Outline for Physics 2140 Exam 1

Charges
- Like charges repel, unlike charges attract
- Charge is conserved
- Conductors and insulators
- Polarization
- Grounding

Coulomb’s Law
- \( \vec{F} = \frac{kq_1q_2 \vec{r}}{r^2} \)
- \( \vec{r} \) always points from source to target
- The force due to multiple source charges: \( \vec{F} = \vec{F}_1 + \vec{F}_2 + \ldots \)
- Using vectors and component notation
- Unit vectors: \( \hat{r} = \frac{\vec{r}}{r} \Rightarrow |\hat{r}| = 1 \)
- Distinguish between source and target charges

Calculating the Electric Field
- The relationship between force and electric field: \( \vec{F} = q_1 \vec{E} \)
- Positive charges are pushed in direction of \( \vec{E} \); negative charges are pushed in the opposite direction (WWPD)
- Electric field defined at all points in space; force defined on objects
- Electric field of a point charge: \( \vec{E} = \frac{kq}{r^2} \hat{r} \)
- Electric field of multiple point charges: \( \vec{E} = \vec{E}_1 + \vec{E}_2 + \ldots \)

Electric Field Lines
- The electric field is always tangent to the field lines.
- Given the electric field lines, find the electric field at a given point, or the force on a charge.
- Identify the charge (sign and relative magnitude) of a source, given the field lines.
- Identify the net charge on a collection of charges

Continuous Charge Distributions
- Line (\( \lambda \)), surface (\( \sigma \)), and volume (\( \rho \)) charge density
- Calculate total charge from density, or vice versa
- Be able to identify the appropriate charge density (\( \lambda, \sigma, \) or \( \rho \)) for a given charge distribution

Symmetry
- when no one can tell you performed an action
- Symmetry of field is the same as the symmetry of its source
- Rotation, reflection, and translational symmetry
- Spherical and infinite-cylindrical symmetry
- Using symmetry to predict the field via contradiction

Integration to Calculate Electric Fields
- Break up distribution into little pieces
- \( \vec{E} = \int d\vec{E} \)
- Writing \( dq \) in terms of coordinates
- Finding \( \vec{R} \)
- Polar coordinates (\( r, \phi, z \))
- Limiting cases (e.g. the approximate field if the object is very large or very short)