COMPUTER SCIENCE & ENGINEERING

SECTION A

ONE MARKS QUESTIONS (1-35)

This question consists of 35 (Thirty Five) multiple choice questions, each carrying one mark. The answers to the multiple choice questions MUST be written only in the boxes corresponding to the questions in the first page of the answer book.

$(35 \times 1 = 35)$

1. A die is rolled three times The probability that exactly one odd number turns up among the three outcomes is
   a. $\dfrac{1}{6}$
   b. $\dfrac{3}{8}$
   c. $\dfrac{1}{8}$
   d. $\dfrac{1}{2}$

2. Consider the following set of equations
   $x+2y = 5$
   $4x+8y = 12$
   $3x+6y+3z = 15$
   This set
   a. has a unique solution
   b. has no solutions
   c. has finite number of solutions
   d. has infinite number of solutions

3. Which of the following statements applies to the bisection method used for finding roots of functions:
   a. converges within a few iterations
   b. guaranteed to work for all continuous functions
   c. is faster than the Newton–Raphson method
   d. requires that there be no error in determining the sign of the function

4. Consider the function $y = |x|$ in the interval $[-1,1]$. In this interval, the function is
   a. continuous and differentiable
   b. continuous but nor differentiable
   c. differentiable but not continuous
   d. neither continuous not differentiable

5. What is the converse of the following assertion ?
   I stay only if you go
   a. I stay if you go
   b. If I stay then you go
   c. If you do not go then I do not stay
   d. If I do not stay then you go

6. Suppose A is a finite set with n elements. The number of elements in the Largest equivalence relation of A is
   a. n
   b. n^2
   c. 1
   d. n + 1

7. Let R_1 and R_2 be two equivalence relations on a set. Consider the following assertions:
   (i) $R_1 \cup R_2$ is an equivalence relation
   (ii) $R_1 \cap R_2$ is an equivalence relation
   Which of the following is correct?
   a. both assertions are true
   b. assertion (i) is true but assertion (ii) is not true
   c. assertion (ii) is true but assertion (i) is not true
   d. neither (i) nor (ii) is true

8. The number of functions from an m element set to an n element set is
   a. m+ n
   b. m^n
   c. n^m
   d. m*n

9. If the regular set A is represented by $A = (01 + 1)^*$ and the regular set 'B' is represented by $B = ((01)^* 1^*)^*$, which of the following is true?
   a. $A \subset B$
   b. $B \subset A$
   c. A and B are incomparable
   d. A=B

10. Which of the following sets can be recognized by a Deterministic Finite-state Automaton?
    a. The numbers 1, 2, 4, 8,……. 2^n, ……. written in binary.
    b. The numbers 1,2,4,…….., 2^n, ……. written in unary.
    c. The set of binary strings in which the number of zeros is the same as the. number of ones.
    d. The set {1, 101,11011,1110111,……}

11. Regarding the power of recognition of languages, which of the following statements is false?
    a. The non-deterministic finite—state automata are equivalent to deterministic finite–state automata.
    b. Non-deterministic Push–down automata are equivalent to deterministic Push–down automata.
    c. Non-deterministic Turing machines are equivalent to deterministic Turing machines.
    d. Multi-tape Turing machines are equivalent to Single-tape Turing machines.

12. The string 1101 does not belong to the set represented by
    a. $110^* (0 + 1)$
    b. $1(0 + l)^* 101$
    c. $(10)^* (01)^* (00 + 11)^*$
    d. $(00 + (11)^* 0)^*$

13. What happens when a bit–string is XORed with itself n-times as shown :
    [B⊕(B⊕(B⊕(B……. n times)]
    a. complements when n is even
    b. complements when n is odd
    c. divides by 2 always
    d. remains unchanged when n is even

14. A multiplexor with a 4 bit data select input is a
    a. 4 : 1 multiplexor
    b. 2 : 1 multiplexor
    c. 16 : 1 multiplexor
    d. 8 : 1 multiplexor

15. The threshold level for logic 1 in the TTL family is
    a. any voltage above 2 5 V
    b. any voltage between 0.8 V and 5.0V
    c. any voltage below 5.0 V
    d. any voltage below V_{cc} but above 2.8 V

16. In serial communications employing S data bits, a parity bit and 2 stop bits, the minimum band rate required to sustain a transfer rate of 300 characters per second is
    a. 2400 band
    b. 19200 band
    c. 4800 band
    d. 1200 band

