

Bihar Engineering University, Patna
End Semester Examination - 2022

Course: B.Tech.
Code: 105503

Semester: V
Subject: Formal language & automata theory

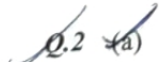
Time: 03 Hours
Full Marks: 70

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 (NFA)
 - (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 L_1 and L_2 are context free languages, $L_1 - L_2$ is _____ context-free.
 - (i) always
 - (ii) sometimes
 - (iii) never
 - (iv) None of these
- (e) _____ is the acyclic graphical representation of a grammar
 - (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^* and x^*x
 - (ii) $1(01)^*$ and $(10)^*1$
 - (iii) $x(xx)^*$ 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) n^2
 - (iii) 2
 - (iv) None of these
- (h) Definition of a language L with alphabet $\{a\}$ is given as $L = \{a^{nk} / k > 0, \text{ and } n \text{ is a positive integer constant}\}$. 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) 
(b) 

Tabulate Chomsky hierarchy of grammars with an example for each.

[7]

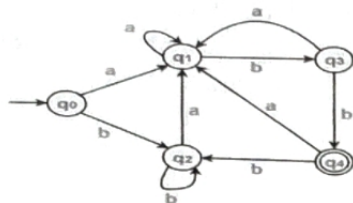
Construct the regular grammar accepting the following language:

[7]

$L = \{w \in \{a, b\}^* / w \text{ is a string over } \{a, b\} \text{ such that the number of } b\text{'s is } 3 \text{ mod } 4\}$

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 : $S \rightarrow ASB/\epsilon$

[14]

$A \rightarrow aAS/a$

$B \rightarrow SbS/A/bb$

- Eliminate ϵ -productions.
- Eliminate unit productions in the resulting grammar.
- Eliminate any useless symbol in the resulting grammar.
- Put the resulting grammar into CNF.

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

[7]

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

[7]

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

[7]

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

[7]

State/ input	0	1
$\rightarrow^* p$	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
$\rightarrow p$	{p, q}	{p}
q	{r, s}	{t}
r	{p, r}	{t}
* s	$\emptyset$	$\emptyset$
* t	$\emptyset$	$\emptyset$

(b) When a CFG is called ambiguous? Show that $S \rightarrow as/aSbS/\epsilon$ is ambiguous.

[7]

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

[7]

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

[7]

Q.9 Write short notes on any two of the following:

[7x2=14]

- Pumping lemma for CFL
- GNF
- Multistack Turing Machine
- NP-hard problem