Bihar Engineering University, Patna
End Semester Examination - 2022

Course: B.Tech. | *Semester: V* | *Time: 03 Hours*
Code: 105503 | *Subject: Formal language & automata theory* | *Full Marks: 70*

Instructions:-
(i) The marks are indicated in the right-hand margin.
(ii) There are NINE questions in this paper.
(iii) Attempt FIVE questions in all.
(iv) Question No. 1 is compulsory.

Q.1 ***Choose the correct option of the following (Any seven question only):*** **[2 x 7 = 14]**

(a) The language $\{ a^m b^n c^{m+n} / m, n \geq 1\}$
(i) regular (ii) context-free but not regular
(iii) Context-sensitive but not context free (iv) type-0 but not context sensitive

(b) Which of the following pairs have DIFFERENT expressive powers?
(i) Deterministic finite automata (DFA) and non-deterministic finite automata (NDFA)
(ii) Deterministic push-down automata (DPDA) and non-deterministic push-down automata (NDPDA)
(iii) Deterministic single-tape Turing machine and non-deterministic single-tape Turing machine
(iv) Single-tape Turing machine and multi-tape Turing machine

(c) The logic of pumping lemma is a good example of
(i) pigeon-hole principle (ii) divide-and-conquer technique
(iii) recursion (iv) iteration

(d) If $L1$ and $L2$ are context free languages, $L1 - L2$ is_____ context-free.
(i) always (ii) sometimes (iii) never (iv) None of these

(e) ____ is the acylic graphical representation of a grammer
(i) Binary tree (ii) Octtree (iii) Parse tree (iv) None of the above

(f) Which of the following pairs of regular expressions are equivalent?
(i) $x^* \text{ and } x^*x$ (ii) $1(01)^* \text{ and } (10)^*1$
(iii) $x(xx)^* \text{ and } (xx)^*x$ (iv) All of the above

(g) The maximum number of states of a DFA converted from an NFA with n states is
(i) n (ii) $n2$ (iii) 2 (iv) None of these

(h) Definition of a language L with alphabet {a} is given as L= $\{a^{nk} / k > 0$, and n is a positive integer constant}. What is the minimum number of states needed in a DFA to recognize L?
(i) $k + 1$ (ii) $n + 1$ (iii) $2n + 1$ (iv) $2k + 1$

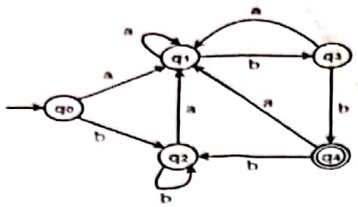
(i) A _____ is context free grammar with atmost one non-terminal in the right handside of the production.
(i) linear grammar (ii) linear bounded grammar
(iii) regular grammar (iv) None of the above

(j) Let N be an NFA with n states and let M be the minimized DFA with m states recognizing the same language. Which of the following is necessarily true?
(i) $m \leq 2^n$ (ii) $n \leq m$ (iii) M has one accept state (iv) $m = 2^n$

Q.2 (a) Tabulate Chomsky hierarchy of grammars with an example for each. **[7]**
(b) Construct the regular grammar accepting the following language: **[7]**
$L = \{w \in \{a,b\}^* / w$ is a string over $\{a,b\}$ such that the number of b's is 3 mod 4$\}$

P.T.O.

Q.3 (a) Minimize the DFA [7]



(b) Define recursively enumerable languages. Let L_1 be recursive and L_2 recursively enumerable. Show that $L_2 - L_1$ is necessarily recursively enumerable. [7]

Q.4 Begin with the grammar : S → ASB/∈ [14]
A → aAS/a
B → SbS/A/bb

(i) Eliminate ∈ –productions.
(ii) Eliminate unit productions in the resulting grammar.
(iii) Eliminate any useless symbol in the resulting grammar.
(iv) Put the resulting grammar into CNF.

Q.5 (a) Design a pushdown automata to accept the following language by empty stack: [7]
$\{0^n 1^n / n \geq 1\}$.

(b) Define deterministic pushdown automata. Explain with an example. [7]

Q.6 (a) Prove using pumping lemna for regular languages that the language $\{0^n / n$ is a perfect square$\}$ is not regular. [7]

(b) Convert the following DFA to regular expression using the state elimination technique. [7]

State/ input	0	1
→*p	s	p
q	p	s
r	r	q
s	q	r

Q.7 (a) Convert the following NFA to DFA and informally describe the language it accepts. [7]

State/ input	0	1
→ p	{p, q}	{p}
q	{r, s}	{t}
r	{p, r}	{t}
* s	∅	∅
* t	∅	∅

(b) When a CFG is called ambiguous? Show that S→ as/aSbS/∈ is ambiguous. [7]

Q.8 (a) Define Turing machine. Design a Turing machine M to recognize the language [7]
$\{1^n 2^n 3^n / n \geq 1\}$.

(b) Construct DFA equivalent to the regular expression: – [7]
$(0+1)^* (00+11) (0+1)^*$

Q.9 Write short notes on any two of the following: [7x2=14]

(i) Pumping lemma for CFL
(ii) GNF
(iii) Multistack Turing Machine
(iv) NP-hard problem