Lecture 1

Monday, August 30, 2021 7:40 PM

Prayer

Spiritual thought: the Lord pours knowledge in these latter days.

- Acts 2:17-18: the Lord pours out his Spirit upon all flesh.... your young men shall see visions, and your old men shall dream dreams.
- D&C 76:12: by the power of the Spirit our eyes were opened and our understanding were enlightened so as to see and understand the things of God.

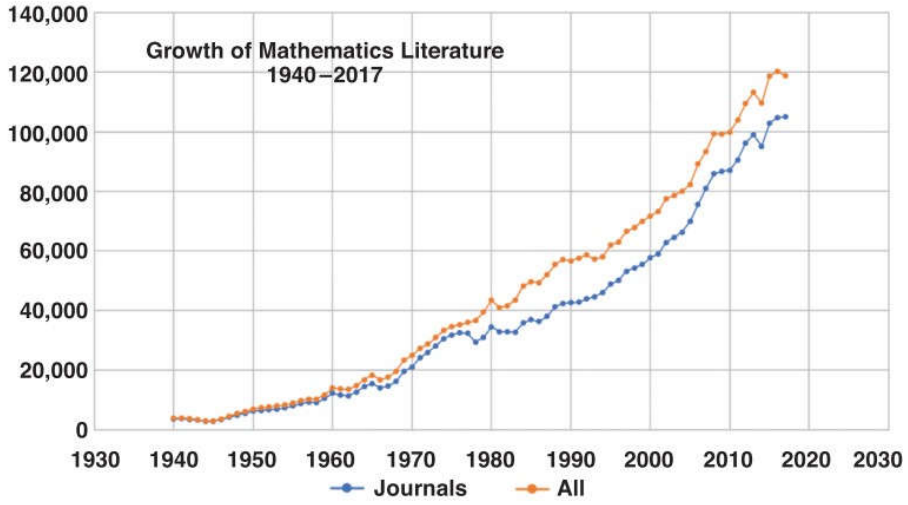


Chart taken from Edward Dunne: "Looking at the Mathematics Literature", Math Review News, 2019

In this course, we will learn elementary tools to solve differential equations (informally "DEQ").

Approximate Year	Concept/technique	Learn in Section	Author
1670s	Derivatives	Math 112	Newton, Leibniz
1670s	Power series method	5.2	Newton
1691	Separation of variables	2.2	Leibniz
1728	Integrating factor	2.1	Euler
1739	Solving higher ordered linear differential equation with constant coefficients	4.2	Euler, Bernoulli
1766	Variation of parameters	3.6, 4.4	Lagrange
1814	Laplace transform	6.1	Laplace
?	Method of undetermined constants	3.5, 4.3	?

* Classifications of DEQ:

  - Linear vs Nonlinear
  - Ordinary vs partial
  - autonomous vs nonautonomous
  - order

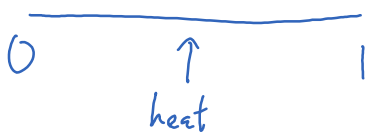
* Examples:

(1) $P(t)$ = population at time t.

Each individual has a birth rate of c. Then

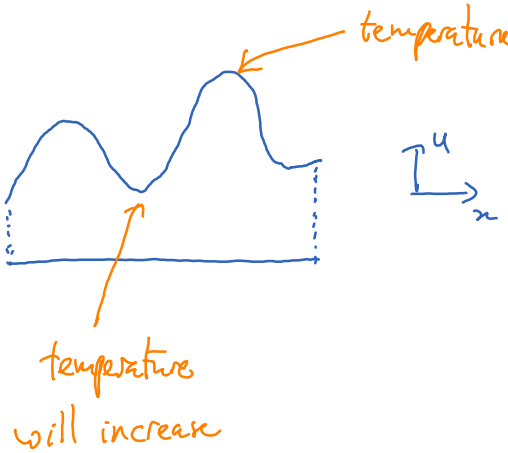
$$P'(t) = cP(t)$$

(2)



$u(x,t)$ = temperature at position x at time t.

At a fixed time t:



$$\underbrace{\frac{\partial u}{\partial t} = c\frac{\partial^2 u}{\partial x^2}}_{\text{heat equation}}$$

(3) dropping an object: the velocity tends to increase in time.

$u(t)$ = velocity at time t.

u' = acceleration at time t

= net force (Newton's second law)

= gravity + air resistance

$= \underbrace{g}_{\text{constant}} + \begin{cases} -cu & \text{(if the object is small, and } u \text{ is small)} \\ -cu^2 & \text{(otherwise)} \end{cases}$

$u' = g - cu$

$u' = g - cu^2$

} these are autonomous equations.

Consider equations of the form $\underbrace{y' = f(t, y)}_{\text{differential eq.}}$.

Initial condition: $y(0) = y_0$ (given)