Teaching Civil Engineering Through Robotics by ASCE

Topics from the NCEES CIVIL PE TEST	Topics taught in Robotics
CONSTRUCTION	
cut and fill	Balancing materials and budgets. Woodworking- using every piece of material.
estimating quantities and cost	Estimate materials need and cost- must stay within their funds that they raised
scheduling	Time frame to prepare is limited, students must schedule and prioritize for every upcoming competition
material quality control and production	There is always one QA officer per team, if the robot does not pass inspection; the entire team does not compete
temporary structures	Temporary supports while building the robot - drive train held in place with brackets when switching out wheels etc.
GEOTECHNICAL	
subsurface exploration and sampling	Guessing the Game prior to kickoff. Lots of options with very little data.
Engineering Properties of Soils and Materials (soil, density, sat soil, shear strength)	Material Properties including InstaMorph
Soil Mechanics Analysis	pressure distribution and effective and total stresses
Earth Structures (Slope stability)	Slope stability of what their robot can drive up
Shallow Foundations (bearing capacity)	Weight of robot is limited to the weight it can hold WITHOUT compressing the field = bearing capacity with factor of safety
Earth Retaining Structures (Stability Analysis)	Stability of robot in motion when the arm or lift is in the highest position, if the robot tips, the robot can't finish the competition

Teaching Civil Engineering Through Robotics by ASCE

STRUCTURAL	
Loading (dead Live Construction)	Dead Load, Live Loads, IMPACT Loads
Analysis	Stability analysis, over turning moment, center of gravity calculations
mechanics of Materials (shear, moment, tension, compression, deflection)	Shear, Moment, Tension, Compression, and Deflection. Deflection is a major impact in maneuverability and lift design
materials (concrete structural steel including light gage)	light gage steel and aluminum used in design
member design (beam, slabs, footings columns)	beam, column, and base design
TRANSPORTATION	
geometric design (horizontal and vertical curves, vertical and horizontal clearances, acceleration and deceleration)	vertical and horizontal clearances, acceleration and deceleration
WATER RESOURCES AND ENVIRONMENTAL	
hydraulics -closed conduit (energy, Bernoulli's, pressure conduit, friction and losses, pump analysis)	Bernoulli's equation, friction losses
hydraulics- open channel (open channel flow, energy dissipation, flood plains, storm water collection	energy dissipation of field objects and other robots
hydrology (storm characterization and frequency, erosion)	This year theme is NATURE'S FURY
wastewater treatment (collection system, lift stations, sewer networks)	distribution system to manage field pieces- i.e. scoop and handle all of the Frisbees you can only release one at a time
water treatment (hydraulic loading, distribution system)	distribution system to manage field pieces- i.e. scoop and handle all of the Frisbees you can at once but can only release one at a time

Teaching Civil Engineering Through Robotics by ASCE

OTHER ENGINEERING TOPICS	
Drafting	Free CAD software starting at Jr FLL (age 6-9) through the high school level
City Planning	Planning Strategy on how best to maneuver the field
Structures – stability, overturning, live loads, dynamic loads	Basis of designing the frame body of the robot
Structures/ transportation- Cantilever Sign design	Robot- Cantilever Arm Design
Budgets	Budgets- How to solve the goals based on your limited budget
Presentations	Presentations to Judges, Community, Engineers and Students
Research	Research
Problem Solving	Problem Solving
Teamwork	Teamwork
Prioritizing Assignments	In addition to robot design, the teams prioritize their time and budget spent on community service, engineering notebook, cadd designs, mid season video and end of season video
Prioritizing Design Options	Prioritizing which elements their team can afford to build while maximizing the points the team can earn during competition
Job Site Safety	Students are required to wear safety eyeglasses in the pit area of ALL competitions and appropriate safety gear during robot construction
Scientific Process	Scientific Process
logic sequencing	Programming
time management	limited time frame for competition - must juggle school and family obligations and priorities
Stability	Robot must not tip over
Over turning moment	M=FD, if your robot turns over, your effectiveness is over
Dead load	DL= Self weight
Live Load	weight of objects robots is holding or moving
blast, wind, and seismic loads	dynamic load vs. static load (robots collide)
serviceability of structures	longevity of robot
deflection criteria	deflection hampers movement