



INTERNATIONAL ATOMIC ENERGY AGENCY
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COLLEGE ON MICROPROCESSORS:
TECHNOLOGY AND APPLICATIONS IN PHYSICS

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LOGIDULE EXERCISES

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These are preliminary lecture notes, intended only for distribution to participants. Missing or extra copies are available from Room 230.

LOGIDULE EXERCISES.

THE MOTOROLA MICROPROCESSOR 'SEES' ITS INPUT AND OUTPUT DEVICES AS CORRESPONDING TO LOCATIONS IN IT'S MEMORY MAP. THUS THE HARDWARE OF THE LOGIDULES TAKES THE MICROPROCESSOR BUS AND DECODES THAT ADDRESS RANGE ASSIGNED TO IT. IN THE CONFIGURATION CHOSEN FOR THESE EXERCISES THE ADDRESS RANGE OF THE LOGIDULE INTERFACE IS HEXADECIMAL BF40 THROUGH HEXADECIMAL BF7F. THE SWITCHES CORRESPOND TO A MICROPROCESSOR READ OF ADDRESS #BF40 AND THE LED DISPLAY CORRESPONDS TO A WRITE TO ADDRESS #BF40.

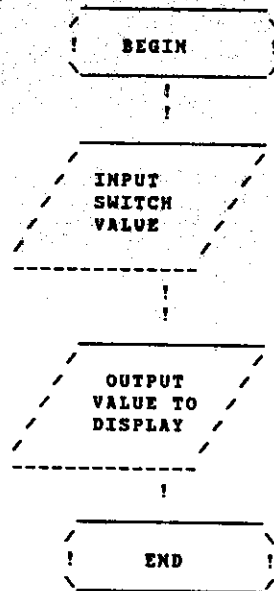
EXERCISE 1.

READ IN THE VALUE OF A SET OF SWITCHES AND OUTPUT THAT VALUE TO THE 'LED' DISPLAY.

SOLUTION:-

TO 'READ' THE VALUE OF THE SWITCHES WE LOAD THE 'A' ACCUMULATOR WITH THE CONTENTS OF ADDRESS BF40. THIS IS THE 'LDA' INSTRUCTION USING THE EXTENDED MODE OF ADDRESSING. SIMILARLY TO 'WRITE' A VALUE TO THE LED'S WE STORE THE CONTENTS OF THE 'A' ACCUMULATOR IN MEMORY LOCATION BF40. THIS IS THE 'STA' INSTRUCTION AGAIN USING THE EXTENDED MODE OF ADDRESSING.

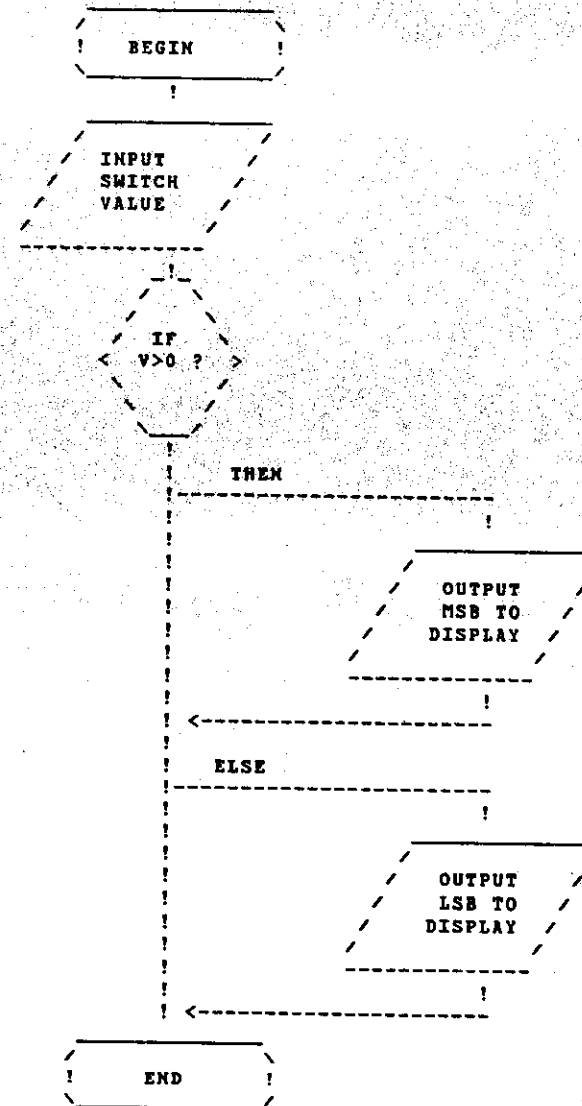
THE FLOWCHART FOR THIS EXERCISE IS THUS VERY SIMPLE AS ARE THE PSEUDO-CODE INSTRUCTIONS.



