**Module 4: Context Free and Non-Context-Free Languages**

Context-Free and Non-Context-Free Languages: Where do the Context-Free Languages(CFL) fit, Showing a language is context-free, Pumping theorem for CFL, Important closure properties of CFLs, Deterministic CFLs. Algorithms and Decision Procedures for CFLs: Decidable questions, Un-decidable questions. Turing Machine: Turing machine model, Representation, Language acceptability by TM, design of TM, Techniques for TM construction.

1. Show that L = {aibici | i >1} is not CFL. **(10m)(Dec-Jan 2011) (Jun/Jul15)**
2. Show that L={anbncn | n>=0} is not context free.**(8M)(July18,19,Sep20)**
3. Show that L = {ww |w ε {0, 1}\*} is not CFL**. (10m)( Dec-Jan 2012)**
4. Prove that L={w ε {a,b,c}\* where na(w)=nb(w)=nc(w)} is not context free. **4M Feb21**
5. State and prove pumping lemma for context free languages. Show that L **=** {anbncn|n>=0} is not context free.**(10M)(Dec18,Jan,Sep20,Feb21)**
6. Prove that “The context free language properly contain the regular languages”.**(4M)(Sep20)**
7. If L1 and L2 are context free languages then prove that L1UL2, L1.L2 and L1\* are context free languages. **(4M)(Dec17)**
8. Discuss the relationship between the deterministic context free language and the languages that are not inherently ambiguous. **(6M)(Jan20)**
9. PT CFL are not closed under intersection, complement or difference. **(8M) (July19,Sep20)**
10. Give a decision procedure to answer each of the following questions:**(12M) (Dec17)**
11. Given a regular expression α and a PDA M, the language accepted by m a subset of the language generated by α?
12. Given a context free grammar G and two strings S1 and S2, does G generate S1S2?
13. Given a context free grammar G, does G generate any even length strings.
14. Given a regular grammar G, is L(G) context free?
15. Using pumping lemma for CFL prove that below languages are not context free

{p | p is a prime}. **(10m)(Dec-Jan 2012)**

1. State pumping lemma for context free languages. Using the CFL pumping lemma, show that the following language is not context free. L={ anbncn/ n>= 1}(**8M) (Dec12, Jan20)**
2. Prove that context free languages are closed under union, concatenation and star.**(8M)(Dec13,Jun15, Dec15,Feb21)**
3. Explain the hierarchy within the class of CFLs (Hierarchy of languages). **(3M)(Jan20**)
4. Show that CFL’s are closed under reverse. **(3M)(Jan20**)
5. Briefly explain the techniques for TM construction. **(4M)(July18,Sep20,Jul22)**
6. Explain multiple TM with a neat diagram. **(5M) (Jul22)**
7. Explain: i) Multitape ii) Non-deterministic TM **(6M) (Feb22)**
8. Demonstrate the model of Linear Bounded Automata (LBA) with a neat diagram. **(8M) (Jul22)**
9. Define Turing Machine and Explain the working principle of TM with diagram. **(5M) (Jan,Sep20,Feb21,22)**
10. Design a Turing machine to accept a Palindrome over {0,1}\*. Also show the transition diagram and instantaneous description on string “10101”. **(12m)(Dec/Jan11,12,14,20Jun14)**
11. Design a TM to recognize a string of the form anbncn where n>=1.Write its transition diagram. Show the moves made by this TM for the string "aabbcc". **(10m)(Jun10,15,Dec12,15,17,Jan20)**
12. Design a TM to accept **{** 0n1n2n where n>=1} and show the moves made by the machine for the string 000111222? **(10M)(Sep20,Feb21,Aug 21,Feb/Jul22)**
13. Design a TM to accept the language L={ 0n1n/ n>=1 }. Write its transition diagram and give instantaneous description for the input "0011". (**12M) (Dec10,16,Jun13,16,18, Jan,Sep20,Jul22)**
14. Design a TM to accept the language L={ WWR/ W € (a+b)\* }. Write its transition diagram and give instantaneous description for the input "abba". (**14M) (Dec13)**
15. Design TM for WCWR over ∑ = {0,1}. Write transition diagram, and ID for w=101C101 **(14M)(Feb22)**
16. Define and differentiate DTM and NDTM. **6M Aug 2021**
17. Define a turing machine. Explain the working of turing machine with a neat diagram.(**8M)**

**(Dec12,13,16,18,Jun14,18,19,Aug21)**

1. Obtain a Turing machine to recognize the language L={anbncn|n>=0}. **(8M)(July19)**
2. Obtain a Turing machine to recognize the language L={0n1n2n|n>=1}. **(8M)(July18,Dec18)**
3. Design a TM to accept strings of a’s and b’s ending with ab or ba.**(8M)(Dec18)**
4. Design a Turing machine for addition of 2 numbers(2+3) with transition diagram and ID for the same. **14M Aug2021**
5. Design a turing machine that performs the following function: (**12M) (Dec15,Jun10)**

q0w ├ \*qfww for any w ϵ {1}\* and also write its transition diagram.