Hall Ticket No | | | | | | | | | | Question Paper Code: AITB03

# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

**Dundigal, Hyderabad - 500 043**

## MODEL QUESTION PAPER - I

Second Year B.Tech IV Semester End Examinations, November – 2018

**Regulations: R18**

## THOERY OF COMPUTATIONS

(Common to CSE / IT)

**Time: 3 Hours** **Max. Marks: 70**

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

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### UNIT – I

1. a) Construct a DFA, the language recognized by the Automaton being L={w/ w contains neither the substring ab nor ba}.Draw the transition table. **[7M]**

   b) Design a DFA for the following language over an alphabet Σ = { 0,1} **[7M]**
   i) The string with even no of 0"s and even no of 1"s
   ii) The string with odd no of 0"s and even no of 1"s

2. a) Construct a DFA that any given decimal number is divisible by 3. **[7M]**

   b) Describe NFA with ε to NFA conversion with an example. **[7M]**

### UNIT – II

3. a) Demonstrate Regular expression? Simplify the following Regular Expression **[7M]**
   i) ε + 1*(011)*(1*(011)*)*=(1+011)*
   ii) (0+11*0)+ (0+11*0)(10+10*1) * (10+10*1) *=1*0(10+10*1) *

   b) Construct the Finite Automata(NFA-ε) for given regular expression (0+1)*00(0+1)* **[7M]**

4. a) IIustrate the steps for conversion of regular grammar to finite automata? Construct the FA for the following grammar **[7M]**
   S→aS/bA/b
   A→aA/bS/a

   b) Construct the DFA Transition diagram for equivalent Regular expression (ab+a) *(aa+b) **[7M]**

### UNIT – III

5. a) Construct leftmost and rightmost derivations for the strings, if the language is given as **[7M]**
   S→AS| ε A→aa|ab|ba|bb
   Strings:
   a) aabbba
   b) baabab
   c) aaabbb

   b) Construct Leftmost Derivation. , Rightmost Derivation, Derivation Tree for the following grammar with respect to the string aaabbabbba. **[7M]**
   S→aB | bA,
   A→aS| bAA|a
   B→bS | aBB |b

6. a) Convert the following grammar into GNF G=({A1,A2,A3},{a,b},P,A) **[7M]**
   A1→A2A3

A2→A3A1/b
A3→A1A2/a

b) Simplify the context free grammar for the given CFG **[7M]**
S-> Ab |Bb
A->a |aS |Baa
B-> b|bS |aBB

**UNIT – IV**

7. a) Construct PDA for the below grammar as shown below **[7M]**
S->aABB |aAA
A->aBB |a
B->bBB | A
that accepts the language generated by given grammar

b) Prove that the below languages are deterministic context free languages? **[7M]**
a) L1={0n1m|n=m and n>=1}
b) L2 = {on1m|n=2m and n>=1}

8. a) Prove that given CFG with following productions **[7M]**
S->aBc
A-> abc
B->aAb
C->AB
C->c
constructs a PDA M such that the language generated by M and G are equivalent.

b) Prove that the below languages are deterministic context free languages? **[7M]**
a) L1={0n1m|n=m and n>=1}
b) L2 = {on1m|n=2m and n>=1}

**UNIT – V**

9. a) Construct a Turing Machine that accepts the language L = {1n2n3n | n ≥1}. Give the transition diagram for the Turing Machine obtained and also show the moves made by the Turing machine for the string 111222333. **[7M]**

b) Describe briefly about the following **[7M]**
a)Church's Hypothesis
b)Counter machine

10. a) Construct Transition diagram for Turing Machine that accepts the language L = {0n1n | n ≥1}. Give the transition diagram for the Turing Machine obtained and also show the moves made by the Turing machine for the string 000111. **[7M]**

b) Construct a Turing Machine that accepts the language L = {a2nbn| n ≥0}.Give the transition diagram for the Turing Machine obtained. **[7M]**

# THOERY OF COMPUTATIONS

| **IV Semester:** CSE/IT | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Course Code** | **Category** | **Hours / Week** | | | **Credits** | **Maximum Marks** | | |
| AITB03 | **Core** | **L** | **T** | **P** | **C** | **CIA** | **SEE** | **Total** |
| | | 3 | 1 | - | 4 | 30 | 70 | 100 |
| **Contact Classes: 45** | **Tutorial Classes: 15** | **Practical Classes: Nil** | | | | **Total Classes: 50** | | |

**OBJECTIVES:**

**The course should enable the students to:**

I. Understand an overview of the theoretical foundations of computer science from the perspective of formal languages.
II. Illustrate finite state machines to solve problems in computing.
III. Understand the hierarchy of problems arising in the computer sciences.
IV. Understand Regular grammars, context free grammar.
V. Construct the model of Push down Automata, Turing Machines..

