Q.2) Generate the assembly code for the following expression using RR and RX type of instructions. [CO4] (02+01+02)

X = ((A + B) – C) + D – E

Find out total number of registers required for execution.

Convert the expression into syntax tree and apply labelling algorithm to determine register requirement for execution.

Use heuristic code generation algorithm to regenerate the code from the syntax tree [assume suitable numeric values for nodes]

Solution:

For the above expression, since all operators have same preference LHS rule is applicable. The expression also includes parenthesis, thus parenthesis rule is also applicable.

1

Possible tree with above rules can be:

1

After applying labelling

algorithm

Total registers = 1

0

1

0

1

0

1

0

Three address code for above expression will be:

T1 = A + B

T2 = T1 – C

T3 = T2 + D

T4 = T3 – E

The execution sequence has dependencies with previous instructions. Possible sequence: T1, T2, T3, T4.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| INSTRUCTION | REGISTER DESC | ADDRESS DESC | ASSEMBLY CODE | Length |
| T1 = A + B | R0 contains T1 | T1 is in R0 | MOV A, R0ADD R0, B | 22 |
| T2 = T1 – C | R0 contains T2 | T2 is in R0 | SUB R0, C | 2 |
| T3 = T2 + D | R0 contains T3 | T3 is in R0 | ADD R0, D | 2 |
| T4 = T3 – E | R0 contains T4 | T4 is in R0 | SUB R0, E | 2 |
| X=T4 | R0 contains X | X is in R0 | MOV R0, X | 2 |
|  |  |  |  | 12 |

Applying heuristic algorithm for code generation using the DAG generated in above figure:

1

:

2

33

0

0

4

0

0

0

Initially all the nodes are un-listed. All the leaf nodes are not to be listed.

A node is listed if all its parents are listed.

The node listing is first considered for left child and then for right child. Initially root node is listed.

Step 1: Root node listed: 1

Step 2: Move left: list node 2

Step 3: Move left list node 3

Step 4: Move left list node 4

Reverse the order: 4, 3, 2, 1

Perform execution:

T1 = A + B

T2 = T1 + C

T3 = T2 + D

T4 = T3 + E

The execution steps are same as above table. Hence number of register required will be 1.

Q.2) Use Sethi-Ulman algorithm and apply various cases [0-4] by drawing the syntax tree for the following instruction to generate the code. [CO4] (01+04)

Z = (A + B) \* C + D / E

For the above instruction, the expression tree is constructed. This tree is called as syntax tree. The syntax tree will have all the internal nodes as operators and all the external nodes as operands.

N1

N3

N2

N4

Total number of registers required for execution, after applying labelling algorithm=2

The sethi – ulman algorithm defines various cases on the syntax tree to generate the assembly code. [Refer class notes for algorithm].

Sequence 1: n1-n2-A

Instructions: Load A, R0

 Add B, R0 🡺 R0 contains [A+B]

Sequence 2: n1-n3-n4-E

Instructions: Load E, R1

 Div D, R1 🡺 R1 contains [D/E]

Sequence 3: n1-n3-C

 Add C, R1 🡺 R1 contains [C+D/E]

Finally:

 Mul R0, R1 🡺 R0 contains final result.