17. The octal representation of an integer is 3428. If this were to be treated as an eight bit integer in an 8085 based computer, its decimal equivalent is
    a. 226
    b. –98
    c. 76
    d. –30

18. Which of the following devices should get higher priority in assigning interrupts?
    a. Hard disk
    b. Printer
    c. Keyboard
    d. Floppy disk

19. Which of the following addressing modes permits relocation without anychan whatsoever in the code?
    a. Indirect addressing
    b. Indexed addressing
    c. Base register addressing
    d. PC relative addressing

20. Which of the following is true?
    a. Unless enabled, a CPU will not be able to process interrupts.
    b. Loop instructions cannot be interrupted till they complete.
    c. A processor checks for interrupts before executing a new instruction
    d. Only level triggered interrupts are possible on microprocessors

21. Which one of the following algorithm design techniques is used in finding all pairs of shortest distances in a graph?
    a. Dynamic programming
    b. Backtracking
    c. Greedy
    d. Divide and Conquer

22. Give the correct matching for the following pairs:
    A. O (log n)
    B. O (n)
    C. O (n log n)
    D. $O(n^2)$
    1. Selection
    2. Insertion sort
    3. Binary search
    4. Merge soft

	A	B	C	D
a.	3	1	2	4
b.	3	1	4	2
c.	1	3	4	2
d.	1	4	3	2

23. How may substrings of different lengths (non-zero) can be formed from a character string of length n ?
    a. n
    b. n^2
    c. 2^n
    d. n(n+1)/2

24. Which of the following statements is false?
    a. A tree with n nodes has (n—l) edges.
    b. A labeled rooted binary tree can be uniquely constructed given its postorder and preorder traversal results.
    c. A complete binary free with n internal nodes has (n + 1) leaves.
    d. The maximum number of nodes in a binary tree of height h is $(2^{h+1} -1)$

25. In a resident – OS computer, which of the following system software must reside in the main memory under all situations ?
    a. Assembler
    b. Linker
    c. Loader
    d. Compiler

26. Which of the following statements is true ?
    a. SLR parser is more powerful than LALR
    b. LALR parser is more powerful than Canonical LR parser
    c. Canonical LR parser is more powerful than LALR parser.
    d. The parsers SLR, Canonical LR, and LALR have the same power.

27. Type checking is normally done during
    a. lexical analysis
    b. Syntax analysis
    c. Syntax directed translation
    d. Code optimization

28. A linker reads four modules whose lengths are 200, 800, 600, and 500 words, respectively. If they are loaded in that order, what are the relocation constants?
    a. 0, 200, 500, 600
    b. 0, 200, 1000, 1600
    c. 200, 500, 600, 800
    d. 200, 700, 1300, 2100

29. Which of the following is an example of a spooled device?
    a. The terminal used to enter the input data for the C program being executed.
    b. An output device used to print the output of a number of jobs.
    c. The secondary memory device in a virtual storage system
    d. The swapping area on a disk used by the swapper.

30. When the result of a computation depends on the speed of the processes involved, there is said to be
    a. cycle stealing
    b. race condition
    c. a time lock
    d. a deadlock

31. A counting semaphore was initialized to 10. Then 6 P (wait) operations and 4 V (signal) operations were completed on this semaphore. The resulting value of the semaphore is
    a. 0
    b. 8
    c. 10
    d. 12

32. A computer has six tape drives, with n processes competing for them. Each process may need two drives. What is the maximum value of n for the system to be deadlock free ?
    a. 6
    b. 5
    c. 4
    d. 3

33. Given two union compatible relations R_1 (A,B) and R_2 (C,D), what is the result of the operation
    $R1 \bowtie_{A=C \wedge B=D} R2$?
    a. $R_1 \cup R_2$
    b. $R_1 \times R_2$
    c. $R_1 - R_2$
    d. $R_1 \cap R_2$

34. Which normal form is considered adequate for normal relational database design?
    a. 2NF
    b. 5NF
    c. 4NF
    d. 3NF

35. There are five records in a database.

Name	Age	Occupation	Category
Rama	27	CON	A
Abdul	22	ENG	A
Jeniffer	28	DOC	B
Maya	32	SER	D
Dev	24	MUS	C

