PTAC: Applied Physics
COURSE OUTLINE & OBJECTIVES
ESC Approved – October 8, 2004

MEASUREMENT

Learning Objectives:
1. Identify/describe Standard English measurement symbols.
2. Identify/describe SI (metric) measurement symbols.
3. Describe how figures impact quality, environmental concerns and economics.
4. Apply measurement standards to practical applications.
5. Perform conversions (Fahrenheit to Celsius, BTU to calories, kg to lb).

A. Standards: SI System (metric) and English System

- **Mass**
  - Kilograms (kg)
  - Pounds (lb)
  - Ton
  - Metric ton

- **Distance**
  - Inches (in)
  - Feet (ft)
  - Yards (yd)
  - Miles (mi)
  - Millimeters (mm)
  - Centimeters (cm)
  - Meters (m)
  - Kilometers (km)

- **Time**
  - Second (s)
  - Minute (min)
  - Hour (hr)
  - Day (day)
  - Month (mo)
  - Year (yr)

- **Velocity**
  - Feet/second (ft/s)
  - Meters/second (m/s)
  - Speed of light (c)

- **Volume**
  - Cubic feet (cf)
  - Standard cubic feet (scf)

- Liters (l)
- Gallons (gal)
- Barrels (bbl)

- **Pressure**
  - Pounds per square inch (psi)
  - Pounds per square inch absolute (psia)
  - Pounds per square inch gauge (psig)
  - Bars (bar)
  - Atmospheres (atm)
  - Inches of mercury (in/Hg)
  - Inches of water (in/H_2O)
  - Millimeters of mercury (mm/Hg)
  - Kilopascal (kPa)
  - Pascal (Pa)

- **Temperature**
  - Fahrenheit (°F)
  - Celsius (°C)
  - Kelvin (K)
  - Rankine (°R)

- **Heat**
  - British Thermal Units (BTU)
  - Calories (cal) [food calories = 1000 cal = kcal]

- **Energy/Power**
  - Joules (J)
  - Watts (W)
  - Horsepower (Hp)
  - Foot-pounds/second (ft-lb/sec)

- **Flow**
  - Gallons per minute (gpm)
  - Barrels per day (bbl/day)
  - Actual cubic feet per minute (acfm)
  - Standard cubic feet per minute (scfm)
  - Pounds per minute (lbs/min)
  - Pounds per hour (lbs/hr)

- **Analytical**
  - pH
  - Parts per million (ppm)
  - Parts per billion (ppb)
  - Weight percent (wt%)
  - Volume percent (vol%)

B. Measurements and Significant Figures

- Scientific notation
- Significant figures
- Accuracy
- Repeatability (precision)
- Collecting, measuring, interpreting results
- Digital readouts
- Lab analyses
- Abnormal results/validity
- Normal measurements
- Error

FORCE and ACCELERATION

Learning Objectives:

1. Define terms associated with force, acceleration, kinematics, and rotational movement.
2. Explain principles of force, acceleration, kinematics, and rotational movement.
3. Identify safety, health and environmental associated with force, acceleration, kinematics, and rotational movement.
4. Apply force, acceleration, and rotational movement to practical applications.
5. Apply kinematics and vector algebra to practical applications.

A. Dynamics

- Newton's Laws
- Compression/decompression
- Vectors
- Principles of kinematics
  - Force (weight force, tension force)
  - Motion (graphs and equations)
  - Energy
  - Inertia
  - Gravity
  - Friction

B. Centrifugal Force and Center of Mass

- Applications:
  - Centrifugal pumps
  - Centrifugal compressors
  - Cyclones
  - Centrifuges
  - Compressors
  - Scaffolding, forklifts, cranes
  - Balancing, rating equipment

- Conservation of angular momentum
- Application of centrifugal force, torque
- Angular kinetic energy and angular momentum
- Center of gravity and moment of inertia
- Creating pressure from rotation
- Critical speed

C. Simple Machines

- Incline plane
- Pulley
- Hydraulic screw
- Fulcrum
- Lever
- Wheel and axel
- Wedge

WORK, ENERGY and MOMENTUM

Learning Objectives:

1. Define terms associated with work, energy and momentum.
2. Explain principles of work, energy and momentum.
3. Identify safety, health and environmental associated with work, energy and momentum.
4. Apply work, energy and momentum to practical applications.
5. Perform energy and mass calculations.

A. Work, Power, and Energy Conservation

- Kinetic energy
- Potential energy
- Conservation of energy
- Power
  - Horsepower
  - Electrical power
- Springs (spring constant and work done by spring force)

B. Impulse and Linear Momentum

- Impulse and momentum
- Conservation of momentum

FLUID MECHANICS

Learning Objectives:

1. Define terms associated with fluids and fluid mechanics.
2. Define matter and state of matter.
3. Explain principles of fluids and fluid mechanics.
4. Identify safety, health and environmental associated with fluids and fluid mechanics.
5. Apply fluids and fluid mechanics to practical applications.
6. Perform calculations associated with fluids and fluid mechanics.