EXERCISE 2.

WRITE TO THE DISPLAY THE RESULT OF A LOGICAL 'OR' OF THE STATE OF THE SWITCHES. IF ANY SWITCH OR SWITCHES ARE 'ON' THEN DISPLAY THE MOST SIGNIFICANT (LEFTMOST) LED. IF NO SWITCH OR SWITCHES ARE IN THE 'ON' CONDITION THEN DISPLAY THE LEAST SIGNIFICANT (RIGHTMOST) LED.

SOLUTION:-
A WAY TO SOLVE THIS PROBLEM IS TO USE THE 'IF THEN ELSE' CONSTRUCT. THE FLOW CHART FOLLOWS:-

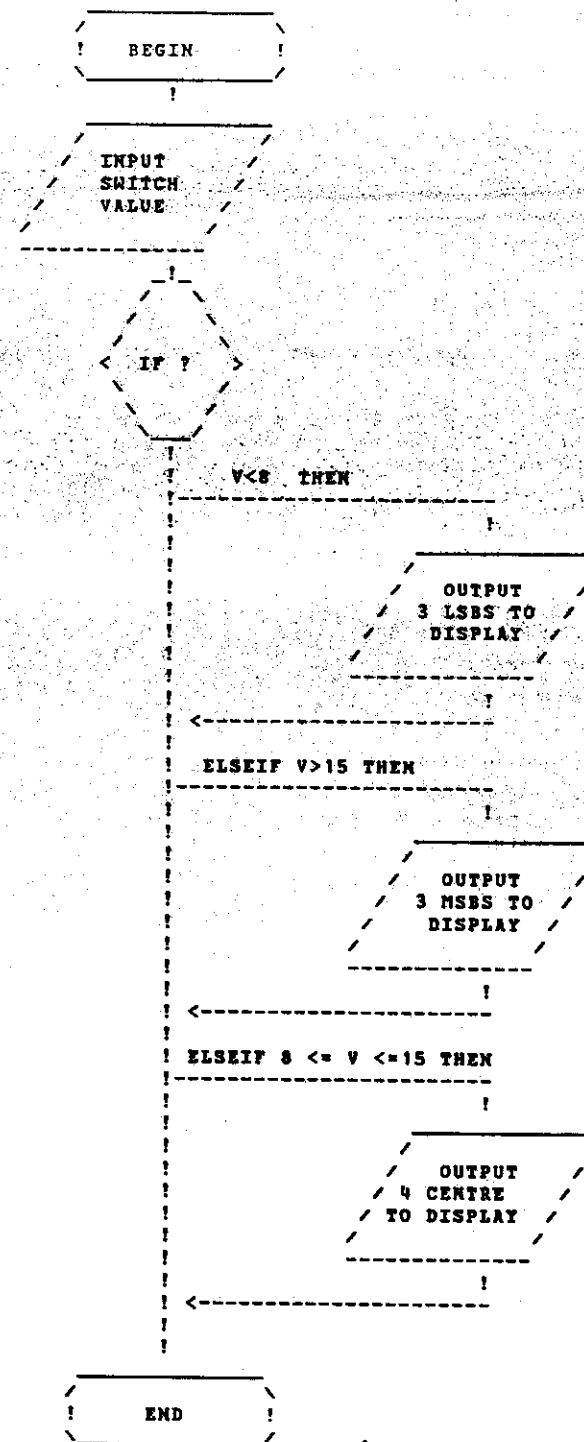


EXERCISE 3.