| **Module-I** | **Finite Automata** | **Classes: 9** |
|---|---|---|

Fundamentals: Alphabet, strings, language, operations; Introduction to finite automata: The central concepts of automata theory, deterministic finite automata, nondeterministic finite automata, an application of finite automata finite automata with epsilon transitions.

| **Module -II** | **Regular Languages** | **Classes: 9** |
|---|---|---|

Regular sets, regular expressions, identity rules, constructing finite automata for a given regular expressions, conversion of finite automata to regular expressions, pumping lemma of regular sets, closure properties of regular sets (proofs not required), regular grammars-right linear and left linear grammars, equivalence between regular linear grammar and finite automata, inter conversion.

| **Module -III** | **Context Free Grammars** | **Classes: 8** |
|---|---|---|

Context free grammars and languages: Context free grammar, derivation trees, sentential forms, right most and leftmost derivation of strings, applications.
Ambiguity in context free grammars, minimization of context free grammars, Chomsky normal form, Greibach normal form, pumping lemma for context free languages, enumeration of properties of context free language (proofs omitted)..

| **Module -IV** | **Pushdown Automata** | **Classes: 9** |
|---|---|---|

Pushdown automata, definition, model, acceptance of context free language, acceptance by final state and acceptance by empty stack and its equivalence, equivalence of context free language and pushdown automata, inter conversion;(Proofs not required); Introduction to deterministic context free languages and deterministic pushdown automata.

| **Module -V** | **Turing Machine** | **Classes: 10** |
|---|---|---|

Turing machine: Turing machine, definition, model, design of Turing machine, computable functions, recursivey enumerable languages, Church's hypothesis, counter machine, types of Turing machines (proofs not required), linear bounded automata and context sensitive language, Chomsky hierarchy of languages.

**Text Books:**

1. John E. Hopcroft, Rajeev Motwani, Jeffrey D. Ullman, ―Introduction to Automata, Theory,
Languages and Computation‖, Pearson Education, 3rd Edition, 2007.

**Reference Books:**

1. John C Martin, ―Introduction to Languages and Automata Theory, Tata McGraw-Hill, 3rd Edition, 2017.
2. Daniel I.A. Cohen, ―Introduction to Computer Theory, John Wiley & Sons, 2nd Edition, 2004.

## OBJECTIVES:

**The course should enable the students to:**

1. Understand an overview of the theoretical foundations of computer science from the perspective of formal languages.
2. Illustrate finite state machines to solve problems in computing.
3. Understand the hierarchy of problems arising in the computer sciences.
4. Understand Regular grammars, context free grammar.
5. Construct the model of Push down Automata, Turing Machines..

## COURSE OUTCOMES (CO's):

1. Understand the functionality of deterministic finite automata and Non-deterministic finite automata.
2. Apply the regular languages , regular expressions to construct finite automata
3. Apply the context free grammars to construct derivation trees and the accept various strings
4. Compare the functionality of push down automata with deterministic finite automata
5. Apply the concept of Turing machines to solve the complex functions

## COURSE LEARNING OUTCOMES:

Students, who complete the course, will have demonstrated the asking to do the following:

| | |
|---|---|
| AITB03.01 | Able to show the importance of alphabets, strings and languages to construct finite automata |
| AITB03.02 | Demonstrate the behavior of deterministic finite automata |
| AITB03.03 | Able to understand the functionality of non- deterministic finite automata |
| AITB03.04 | Show the differences between the deterministic finite automata and non- deterministic finite automata |
| AITB03.05 | Able to understand the Regular sets, regular expressions, identity rules |
| AITB03.06 | Analyze the construction of finite automata for a given regular expressions |
| AITB03.07 | Able to understand the conversion of finite automata to regular expressions |
| AITB03.08 | Able to understand the pumping lemma of regular sets, regular grammars, right linear and left linear grammars |
| AITB03.09 | Able to create right most and leftmost derivation trees for given strings |
| AITB03.10 | Analyze the Ambiguity in context free grammars |
| AITB03.11 | Able to understand the minimization process of context free grammars |
| AITB03.12 | Apply the push down automata for acceptance of context free languages |
| AITB03.13 | Apply the Chomsky normal form and Greibach normal forms to eliminate the Ambiguity in context free grammars |
| AITB03.14 | Able to construct the push down automata for given context free languages |
| AITB03.15 | Able to construct the deterministic push down automata to accept the context free languages |
| AITB03.16 | Show the difference between deterministic push down automata and non- deterministic push down automata |
| AITB03.17 | Able to understand the functionality of Turing machine |
| AITB03.18 | Able to understand the recursively enumerable languages and Church's hypothesis |
| AITB03.19 | Analyze the functionality of different types of Turing machines |
| AITB03.20 | Apply the linear bounded automata and context sensitive language. |