There is an index file associated with this and it contain the values 1, 3, 2, 5 and 4. Which one of the fields is the index built from?
    a. Age
    b. Name
    c. Occupation
    d. Category

TWO MARKS QUESTIONS (21-60)
This question consists of 20 (Twenty) multiple choice questions, each carrying two marks. The

answers to the multiple choice questions of this section MUST be written only in the boxes corresponding to the questions, in the second page of the answer book. **(20 x 2 = 40)**

36. The rank of the matrix given below is :

1	4	8	7
0	0	3	0
4	2	3	1
3	12	24	21

   a. 3
   b. 1
   c. 2
   d. 4

37. Consider the following determinant

$$\Delta = \begin{vmatrix} 1 & a & bc \\ 1 & b & ca \\ 1 & c & ab \end{vmatrix}$$

Which of the following is a factor of Δ ?
   a. a+b
   b. a–b
   c. a+b+c
   d. abc

38. The binary relation R = {(1 1)}, (2, 1), (2, 2), (2, 3), (2, 4), (3, 1), (3, 2), (3, 3) (3,4)} on the set A(1,2,3,4} is
   a. Reflexive, symmetric and transitive
   b. Neither reflexive, nor irreflexive but transitive
   c. Reflexive, symmetric and transitive
   d. Irreflexive and anti-symmetric

39. In a room containing 28 people, there are 18 people who speak English, 15 people who speak Hindi and 22 people who speak Kannada. 9 persons speak both English and Hindi, 11 persons speak both Hindi and Kannada whereas 13 persons speak both Kannada and English How many people speak all the three languages?
   a. 9
   b. 8
   c. 7
   d. 6

40. Let L be the set of all binary strings whose last two symbols are the same The number of states in the minimum state deterministic finite-state automaton accepting L is
   a. 2
   b. 5
   c. 8
   d. 3

41. Which of the following statements is false?
   a. Every finite subset of a non-regular set is regular
   b. Every subset of a regular set is regular
   c. Every finite subset of a regular set is regular
   d. The intersection of two regular sets is regular

42. The function represented by the Karnaugh map given below is:

A \ BC	00	01	10	11
0	1	0	0	1
1	1	0	0	1

   a. A.B
   b. AB+BC+CA
   c. $\overline{B \oplus C}$
   d. A.BC

43. Which of the following operations is commutative but not associative
   a. AND
   b. OR
   c. NAND
   d. EXOR

44. Formatting of a floppy disk refers to
   a. arranging the data on the disk in contiguous fashion
   b. writing the directory
   c. erasing the system area
   d. writing identification information on all tracks and sectors.

45. The address space of 8086 CPU is
   a. one Megabyte
   b. 256 Kilobytes
   c. 1 K Megabytes
   d. 64 Kilobytes

46. A complete n–ary tree is one in which every node has O or n sons. If x is the number of internal nodes of a complete n–ary tree, the number of leaves in it is given by
   a. x(n–1)+1
   b. xn–1
   c. xn + 1
   d. x(n+l)

47. What value would the following function return for the input x = 95?

```
    function fun (x : integer) : integer;
begin
    If x > 100 then fun : = x–10
        Else fun : fun(fun(x+ 11))
end;
```

a. 89
b. 90
c. 91
d. 92

48. What is the result of the following program?

```
Program side-effect (input, output);

var x, result : integer;

function f (var x : integer) : integer;

begin

       x := x + 1;      f := x;

end;

begin

   x := 5

   result := f(x) * f(x);

   writeln (result);

end.
```

a. 5
b. 25
c. 36
d. 42

49. Let A be a two dimensional array declared as follows:

A : array [1 ... 10] [1 ... 15] of integer;

Assuming that each integer takes one memory locations the array is stored in row-major order and the first element of the array is stored at location 100, what is the address of the element A[i][j] ?

a. 15i+j+84
b. 15j+i+84
c. 10i+j+89
d. 10j+i+89

50. Faster access to non-local variables is achieved using an array of pointers to activation records, called a

a. stack
b. heap
c. display
d. activation tree

51. The overlay tree for a program is as shown below:
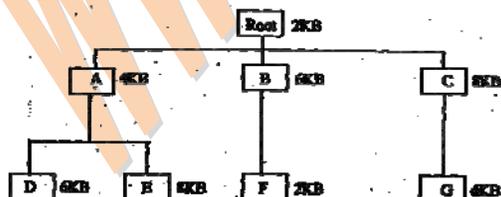
What will be the size of the partition (in physical memory) required to load (and run) this program?