THE SWITCHES REPRESENT THE BINARY 'OUTPUT' FROM AN ANALOGUE TO DIGITAL CONVERTOR. ONLY THE MIDRANGE FROM #8 TO #15 IS ACCEPTABLE AND IN THIS CASE THE MIDDLE FOUR LEDS OF THE DISPLAY ARE LIT. IF THE 'OUTPUT' IS LESS THAN #8 THE LEAST SIGNIFICANT THREE BITS OF THE DISPLAY ARE LIT AND IF THE 'OUTPUT' IS GREATER THAN #15 THE THREE MOST SIGNIFICANT BITS ARE LIT.

SOLUTION:-

THIS MAY SIMPLY BE SOLVED USING THE 'IF THEN ELSE IF..' CONSTRUCT AS SHOWN IN THE FLOW CHART OVERLEAF.

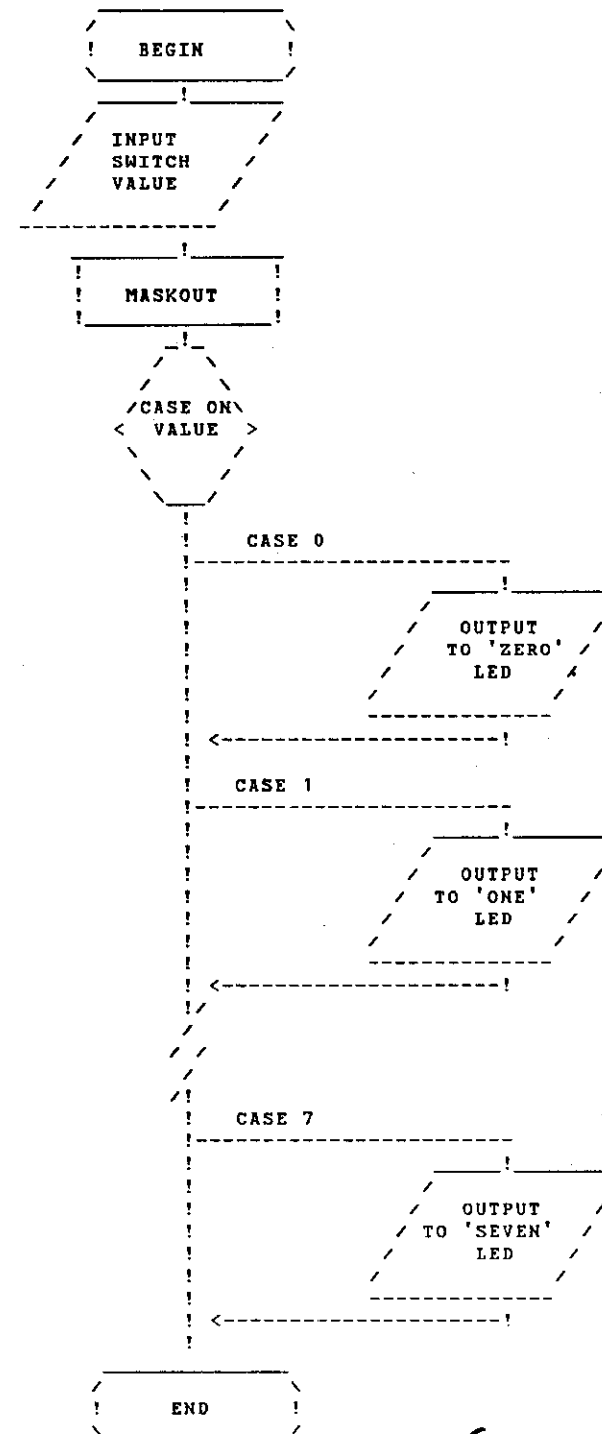


EXERCISE 4.

