

Each question is worth 10 points.

1. As blood moves from the heart out to the capillaries and back to the heart, the systolic pressure continuously drops. Consider a person whose blood pressure ρ (in millimeters of mercury) is given by

$$\rho = \frac{25t^2 + 125}{t^2 + 1}, \quad 0 \leq t \leq 10$$

Where t is measured in seconds. At what rate is the blood pressure changing 5 seconds after blood leaves the heart?

2. Air is being pumped into a spherical balloon at the rate of 4.5 cubic inches per minute. Find the rate of change of the radius when the radius is 2 inches.
3. The product of two positive numbers x and y is 288. Minimize the sum of the second number and twice the first number. Namely, under the condition $xy = 288$, find the minimum of $S = 2x + y$.

4. Show that the graph of the normal probability density function

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$$

has points of inflection at $x = \pm 1$.

5. Evaluate the limits of (1) $\lim_{x \rightarrow 0} \frac{\sin 4x}{x}$ and (2) $\lim_{x \rightarrow 0} \frac{e^{3x} - 1}{x}$

6. A ball is thrown into the air upward from the top of a 160-foot cliff. The initial velocity of the ball is 48 feet per second, which implies that the position function (height) is

$$S = -16t^2 + 48t + 160$$

Where the time t is measured in seconds. Find the height, the velocity, and the acceleration of the ball when $t = 3$.

7. Find the slope of the graph of $2x^2 - y^2 = 1$ at the point $(1, 1)$.
8. Evaluate the improper integrals:

$$(1) \int_{-\infty}^0 \frac{1}{(1-2x)^{\frac{3}{2}}} dx \quad (2) \int_0^{\infty} 2xe^{-x^2} dx$$

9. Use a double integral to find the area of the region bounded by the graphs of $y = x^2$ and $y = x^3$.

10. A company makes two substitute products whose demand functions are

$$x_1 = 200(\rho_2 - \rho_1) \text{ and } x_2 = 500 + 100\rho_1 - 180\rho_2,$$

where ρ_1 and ρ_2 are the prices per unit (in dollars) and x_1 and x_2 are the numbers of units sold. The costs of producing the two products are \$0.50 and \$0.75 per unit, respectively. Find the prices that will yield a maximum profit.

I. Choice question (2% for each)

1. Which of the following is not a general programming language type ? (a) machine languages (b) low-end languages (c) assembly languages (d) high-level languages
2. Programs that directly execute high-level language programs without compiling are called (a) assemblers (b) interpreters (c) compilers (d) translators
3. Using standard library functions can be more efficient because (a) they save programming time (b) they are carefully written to perform optimally (c) they increase program portability (d) all of the above
4. Which statement about bubble sort is true ? (a) a maximum of n passes are needed to sort the array, where n is the number of elements (b) swapping values requires two assignments (c) performance is maximized among the sorting procedures (d) the algorithm is very simple compared to other sorting procedures
5. Which of the following is not a characteristic nor a feature of databases? (a) Many users can use the same database at the same time; (b) Relationships provide information connecting different entities; (c) Only one user at a time can access data from the database; (d) Access to data is facilitated by nonprocedural access

II. Briefly answer the following questions (10% for each)

1. The following recursive algorithm (in C language) adds the values in an array $A[1..n]$. Please write an recursive method for computing the minimum value in that array (Hint: you can follow the style of adding algorithm). (10%)

```
float sum(n) {  
    if ( $n \leq 1$ ) return(A[1]);  
    else return(sum( $n - 1$ ) + A[n]);  
}
```

2. For the following function mystery, calculate how many times the statement No. 5 will execute (in terms of value "n").

```
int mystery(n) { (10%)  
    1. int  $r = 0$ ;  
    2. for (int  $i = 1$ ;  $i \leq n - 1$ ;  $i++$ )  
    3.     for (int  $j = i + 1$ ;  $j \leq n$ ;  $j++$ )  
    4.         for (int  $k = 1$ ;  $k \leq j$ ;  $k++$ )  
    5.              $r = r + 1$ ;  
    6. return  $r$ ; }
```

3. A message on the network contains three pairs of addresses, namely, pairs of port numbers, IP addresses and network card addresses. Please discuss their usages, such as what is the usage of port number, how to find the IP address given the domain address, and how to find the network card address given the IP address.
4. What is the difference among database, data warehouse, and data mining.
5. C# provide multiple inheritance, but Java does not. Give several reasons about why

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