a. 12 KB
b. 14 KB
c. 10 KB
d. 8 KB

52. Consider n processes sharing the CPU in a round-robin fashion. Assuming that each process switch takes s seconds, what must be the quantum size q such that the overhead resulting from process switching is minimized but, at the same time, each process is guaranteed to get its turn at the CPU at least every t seconds?

a. $q \le \dfrac{t - ns}{n - 1}$

b. $q \ge \dfrac{t - ns}{n - 1}$

c. $q \le \dfrac{t - ns}{n + 1}$

d. $q \ge \dfrac{t - ns}{n + 1}$

53. If an instruction takes i microseconds and a page fault takes an additional j microseconds, the effective instruction time if on the average a page fault occurs every k instructions is:

a. $i + \dfrac{j}{k}$

b. $i + j * k$

c. $\dfrac{i + j}{k}$

d. $(i + j) * k$

54. Which of the following query transformations (i.e., replacing the l.h.s. expression by the r.h.s. expression) is incorrect ? R_1 and R_2 are relations, C_1 C_2 are selection conditions and A_1, A_2 are attributes of R_1.

a. $\sigma_{c_1} (\sigma_{c_1} (R_1)) \to \sigma_{c_1} (\sigma_{c_2} (R_1))$

b. $\sigma_{c_1} (\pi_{A_1} (R_1)) \to \sigma_{A_1} (\sigma_{c_1} (R_1))$

c. $\sigma_{c_1} (R_1 \cup R_2) \to \sigma_{c_1} (R_1) \cup \sigma_{c_1} (R_2)$

d. $\pi_{A_2} \sigma_{c_1} (R_1)) \to \sigma_{c_1} (\pi_{A_2} (R_1))$

55. Suppose the domain set of an attribute consists pf signed four digit numbers. What is the percentage of reduction in storage space of this attribute if it is storage as an integer rather than in character form?

a. 80%
b. 20%
c. 60%
d. 40%

56. Answer the following :
   a. Two friends agree to meet at a park with the following conditions. Each will reach the park between 4.00 p.m. and 5.00 p.m. and will see if the other has already arrived. If not, they will wait for 10 minutes or the end of the hour whichever is earlier and leave. What is the probability that the two will not meet?
   b. Give a regular expression for the set of binary strings where every O is immediately followed by exactly k 1's and preceded by atleast k 1's (k is a fixed integer).

57. Design a deterministic finite state automaton (using minimum number of states) that recognizes the following language:
   $L = \{w \in \{0, 1\}^* \mid w$ interpreted as a binary number (ignoring the leading zeros) is divisible by five)
   a. The implication gate shown below, has two inputs (x and y), the output is 1 except when x = 1 and y = 0. Realize f $= \bar{x}y + x\bar{y}$ using only four implication gates.
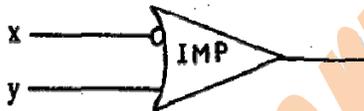
   b. Show that the implication gate is functionally complete

58. Answer the following :
   a. Solve the following recurrence relation
   $x_n = 2x_{n-1} - 1, n > 1$
   $x_1 = 2$
   b. Consider the grammar
   $S \rightarrow Aa \mid b$
   $A \rightarrow Ac \mid Sd \mid \in$
   Construct an equivalent grammar with no left recursion and with minimum number of production rules.

59. Answer the following :
   a. Suppose we have a database consisting of the following three relations. FREQUENTS (student, parlor) giving the parlors each student visits. SERVES (parlor, ice-cream) indicating what kind of ice-creams each parlor serves. LIKES (student, ice-cream) indicating what ice-creams each student likes.

(Assume that each student likes at least one ice-cream and frequents at least one parlor).

Express the following in SQL:
Print the students that frequent at least one parlor that serves some ice-cream that they like.
   b. In a computer system where the 'best-fit' algorithm is used for allocating 'jobs' to 'memory partitions', the following situation was encountered:

Partition sizes in KB	4K 8K 20K 2K						
Job sizes in KB	2K 14K 3K 6K 6K 18K 20K 2K						
Time for completion	4 10 2 1 4 1 8 6						

When will the 20K job complete?