OCTAL TO DECIMAL CONVERSION. READ THE VALUE OF THE THREE LEAST SIGNIFICANT SWITCHES AND LIGHT THE LED THAT CORRESPONDS TO THE DECIMAL EQUIVALENT. FOR EXAMPLE IF THE SWITCHES READ '101' THEN LIGHT UP THE FIFTH LED.

SOLUTION:-

SINCE THERE IS A ONE TO ONE RELATIONSHIP BETWEEN THE VALUE INPUT AND THE DISPLAY OUTPUT THE 'IF THEN ELSE IF..' CONSTRUCT BECOMES UNNECESSARILY CUMBERSOME AND IN FACT THIS IS A CANDIDATE FOR THE 'CASE' CONSTRUCT. THE FLOWCHART LOOKS THE SAME BUT IN THE CODING THERE IS ONLY ONE CALCULATION AS OPPOSED TO THE MANY GENERATED BY THE 'IF THEN ELSE IF..' FORM.



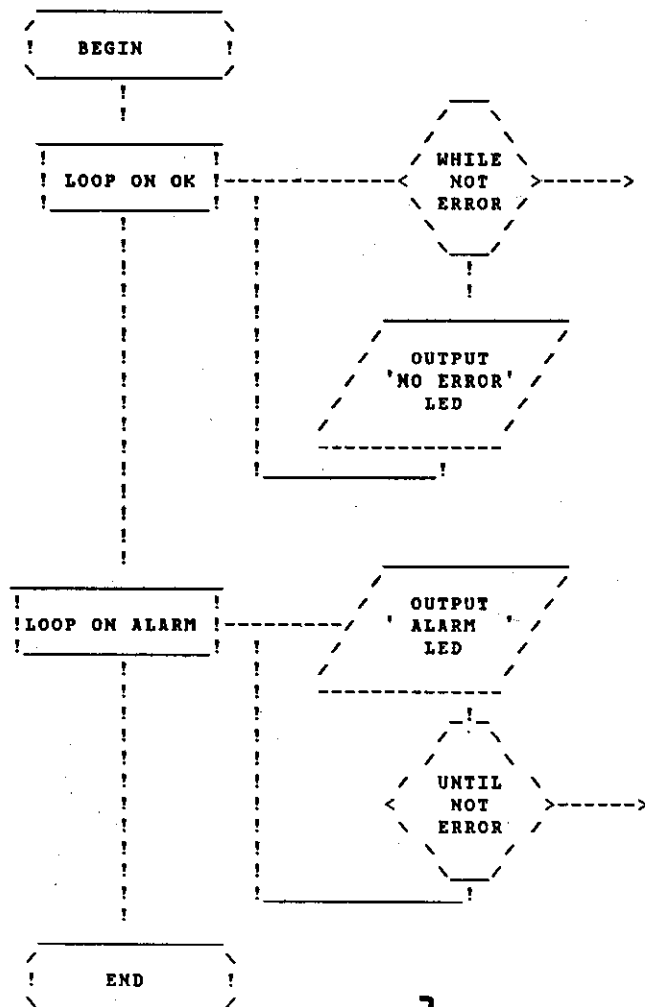
EXERCISE 5.

THE SWITCHES REPRESENT ERROR DETECTORS AT AN EXPERIMENTAL INSTALLATION. A MICROPROCESSOR SURVEYS THESE DETECTORS AND IF ALL IS WELL IT SETS THE 'NO ERROR' LAMP. IN THE CASE OF AN ERROR DETECTED THE ALARM IS SET AND REMAINS SET UNTIL THE ERROR DISAPPEARS. AT THAT POINT THE MICROPROCESSOR RETURNS CONTROL TO THE OPERATOR.