A. Types of Matter

- Solids, liquids and gases and their properties.
- Fluids = gas and liquid

B. Properties of Fluids

- Viscosity
- Density (mass and weight)
- Specific gravity
- Surface tension

C. Principles of Fluids

- Pressure applied equally outward (Pascal)
- Newton's laws
- Gas laws
- Fluid density, fluid pressure gradients and hydrostatics.
- Hydraulics, buoyancy, manometers, segregated fluid column
- Hydraulics (Bernoulli)
- Buoyancy (Archimedes)
- Pressure
  - Absolute
  - Gauge
  - Vapor
  - Head
  - Elevation head
  - Velocity head
  - partial
- Flows
  - laminar flow
  - turbulent flow
  - critical flow (*chokes/orifices and mixing equipment)*
- Eductor/velocity/pressure changes (Bernoulli)
- Delta P orifice (Bernoulli)
- Energy loss due to friction and heat
- Reynold's Number

- Mixing fluids/energy required
- Immiscible/miscible fluids
- Fluid flow/hammer effects
- Pulsation dampeners (exerting maximum force for short periods of time—in pulses)
- Conservation of fluid flow
- Applications:
  - tank equalization
  - impeller balance versus vibration

THERMODYNAMICS

Learning Objectives:

1. Define terms associated with thermodynamics.
2. Explain principles of thermodynamics.
3. Identify safety, health and environmental associated with thermodynamics.
4. Apply thermodynamics to practical applications.
5. Perform calculations associated with thermodynamics.

A. Temperature and Heat

- Difference between temperature and heat
- Sensible heat, latent heat, superheat, specific heat, BTU, calories
- Calorimetry
- Boiling and condensation
- Melting and freezing
- Delta T
- Measurement scales (F, C, R, K)
- Boiling/freezing points
- Vaporization
- Vapor pressure
- Rules of heat transfer (surface area, temperature differences, heat transfer coefficient)
- Conservation of energy
- Heat sources (friction, reaction, electricity, steam, fuel)
- Pressure/temperature/volume relationships (ideal gas law/critical pressure and temperature)
- Partial pressures
- Reactions
  - Exothermic
  - Endothermic

B. Thermal Expansion and Transfer of Thermal Energy

- First Law of Thermodynamics
  - Material balance (mass/heat balance)
- Second Law of Thermodynamics (entropy)
  - Heat/energy balance
- Conduction/convection/radiation
- Cocurrent/countercurrent flows
- Thermal expansion coefficient
- Applications:
  - Heat engines (Carnot efficiency)
  - Refrigeration
  - Heat transfer equipment
  - Heat tracing/insulation
  - Bimetallic measuring devices
  - Equipment fouling/insulating properties
  - Fixed vs. floating head exchangers

SOUND and ELECTROMAGNETIC RADIATION

Learning Objectives:

1. Define terms associated with sound and electromagnetic radiation.
2. Explain principles of sound and electromagnetic radiation.
3. Identify safety, health and environmental associated with sound and electromagnetic radiation.
4. Apply sound and electromagnetic radiation to practical applications.
5. Perform measurements associated with sound and light intensity.

A. Simple Harmonic Motion

- Set up harmonic distortion in equipment (vibration at critical speed)

B. Wave Characteristics

- Wave length
- Frequency
- Amplitude

C. Intensity, Sources and Propagation of Sound

- Decibels/OSHA
- Sonic instruments
- Corrosion/erosion tests

D. Intensity, Sources and Propagation of Light

- Refraction
- Lighting/OSHA
- Sources
- Electromagnetic spectrum
  - Radio/TV
  - IR
  - Visible light
  - Ultraviolet (simulate reaction)
  - X-Rays
  - Gamma rays
  - Nuclear radiation
    - Alpha particles
    - Beta particles

E. Sound and Light Units

- Hertz (hz)
- Watts per meter squared (watts/m^2)
- Decibels (db)
- Lumens

ELECTRICITY and MAGNETISM

Learning Objectives:

1. Define terms and equipment associated with electricity and magnetism.
2. Explain principles of electricity and magnetism.
3. Identify safety, health and environmental associated with electricity and magnetism.
4. Apply electricity and magnetism to practical applications.
5. Perform measurements using electrical equipment.
6. Perform basic calculations associated with electricity and magnetism.

A. Types of Electricity

- Static
- Direct Current (DC)
- Alternating Current (AC)
- Single phase, 2-phase, 3-phase
- Cycles
- Polarity

B. Measurements of Electricity and Magnetism

- Ohm's Law (E=IR)
- Voltage (E)
- Current (I)
- Resistance (R)
- Farads
- Henrys
- Teslas
- Wattage/power (watt)
- Conductivity (siemens)

C. Electricity and Magnetism

- Electric fields (volt per meter)
- Magnetic fields (amp per meter)
- Speed of light ©

D. Applications

- Motors
- Electric Heaters
  - switchgear
- MCC
- Generators
- Circuit breakers
  - Oil
  - air
  - fuses
  - ground fault circuit interrupters
- Transformers
- Motor loops
- Busses
- Diodes
- Start/stop switches
- LEDs
- Electrical sources and distribution systems
  - Power grid
  - Transformers
  - Switchgear
  - Rheostats
  - UPS (uninterruptible power supply)
  - Inverter
  - Interruptible power
  - Batteries