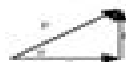


POE Final Exam Study Guide

Simple Machines - IMA: Ideal Mechanical Advantage = Distance effort moves / distance load moves - AMA: Actual Mechanical Advantage = Load / Effort - Efficiency = AMA / IMA x 100% Nothing in the real world is more than 100% efficient. - Classification of Levers: Class 1, fulcrum is in the middle, class 2 load is in the middle, class 3 effort is in the middle - IMA of a lever: Length of effort arm/ length of load arm - IMA of a wheel and axle: radius of effort arm/ radius of load arm - IMA of a screw: circumference / pitch of screw (inches per thread) = $\pi d/P$ - IMA of an inclined plane: Length of sloped side of the ramp/ height of ramp - IMA of a wedge: Length of sloped side of the wedge/ width of the wedge - IMA of a pulley: Number of strands supporting the load. - Compound Machines: $MA_{total} = MA_A \times MA_B$	Energy: Energy source classifications: Nonrenewable: can be used up; oil, coal, uranium. Renewable: more can be made; bio fuels, plants, animals Unrenewable: we don't do anything to make more; solar, wind, hydro-electric. (many books combine unrenewable and renewable) Work: Force times the distance. Power: Work per unit time or Work/Time Hydrogen Fuel: - Hydrogen fuel cells combine hydrogen and oxygen to create electricity. - They create no pollution, only water. - It is an emerging technology with many issues such as storage and distribution.
Gears, sprockets and drive pulleys These machines transform rotational energy by changing position, rotational directions, speed and torque. ω is rotational speed (rpm) τ is torque (in lbs. or Nm) - Gear Ratio: (GR) = Number of teeth_{load} / number of teeth_{driver} = N_L/N_D - GR = $N_D/N_L = D_D/D_L = \omega_D / \omega_L = v_D / v_L$ - Sprockets use chains: noisier, more expensive, stronger, need lubrication - Drive pulleys use belts: quieter, cheaper, weaker, no lubrication	Electricity: Voltage: (abv. V or E) – units are volts(V): Electric motor force: pressure or force of electricity Current: (abv. I) – units are amps (A): flow of electrons Resistance: (abv. R) – units are Ohms (Ω): resistance to current flow Ohms law: $V = I \times R$ Power: $P = V \times I$ Series Resistors: One path for current – $R_{total} = R_1 + R_2$ Parallel Resistors: Multiple paths for current – $1/R_{total} = 1/R_1 + 1/R_2$ or $R_{total} = R_1 \times R_2 / (R_1 + R_2)$ (22%)
Thermodynamics Matter is made up of molecules in motion (kinetic energy) An increase in temperature increases motion Absolute Zero occurs when all kinetic energy is removed from a object 0 K = -273° C 1st law of thermodynamics: Energy cannot be created or destroyed. 2nd law of thermodynamics: thermal energy moves from hot to cold – Entropy (measure of disorder of energy) always increases. 1st law of thermodynamics: Energy cannot be created or destroyed. Thermal energy can be transferred: convection (moving fluids), conduction (touching objects) or radiation (electromagnetic waves through space or air). Rate of transfer: $P = A \times \Delta T / R$ value = $k \times A \times \Delta T / L$, where the R-value is the thermal resistance, T is temperature, A is area, L is length and k is thermal conductivity. Heat Energy transfer: $Q = m \times C_p \times \Delta T$ where C_p is the specific heat capacity of a material and m is the mass of the object Multiple Layers of Insulation: Add the R-values of multiple layers to get the total R-value.	Design Process Define a Problem: Identify a problem that exists. Determine the root cause. Gather information. Brainstorm: Present ideas in group. Generate and record ideas. Seek quantity not quality. Keep the most ideas through equally rapid sessions. Research and Generate Ideas: Analyze the reasons for the need, want, or problem. Investigate who or what it is that is affected, and consider the need, want, or problem from their perspective. Research any existing solutions, and identify why they are not adequate or appropriate. Listen to clients to solve problems that they have discovered. Perform market research to determine if a want or need exists and determine the development of a design solution. Identify Criteria and Specify Constraints: Identify the end user if the client is not. Refine the problems to the agreement of both client and engineer. Identify what the solution must do, and the degree to which it will be pursued. Identify the limitations within which the engineer must perform his/her duties. Compile