THE 'OK' SIGNAL IS THE LSB OF THE DISPLAY, THE 'ALARM' IS EVERY BIT EXCEPT THE LSB OF THE DISPLAY.

SOLUTION.

BEFORE SETTING THE 'NO ERROR' LAMP WE MUST FIRST CHECK THE ERROR DETECTORS. HENCE IN THIS LOOP IT MUST BE A 'WHILE ...DO' LOOP. HAVING DETECTED AN ERROR WE MUST FIRST SET THE ALARM BEFORE SEEING IF THE ERROR HAS DISAPPEARED. HENCE THE ALARM CONDITION MUST BE A 'LOOP..UNTIL' LOOP.

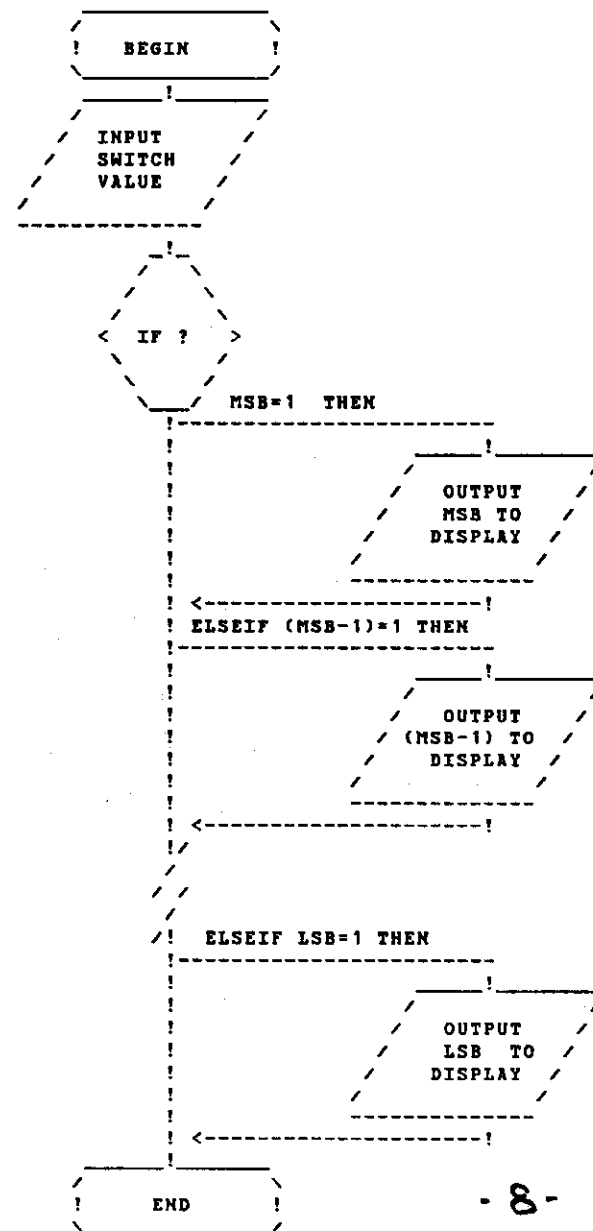


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EXERCISE 6.

TAKE THE VALUE OF THE SWITCHES AND DISPLAY ONLY THE LED THAT CORRESPONDS TO THE HIGHEST PRIORITY (LEFTMOST) SWITCH THAT IS IN THE 'ON' STATE.

SOLUTION:- WE MAY SOLVE THIS PROBLEM USING THE 'IF THEN ELSE IF..' CONSTRUCT AS SHOWN IN THE FIRST FLOWCHART. HOWEVER THE BIT TEST THAT IS DONE IS SIMILAR IN EVERY CASE AND THUS THERE ARE EIGHT VIRTUALLY IDENTICAL SEGMENTS OF CODE TO BE WRITTEN. IT WOULD BE MORE EFFICIENT TO EMBED THE TEST IN A LOOP AS SHOWN IN THE SECOND FLOW CHART WHICH ILLUSTRATES THE CONDITIONAL DO LOOP.



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