## MAPPING OF SEMESTER END EXAMINATION TO COURSE LEARNING OUTCOMES:

| SEE Question Number | | COURSE LEARNING OUTCOME | | Course Outcomes | Blooms Taxonomy Level |
|---|---|---|---|---|---|
| 1 | a | AITB03.01 | Construct a DFA, the language recognized by the Automaton being L={w/ w contains neither the substring ab nor ba}.Draw the transition table. | CO1 | Apply |
| | b | AITB03.02 | Design a DFA for the following language over an alphabet Σ = { 0,1}<br>i) The string with even no of 0‟s and even no of 1‟s<br>ii) The string with odd no of 0‟s and even no of 1‟s | CO1 | Create |
| 2 | a | AITB03.03 | Construct a DFA that any given decimal number is divisible by 3. | CO1 | Apply |
| | b | AITB03.02 | Describe NFA with ε to NFA conversion with an example. | CO1 | Understand |
| 3 | a | AITB03.04 | Demonstrate Regular expression? Simplify the following Regular Expression<br>i) ε + 1*(011)*(1*(011)*)*=(1+011)*<br>ii) (0+11*0)+ (0+11*0)(10+10*1) *<br>(10+10*1)*=1*0(10+10*1) * | CO2 | Understand |
| | b | AITB03.05 | Construct the Finite Automata(NFA-ε) for given regular expression (0+1)*00(0+1)* | CO2 | Apply |
| 4 | a | AITB03.05 | IIustrate the steps for conversion of regular grammar to finite automata? Construct the FA for the following grammar<br>S→aS/bA/b<br>A→aA/bS/a | CO2 | Understand |
| | b | AITB03.06 | Construct the DFA Transition diagram for equivalent Regular expression (ab+a) *(aa+b) | CO2 | Apply |
| 5 | a | AITB03.07 | Construct leftmost and rightmost derivations for the strings, if the language is given as<br>S→AS\| ε A→aa\|ab\|ba\|bb<br>Strings:<br>a) aabbba<br>b) baabab<br>c) aaabbb | CO3 | Apply |
| | b | AITB03.08 | Construct Leftmost Derivation. , Rightmost Derivation, Derivation Tree for the following grammar with respect to the string aaabbabbba.<br>S→aB \| bA,<br>A→aS\| bAA\|a<br>B→bS \| aBB \|b | CO4 | Apply |
| 6 | a | AITB03.09 | Convert the following grammar into GNF<br>G=({A1,A2,A3},{a,b},P,A)<br>A1→A2A3<br>A2→A3A1/b<br>A3→A1A2/a | CO4 | Understand |
| | b | AITB03.10 | Simplify the context free grammar for the given CFG<br>S-> Ab \|Bb<br>A->a \|aS \|Baa<br>B-> b\|bS \|aBB | CO4 | Analyze |
| 7 | a | AITB03.11 | Construct PDA for the below grammar as shown below<br>S->aABB \|aAA<br>A->aBB \|a<br>B->bBB \| A | CO4 | Apply |

| | | | | | |
|---|---|---|---|---|---|
| | | | that accepts the language generated by given grammar | | |
| | b | AITB03.12 | Prove that the below languages are deterministic context free languages?<br>a) L1={0n1m\|n=m and n>=1}<br>b) L2 = {on1m\|n=2m and n>=1} | CO4 | Evaluate |
| 8 | a | AITB03.13 | Prove that given CFG with following productions<br>S->aBc<br>A-> abc<br>B->aAb<br>C->AB<br>C->c<br>constructs a PDA M such that the language generated by M<br>and G are equivalent. | CO5 | Evaluate |
| | b | AITB03.14 | Prove that the below languages are deterministic context free languages?<br>a) L1={0n1m\|n=m and n>=1}<br>b) L2 = {on1m\|n=2m and n>=1} | CO4 | Evaluate |
| 9 | a | AITB03.15 | Construct a Turing Machine that accepts the language<br>L = {1n2n3n \| n ≥1}. Give the transition diagram for the Turing Machine obtained and also<br>show the moves made by the Turing machine for the string 111222333. | CO5 | Apply |
| | b | AITB03.16 | Describe briefly about the following<br>a)Church's Hypothesis<br>b)Counter machine | CO5 | Understand |
| 10 | a | AITB03.17 | Construct Transition diagram for Turing Machine that accepts the language L = {0n1n \| n ≥1}. Give the transition diagram for the Turing Machine obtained and also show the moves made by the Turing machine for the string 000111. | CO5 | Apply |
| | b | AITB03.18 | Construct a Turing Machine that accepts the language<br>L = {a2nbn\| n ≥0}.Give the transition diagram for the Turing Machine obtained. | CO5 | Apply |

**Signature of the Faculty** **HOD, IT**