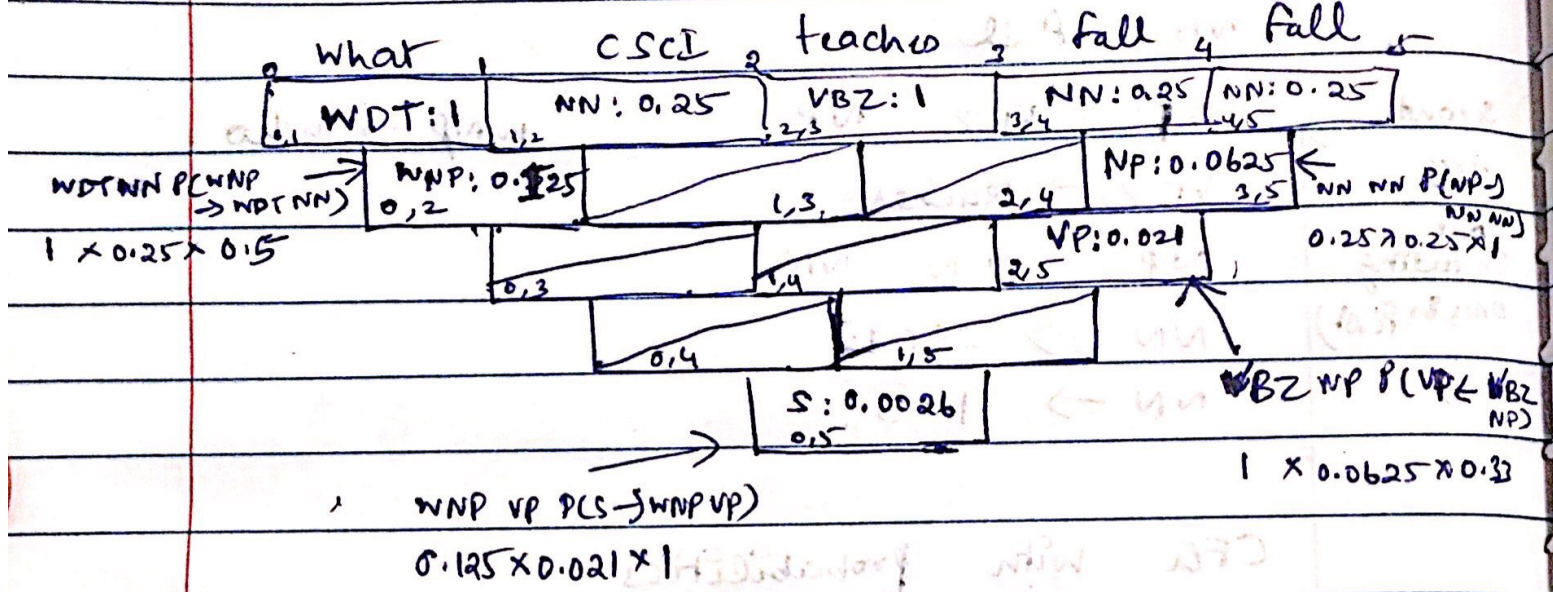
PP → IN NN / 1

IN → in / 1

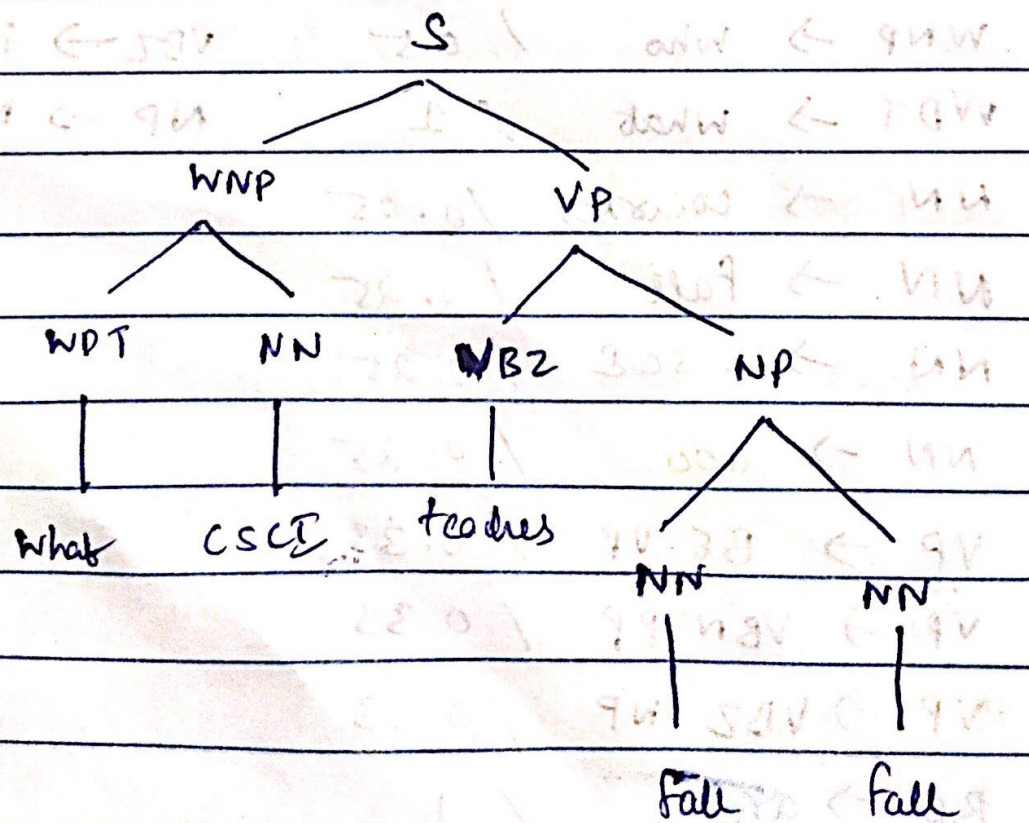
VBZ → teaches / 1

NP → NN NN / 1

5)b) CYK Parsing ~~without~~ Probabilities.



5)c) Final parse tree.



P(free) = P(S → WNP VP)
P(WNP → WDT NN) P(WDT → which)
P(NN → CSCI) P(VP → VBZ NP)
P(VBZ → teaches) P(NP → NN NN)
P(NN → fall) P(NN → fall)

= 1 × 0.5 × 1 × 0.25 × 0.33 × 1 × 1
× 0.25 × 0.25

= 0.0026