Roll No: Name:

Answer must be written in the space provided. No Answer booklet / additional sheets.

1. (2 marks) Does non-determinism add power to PDA. Present two case studies for which NPDA exist but not DPDA.

2. (1.5+1.5=3 marks) Write the definition of Pumping Lemma for Context Free Languages. Also, its contrapositive.

3. (3 marks) Design a PDA or show that none exists for $L = \{ww \mid w \in \{a, b\}^*\}$.

4. (1.5+1.5=3 marks) Write a deterministic PDA and a CFG in GNF for the set of all strings ending with 'ab'.

5. (2+2=4 marks) Write PDA for $a^{3n}b^{4n}$. Also, write the CFG in CNF.

6. **Extra Credit: 4 marks** Given two context free languages L_1 and L_2, which of the following are context free (i) $L_1 - L_2$ (ii) L_1^c (complement of L_1) (iii) $L_1 \cap L_2$. Justify your answer with suitable case studies.

Space for Rough work (Do NOT use any additional sheets)