

AKR/19/16

2016-17

COMPUTER SCIENCE

FIRST PAPER

Full Marks : 200

Time : 3 hours

*The figures in the margin indicate full marks  
for the questions*

Answer *any ten* questions

1. (a) Design finite automata (deterministic or non-deterministic) to accept the following languages over  $\{a, b\}$  :  $4 \times 3 = 12$
- (i) Language consisting of all strings not having more than three consecutive occurrences of  $b$
  - (ii) Language consisting of all strings having 'aabb' as a substring
  - (iii) Language consisting of all strings having lengths that are multiples of 4

8T/13

( Turn Over )

(b) Give regular expressions for the following languages over  $\{a, b, c\}$  :  $2 \times 3 = 6$

(i) Language consisting of all strings containing no more than three  $a$ 's

(ii) Language consisting of all strings having exactly one  $a$

(iii) Language consisting of all strings having 'abc' as a substring

(c) State the pumping lemma for regular languages. 2

2. (a) Is the language  $L = \{a^n b^n / n \geq 0\}$  regular? Justify or prove your answer. 4

(b) Remove useless symbols and unit productions from the grammar  $G = (V, T, P, S)$  where  $V = \{S, A, B, C\}$  and  $T = \{a, b\}$  with  $P$  consisting of

$$S \rightarrow bS / A / C$$

$$A \rightarrow a$$

$$B \rightarrow aa$$

$$C \rightarrow aCb$$

Then convert the grammar to Chomsky normal form. 5

(c) Prove that the union of two context-free languages is a context-free language. Is the set of CFL's closed under intersection? Is it closed under complementation?  $9+2=11$

3. (a) Construct a pushdown automaton to accept the language

$$L = \{w c w^R / w \in (0+1)^*\}$$

10

- (b) What is the language accepted by the following PDA where  $z_0$  is the starting stack symbol and  $q_2$  is the only final state? The input alphabet is  $\Sigma = \{a, b\}$ .  $\delta$  is the transition function :

3

$$\delta(q_0, a, z_0) = (q_1, A z_0)$$

$$\delta(q_1, b, A) = (q_0, \epsilon)$$

$$\delta(q_0, \epsilon, z_0) = (q_2, z_0)$$

- (c) Let  $G$  be the grammar

$$S \rightarrow aB \mid bA$$

$$A \rightarrow a \mid aS \mid bAA$$

$$B \rightarrow b \mid bS \mid aBB$$

For the string  $aaabbbab$ , find a—

- (i) leftmost derivation;
- (ii) rightmost derivation;
- (iii) parse tree;

in  $G$ .

2+2+3=7

( 4 )

4. (a) What functions are performed in general by processor registers? Name any four registers that are used for instruction execution in a general purpose computer. Write briefly the functions of each. What is a PSW?  $2+8+2=12$

(b) A computer uses a memory unit with 256 K words of 32 bits each. A binary instruction code is stored in one word of memory. The instruction has four parts—an indirect bit, an operation code, a register code part to specify one of the 64 registers and an address part.

(i) How many bits are there in the operation code, the register code part and the address part?

(ii) Draw the instruction word format and indicate the number of bits in each part.  $3+2=5$

(c) What is the difference between a direct and an indirect address instruction? 3

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5. Explain the concept of cache memory. Draw block diagrams to explain the placement of single cache and multilevel cache. What is the property of computer programs that makes the use of cache memory profitable? Explain either the associative mapping or set-associative mapping scheme used for mapping main memory blocks to cache, showing how a memory address is divided into fields.  $5+2+2+2+9=20$

6. (a) What are the features of computer memory? With respect to speed and capacity, computer memory can be organized into a hierarchy. Draw the hierarchy.  $4+5=9$

(b) What is the basic advantage of using interrupt initiated data transfer over data transfer under program control without an interrupt? What is DMA? Explain.  $5+6=11$

7. (a) Differentiate between sequential and combinational circuits. Give examples of each.  $2\frac{1}{2}+2\frac{1}{2}=5$

(b) Implement the function

$$F(A, B, C) = \sum(1, 3, 5, 6)$$

with a multiplex.

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(c) Design a circuit that compares two 4-bit numbers,  $A$  and  $B$  to check if they are equal. The circuit has one output  $x$ , such that  $x=1$  if  $A=B$  and  $x=0$  if  $A \neq B$ .

8

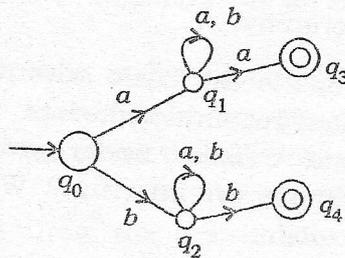
8. (a) Give an example of a language that is context sensitive but not context free.

3

(b) Design a Turing machine to accept the language consisting of all strings over  $\{a, b\}$  having lengths that are multiples of 3.

8

(c) What language is accepted by the following NFA?



Construct a DFA for the same language.

4+5=9

9. (a) What rules are followed in designing a good user interface? Explain. What are the ways of testing a user interface?

6+4=10

( 7 )

- (b) Briefly explain the design principles for function-oriented design. 10
10. (a) What are the important attributes that all software products should have? 4
- (b) Point out the importance of phased development process. What are the basic phases of software development?  
2+6=8
- (c) What is black-box testing? Describe the different approaches in designing black-box test cases. 2+6=8
11. (a) What are the important characteristics of a good SRS? How is SRS validated?  
6+4=10
- (b) What do you mean by object-oriented design and UML in the context of software engineering? 5+5=10
12. (a) What is a process? What are the different states of a process? What is a thread? Define user level and kernel level thread. 1+4+1+4=10
- (b) Define the terms critical region and mutual exclusion. 2
- (c) What is a semaphore? What is producer consumer problem? How can we solve producer consumer problem using semaphore? 2+1+5=8

13. (a) Define preemptive and non-preemptive scheduling. 2+2=4
- (b) Briefly describe the following : 7×2=14
- (i) Round robin scheduling
- (ii) First come, first serve scheduling
- (c) What is mutex? 2
14. (a) Describe briefly the major functions performed by an operating system. 12
- (b) What is a page fault? Consider the following page reference string :
- 1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7
- How many page faults would occur for the First in, First out page replacement algorithm if there are 4 frames? Consider that all frames are initially empty. Show the reference strings. 8
15. (a) What is deadlock? What are the necessary and sufficient conditions for deadlock to occur? What is the difference between deadlock and starvation? 2+4+3=9
- (b) List any four major components of any modern operating system. Differentiate between system calls and API. Briefly explain each. 6+5=11

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