SECTION B
FIVE MARKS Questions (60 to 79)

That are Twenty questions here numbered 60 to 79. Answer any Ten (10) questions from this set. Each question carries 5 marks. If you answer more than 10 questions, only the first ten will be evaluated.
All the parts of a question MUST be answered together. For example if Q.60a is answered first and Q.60b subsequently elsewhere in the answer book only Q.60a will be evaluated and Q.60b will be ignored.

60. Answer the following :
   a. Find the points of local maxima and minima, if any, of the following function defined in $0 \le x \le 6$.
   $x^3 - 6x + 9x + 15$
   b. Integrate $\int_{-\pi}^{\pi} x \cos x \, dx$

61. Derive the expression for the number of operations required to solve a system of linear equations in n unknowns using the Gaussian Elimination Method. Assume that one operation refers to a multiplication followed by an addition.

62. Answer the following :
   a. Prove by induction that the expression for the number of diagonals in a polygon of n sides is
   $\dfrac{n(n-3)}{2}$
   b. Let R be a binary relation on A = (a, b, c, d, e, f, g, h} represented by

following two component digraph. Find the smallest integers m and n such $m < n$ and $R^m = R^n$.
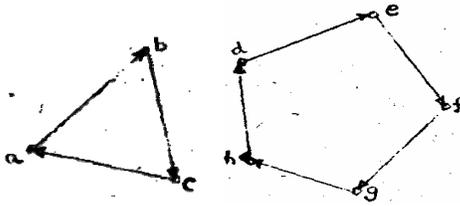
63. Suppose $A = \{a, b, c, d\}$ and $\prod_1$ is the following partition of A
$\prod_1 = \{\{a, b, c\}, \{d\}\}$
a. List the ordered pairs of the equivalence relations induced by $\prod_1$
b. Draw the graph of the above equivalence relation
c. Let $\prod_2 = \{\{a), \{b\}, \{c\}, \{d\}\}$
$\prod_3 = \{\{a, b, c, d,\}\}$
and $\prod_4 = \{\{a, b\}, \{c, d\}\}$
Draw a Poset diagram of the pose.
$\langle\{\prod_1, \prod_2, \prod_3, \prod_4\}, \text{ refines}\rangle$

64. Let $(A, *)$ be a semi-group. Furthermore, for every a and b in A , if $a \ne b$, then $a * b \ne b * a$.
a. Show that for every a in A
$a * a = a$
b. Show that for every a, b in A
$a * b * a = a$
c. Show that for every a, b, c in A
$a * b * c = a * c$

65. Let $M = (\{q_0, q_1\}, \{0,1\}, \{z_0, X\}, \delta, q_0, z_0, \phi)$ be a Pushdown automaton where δ is given by
$\delta (q_0, 1, z_0) = \{(q_0, Xz_0)\}$
$\delta (q_0, \in, z_0) = \{(q_0, \in)\}$
$\delta (q_0, 1, X) = \{(q_0, XX)\}$
$\delta (q_1, 1, X) = \{(q_1, \in)\}$
$\delta (q_0, 0, z_0) = \{(q_1, X)\}$
$\delta (q_1, 0, z_0) = \{(q_0, z_0)\}$
a. What is the language accepted by this PDA by empty store ?
b. Describe informally the working of the PDA.

66. Answer the following :
a. Let $G_1 = (N, T, P, S_1)$ be a CFG where,
$N = \{S1, A, B\}$ $T = \{a, b\}$ and
P is given by
$S_1 \rightarrow a S_1 b$ $S_1 \rightarrow a B b$
$S_1 \rightarrow a A b$ $B \rightarrow Bb$
$A \rightarrow a A$ $B \rightarrow b$
$A \rightarrow a$
What is L(G1) ?

b. Use the grammar in Part (a) to give a CFG for $L_2 = \{a^i b^j a^k b^l \mid i, j, k, l \ge 1, i = j$ or $k = 1\}$ by adding not more than 5 productions rules.
c. Is L_2 inherently ambiguous ?

67. Answer the following :
a. Draw the schematic of an 8085 based system that can be used to measure the width of a pulse. Assume that the pulse is given as a TTL compatible signal by the source which generates it.
b. Write the 8085 Assembly Language program to measure the width of the pulse. State all your assumptions clearly.