the information into a design brief. Explore Possibilities: Initiate further development of brainstorming ideas with constraints and tradeoffs considered. Explore alternative ideas based on further knowledge and technology. Develop a Design Proposal: Develop detailed and annotated sketches. Determine the type(s) of material from which the solution will be constructed. Make computer models. Create technical drawings from the computer model(s). Make a Model or Prototype: Make study models (scaled models or mock-ups). Fabricate a functional prototype. Test and Evaluate the Design using Specifications: Test the prototype under controlled conditions. Test the prototype under actual conditions. Record the results. Evaluate results to determine if problems exist and further work is needed. Refine the Design: Reassess the validity of the design criteria and make adjustments to the design brief, if necessary. Work through the design process until the solution satisfies the design criteria. Update the documentation of the final solution. Create or Make Solutions: Determine Custom/Mass Production. Consider packaging. Communicate Processes and Results: Present oral presentations with visual aids (computer generated slide shows, models, prototypes). Develop written reports with appropriate graphic documentation (charts, graphs, technical drawings, renderings, etc.). Market the Product. Distribute.
Statics Newton's First Law of Motion (law of inertia): An object in a state of rest or uniform motion will continue to be so unless acted upon by another force. Newton's Second Law of Motion: The acceleration of an object is proportional to the net force acting on the object and inversely proportional to the object's mass. ($F=MA$) Newton's Third Law of Motion: For every action force, there is an equal and opposite reaction force. Static Equilibrium: A condition where there are no net external forces acting upon a particle or rigid body and the body remains at rest or continues at a constant velocity. Σ Moments = 0, Σ Forces in x direction = 0, and Σ Forces in y direction = 0 Moment: the rotational forces acting on an object = Force * perpendicular distance. Centroid: is the center of mass of an object and can be calculated from its dimensions. - Square: $\bar{x} = \frac{1}{3} \text{ base} / 2$, $\bar{y} = \frac{2}{3} \text{ height} / 2$ - Square: $\bar{x} = \frac{1}{3} \text{ base} / 3$, $\bar{y} = \frac{2}{3} \text{ height} / 3$ - Square: $\bar{x} = \text{radius}$, $\bar{y} = (4 \times \text{radius}) / (3 \times \pi)$ Centroid of compound shapes: $\bar{x} = \Sigma (x_i \times A_i) / \Sigma A_i$, where x_i is the centroid of each shape and A_i is the area of each shape. Moment of Inertia: describes the stiffness of a beam due to its cross section $I = bh^3/12$ for a rectangular cross section with height of h and width of b Max Deflection: describes how much it can bend = $FL^3 / (48 EI)$ where F is the applied force, L is length, I is moment of inertia and E is the modulus of elasticity, a property of the material. Free Body Diagrams: illustrate forces acting upon a given body including applied and reaction and are a necessary step in solving for static equilibrium. Normal Force: a reaction force that is perpendicular to the surface the object touches. Vector Quantities: have both magnitude and direction and trigonometry can be used to break them down into x and y components. $F_x = F \times \cos(\theta)$ and $F_y = F \times \sin(\theta)$ and $\theta = \tan^{-1}(F_y/F_x)$ Solving for Static Equilibrium: - Assume the body is rigid. - Choose a rotational point (with most unknowns go through it) and solve for $\Sigma M = 0$ - Then solve for $\Sigma F_x = 0$, and $\Sigma F_y = 0$	Materials Materials: are the substances with which all objects are made, each with its own physical and chemical properties. Elements: one type of atom – cannot be broken down Compounds: multiple elements chemically bonded. Mixtures: multiple elements or compounds not chemically bonded. Material Classification: metallic, ceramic, organic, polymeric, and composite. Manufacturing Processes: such as machining, casting, molding, and joining convert raw materials into consumer goods. Recycling: an important consideration when choosing materials. Material selection: is based upon mechanical, thermal, electromagnetic, and chemical properties as well as cost.



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Yi-Tong Ma



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