South Dakota School of Mines and Technology

**Department of Computer and Mathematical Sciences**

Math 373 HQ 1A Oct 8, 2014

# Turn in ONLY the printed sheets. Enter solutions in space provided ONLY.

There may be MORE data provided than needed to solve a problem.

No calculators, notes, books, reference materials

Each problem is worth 100%/6.

Work the easiest problems with the shortest answers first.

1. Mark the location of  in the first derivative term that would satisfy the Mean Value Theorem of Derivatives.

f(x)

x2

x1

1. For f(x) = x3 + 5x2 - 1

a) Write the first order Taylor Series approximation in terms of x and h for the above function.

b) What is the value of  that makes the first order approximation exact when x = 1 and h = 0.1?

3. a) Write the 2D USS Heat Equation in incremental form.



1. Solve it for the new temperature at any time step.
2. Show the solution if the maximum time step is to be used in the computation..

4. What is the largest time step allowed in the elementary method of solving a 1D USS HT problem if  = 0.5 cm2/sec and ∆x = 0.2 cm?

5. Multiple choice (Circle the correct answer)

i Which of the following is NOT one of the five steps to deriving a differential equation?

1. Substitute the flux equation (i.e. Fourier’s Law, Newton’s Law of Viscosity, etc.)
2. Make a sketch
3. Divide by the independent ’s and take the limit as they go to zero
4. Use the BC’s to evaluate C1 and C2
5. What is the shape of a differential element for a three-dimensional heat conduction problem in rectilinear coordinates (3D USS HT)?
6. An infinite flat sheet x thick
7. An infinitely long French-fry-shaped element with a cross section y by x
8. A small cube x by y by z
9. None of the above
10. What is the shape of a differential element for a heat conduction problem in a cylinder in which the temperature varies in both the radial and axial directions? No generation.

# A solid cylinder L long

1. A tube L long with a radius r and a wall thickness of r
2. A ring z long with a radius r and wall thickness of r
3. A thin disk z thick with a radius r
4. What shape of the differential element for a heat conduction problem involving a sphere in which the temperature varies with r?

## A solid sphere with radius r

1. A solid sphere with radius r
2. A spherical shell r thick with radius r
3. A small element θ, dφsinθ, by r at radius r.
4. What is the area through which the radial flux (r-dir) moves in a cylindrical element L long?

A. rL

B. 2rL

C. r2

D. 2rr

1. How much energy can be stored at a surface with a boundary condition?

A. 

B. infinite

C. Area\*x\*density\*Cp\*T

D. qcond

1. A fixed heat flux of 10 Joules/(sec\*cm2) is being added into the solid steel bar below at x=0.

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q

x=

x=x

a) Will the temperature at x = x be lower, same, or higher than the temperature at x = 0 if q > 0?

1. Write the equation that describes the boundary temperature’s relationship to the temperature at x = x. Use the notation in the sketch above.

**Remember to put your name on the front and back of the exam.**

**Scratch Paper:** detach and discard or take with you.