68. Design a synchronous counter to go through the following states :
1, 4, 2, 3, 1, 4, 2, 3, 1, 4………………..

69. Calculate the total time required to red 35 sectors on a 2 sided floppy disk. Assume that each track has 8 sectors and the track to track step time is 8 milliseconds. The first sector to be read is sector 3 on track 10. Assume that the diskette is soft sectored and the controller has a 1 sector buffer. The diskette spins at 300 RPM and initially, the head is on track 10.

70. For a set-associative Cache Organization, the parameters are as follows :
t_c – Cache access time
t_m – Main memory access time
ℓ – number of sets
b – block size
$k * b$ – set size
Calculate the hit ratio for a loop executed 100 times where the size of the loop is $n*b$, and $n = k*m$ is a non-zero integer and $l < m \le \ell$.
Give the value of the hit ratio for $\ell = 1$.

71. Answer the following :
a. Let p be a pointer as shown in the figure in a singly linked list.
What do the following assignment statements achieve ?
$q := p \rightarrow next$
$p \rightarrow next := q \rightarrow next$
$q \rightarrow next := (q \rightarrow next) \rightarrow next$
$(p \rightarrow next) \rightarrow next := q$
b. Compute the post fix equivalent of the following infix expression.
$3 * \log(x + 1) - a/2$

72. Draw the binary tree with node labels a, b, c, d, e, f and g for which the inorder and

postorder transversals result in the following sequences.

Inorder   a f b c d g e
Postorder   a f c g e d b

73. Answer the following :
   a. Derive a recurrence relation of the size of the smallest AVL tree with height h.
   b. What is the size of the smallest AVL tree with height 8?

74. Answer the following :
   a. An identifier in a programming language consists of upto six letters and digits of which the first character must be a letter. Derive a regular expression for the identifier.
   b. Build and LL(1) parsing table for the language defined by the LL(1) grammar with productions
   Program $\rightarrow$ begin d semi X end
   X $\rightarrow$ d semi X | sY
   Y $\rightarrow$ semi s Y | $\in$

75. Let the attribute 'val' give the value of a binary number generated by S a1 the following grammar:
   S $\rightarrow$ LL | L
   L $\rightarrow$ LB | B
   B $\rightarrow$ 0 | 1
   For example, an input 101.101 gives S.va1 = 5.625.
   Construct a syntax directed translation scheme using only synthesized attributes, to determine S.val.

76. Answer the following :
   a. Four jobs are waiting to be run. Their expected run times are 6, 3, 5 and x. In what order should they be run to minimize the average response time?
   b. Write a concurrent program using par begin – par end to represent the precedence graph shown below.
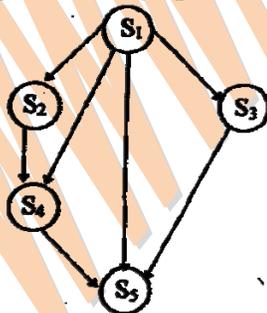
77. Answer the following :

a. Free disk space can be kept track of using a free list or a bit map. Disk addresses require D bits. For a disk with 13 blocks, F of which is free, state the condition under which the free list uses less space than the bit map.
b. Consider a disk with C cylinders, t tracks per cylinder, s sectors per track and a sector length $s\ell$. A logical file L with fixed record length $r\ell$ is stored contiguously on this disk starting at location (c_L, t_L, s_L), where c_L, t_L and s_L are the cylinder, track and sector numbers, respectively. Derive the formula to calculate the disk address (i.e. cylinder, track and sector) of logical record n assuming that $r\ell = s\ell$.

78. Consider the following database relations containing the attributes
   Book-id
   Subject - Category – of - book
   Name – of - Author
   Nationality - of - Author
   with Book-id as the primary key.
   a. What is the highest normal form satisfied by this relation?
   b. Suppose the attributes Book - title and Author - address are added to the relation, and the primary key is changed to Name - of - Author, Book - title), what will be the highest normal form satisfied by the relation?

79. Consider the following relational database schemes:
   COURSES (Cno. name) -
   PRE-REQ (Cno, pie - Cno)
   COMPLETED (student no, Cno)
   COURSES give the number and name of all the available courses.
   PRE-REQ gives the information about which courses are pre-requisites for a given course.
   COMPLETED indicates what courses have been completed by students.
   Express the following using-relational algebra:
   List all the courses for which a student with student-no 2310 has completed all the pre-requisites.