Group project 1:
MAC 2302 (Sec 0693)
Due on 9th June,2011. Please write in detail your solution in a separate paper clearly.You also need to present the problem in class on the due date.
Total Points: 30

Problem 1.

a) Verify that $V = \frac{1}{\sqrt{t}} e^{-x^2/4Kt}$ is a solution of

$$\frac{\partial^2 V}{\partial x^2} = \frac{1}{K} \frac{\partial V}{\partial t}$$

b) Transform $\frac{\partial V}{\partial t} = K \frac{\partial^2 V}{\partial x^2} - hV$ to $\frac{\partial W}{\partial t} = K \frac{\partial^2 W}{\partial x^2}$ with the transformation $V = e^{-ht} W$

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Problem 2.

Find the curve for which the angle between the tangent and radius vector at any point is twice the vectorial angle.

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Problem 3.

Find the curve such that its length between any two points PQ is proportional to the difference of the distances of Q and P from fixed point O

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Problem 4.

Find the orthogonal trajectories of the family of semi-cubical parabolas $ay^2 = x^3$, where a is a variable parameter.

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Problem 5.

Find the curve for which the projection of the ordinate on the normal is constant.

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Problem 6.

The tangent at any point P of a curve meets the axis of x in T. Find the curve for which $OP = PT$, O being the origin.

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Problem 7.

Prove that all curves satisfying the differential equation

$\frac{dy}{dx} = 1 + x(\frac{dy}{dx})^2 + x^2\frac{d^2y}{dx^2}$

cuts the axis of y at 45°

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Problem 8.

Find the two family of curves which satisfies the differential equation
$x(\frac{dy}{dx})^2 - y\frac{dy}{dx} + 1 = 0$ and also find the curve where the two families intersect.

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Problem 9. Sow that for n a positive integer,

$\Gamma(n+\frac{1}{2}) = \frac{(2n-1)(2n-3).....3.1}{2^n}\sqrt{pi}$

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Problem 10. Prove that $\int_0^\infty e^{-x^2} x^s dx = \frac{1}{2}\Gamma(\frac{s+1}{2})$.

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Problem 11. The Bessel function $J_n(x)$ can be defined by

$$J_n(x) = \frac{x^n}{\sqrt{\pi}2^n\Gamma(n+\frac{1}{2})}\int_0^\pi \cos(x\cos(\theta))\sin^{2n}\theta d\theta$$

Show that

a) $J_{n+1} = J_{n-1} - 2J_n', n \geq 1$

b) $J_n'' + \frac{1}{x}J_n' + (1 - \frac{n^2}{x^2})J_n = 0, n \geq 0.$

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Problem 12. Show that

$$\Gamma(s) = \int_0^1 [\ln(\frac{1}{y})]^{s-1} dy$$