Algorithms and Programs for Engineers
Midterm exam – 90 minutes

1. (2 marks) Consider the QuickSort algorithm with the following partitioning procedure:

```
Partition (A,l,r)
    x := A[l]
    i := l−1
    j := r+1
    while TRUE
        repeat j := j−1 until A[j] ≤x
        repeat i := i+1 until A[i] ≥x
        if i<j then switch A[i]↔A[j]
        else return j
```

a) Specify a QuickSort algorithm that uses the given partitioning function.
b) Condider the array 7 14 10 9 15 4 11 8. Show the array after each call of the Partition function of the QuickSort algorithm.

2. (3 marks) For each of the following, write C++ statements that perform the specified task. Assume that unsigned integers are stored in two bytes and that the starting address of the array is at location 1002500 in memory.

a. Declare an array of type `unsigned int` called `values` with five elements, and initialize the elements to the even integers from 2 to 10. Assume that the symbolic constant `SIZE` has been defined as `5`.
b. Declare a pointer `vPtr` that points to an object of type `unsigned int`.
c. Use a `for` statement to print the elements of array `values` using array subscript notation.
d. Write two separate statements that assign the starting address of array `values` to pointer variable `vPtr`.
e. Use a `for` statement to print the elements of array `values` using pointer/offset notation.
f. Use a `for` statement to print the elements of array `values` using pointer/offset notation with the array name as the pointer.
g. Use a `for` statement to print the elements of array `values` by subscripting the pointer to the array.
h. Refer to the fifth element of `values` using array subscript notation, pointer/offset notation with the array name as the pointer, pointer subscript notation and pointer/offset notation.
i. What address is referenced by `vPtr + 3`? What value is stored at that location?
j. Assuming that `vPtr` points to `values[ 4 ]`, what address is referenced by `vPtr -= 4`? What value is stored at that location?

3. (1 mark) Perform the task specified by each of the following statements:

a) Write the function header for a function called `exchange` that takes two pointers to double-precision, floating-point numbers `x` and `y` as parameters and does not return a value.

b) Write two statements that each initialize character array `vowel` with the string of vowels, `"AEIOU"`.

4. (1 mark) Assume ip is a pointer to an int. Then, write a statement that will dynamically allocate an array of 500 integers and stores its address in ip. Write a statement that will free the memory allocated in the statement you just wrote.

5. (2 marks) Write a function that dynamically allocates an array of integers. The function should accept an integer argument indicating the number of elements to allocate. The function should return a pointer to the array.

6. (1 mark) Are each of the following definitions valid or invalid? If any are invalid, why?

a) int *iptr = &ivar;
int ivar;

b) int ivar, *iptr = &ivar;

c) float fvar;
int *iptr = &fvar;

d) int nums[50], *iptr = nums;