ENGINEERINTRAININGEXAM.COM | JUSTIN DICKMEYER, PE

A complete Study Guide
to Setting Yourself up
for Success on the
Engineer In Training Exam

THE EIT ACADEMY BOOT CAMP

EIT ACADEMY | BOOT CAMP

A complete Study Guide to Setting Yourself up for Success on the Engineer In Training Exam

BY JUSTIN DICKMEYER, PE OF

ENGINEERINTRAININGEXAM.COM

The information contained in the “EIT ACADEMY BOOT CAMP” and the ”EIT ACADEMY MATHEMATICS” course, is meant to serve as a comprehensive collection of subjects and problems that the author of this study guide has applied to substantially increase success on the Engineer in Training Exam. Summaries, strategies, tips and tricks are only recommendations by the author, and completing this study guide does not guarantee that one’s results will exactly mirror our own results. The author of this exam has made all reasonable efforts to provide current and accurate information for the readers of this study guide. The author will not be held liable for any unintentional errors or omissions that may be found.

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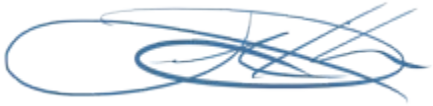
A Note from Me to You:

You probably made your way to this eBook via my website, EngineerInTrainingExam.com, or maybe it was passed on by a friend. Whichever is the case, I want to begin by thanking you for taking the time to absorb the information within.

I put together this guide simply to help you focus in on taking and dominating the Engineer in Training Exam, to attempt to give you an option to the ordinary routine of 'most people'. It wasn't too long ago that I myself began the journey of becoming a Registered Professional Engineer. **I was motivated from the start and had the desire to succeed, but found myself locked behind a mind overwhelmed with the massive task of studying for the Engineer in Training exam.** Looking for simple guidance in preparing for the exam, I turned to the internet, only to find myself failing to uncover any source of real value dedicated to preparing for the EIT exam. With no time to spare, I delved forward on my journey creating my own path to success.

This eBook is a guide, and the purpose of it is simply to do just that, guide you. It is not a system, and definitively is not the only resource needed to take and pass the Engineer in Training exam. However, it will walk you through a beginning, middle, and end game to setting up and dominating your EIT exam journey. If I am able to help just one person dominate the Engineer in Training Exam, then I feel the time I have spent to put together this eBook will be well worth it.

To all my subscribers, followers, and friends, thank you for the gift of your support and time. If you are not a subscriber, I hope that this free guide will pay forward the opportunity for EngineerInTrainingExam.com to be your all in one EIT exam preparation resource. If at anytime during this eBook you need to contact me, don't hesitate to shoot me a personal email at Justin@EngineerInTrainingExam.com. So for now, take care of yourself and your loved ones. Good Luck!



Justin Dickmeyer, PE

Table of Contents

PREPARING FOR THE ENGINEER IN TRAINING EXAM

SETTING YOURSELF UP FOR SUCCESS

SCHEDULING FOR SUCCESS

DEVELOPING SELF DISCIPLINE

EIT ACADEMY | **BOOT CAMP**

DEFINING THE ENGINEER IN TRAINING EXAM

The Engineer in Training (EIT) exam, formally known as the Fundamentals of Engineering (FE) exam, is the first step in acquiring your Professional Engineer (PE) License.

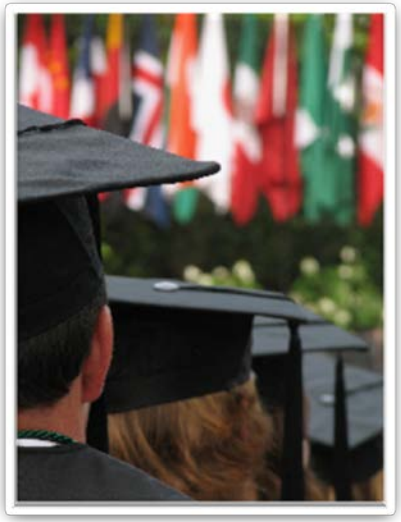
The road to acquiring the Professional Engineer license can be broken down to three step process, each step with its unique requirements and characteristics; the steps are as follows:

1. **Take and pass the Engineer in Training exam**
2. **Gain the required experience as an Engineer in Training (EIT) while working under a Registered Professional Engineer**
3. **Take and pass the Professional Engineering exam**

When you become a Professional Engineer, you become part of an elite group of Engineers that are given an array of exclusive benefits. Such benefits include running your own Engineering Firm, stamping and sealing drawings, and a wider range of available job positions with greater personal compensation. For the sake of keeping our focus, let's return to covering step 1 of the PE process, the Engineer in Training exam.

The EIT exam is developed by the National Council of Examiners for Engineering and Surveying (NCEES) and is taken over an 8 hour period in one day. The exam is broken up in to two independent testing sessions, morning and afternoon, each 4 hours in length. The exam as a whole is comprised of 180 multiple choice questions and is currently taken on paper, but soon NCEES is aiming to move the exam to a computer format in all States.

The exam is administered by the NCEES semiannually (typically April and October) and at specific locations throughout every state. The specific date of the tests are not universal but are defined by each State's Board of Engineers. The cost also varies, but can range anywhere from free to a few hundred dollars. A page dedicated to the State by State Requirements can be referenced further for your specific State's information.



EDUCATIONAL REQUIREMENTS

The Education requirements set forth to sit for the Engineer in Training exam vary widely from state to state. For the majority, if you are attending or have graduated from an EAC/ABET accredited engineering program, you will be good to go to sit for the exam. However, it is not uncommon that states accept degrees from other accredited programs such as TAC/ABET and ASAC/ABET; again it is dependent on the specific state. Some states even allow individuals who have graduated from Non EAC/ABET, Non TAC/ABET and Non ASAC/ABET to sit for the exam. These states may require some further educational requirements during step 2 of the PE process.

I probably just completely confused you, and that was not my intent, but my point is, educational requirements vary, so don't let anyone tell you that you must have this degree or that degree, make sure to check for yourself. The State by State Requirements page at EngineerInTrainingExam.com can shed some nice light on your specific State's guidelines.

If you were raised outside the United States and received your degree from a foreign country, there is no need to worry, you still have a chance to take the Engineer in Training exam. Most states nowadays accept equivalent foreign education by determining eligibility through services such as the Center for Professional Engineer Education Services (CPEES) and American Association of Collegiate Registrars and Admissions Officers (AACRA). If you fall in to this category, make sure to contact your State Board immediately prior to setting forth on your journey to get accurate details on their requirements. This is important because they will determine when, how, and what steps are required to obtain the opportunity to sit for the EIT Exam.

So that's the test in a nut shell. Now that you are well primed with what the test is all about, it's time to consider committing yourself and applying. The registration process for the EIT exam is fairly straight forward, but there is a sequence and deadlines that must be considered, and unfortunately it can't be done all in one place. The steps to take are:

1. ***Register for the examination with NCEES***
2. ***Register for the examination through your***

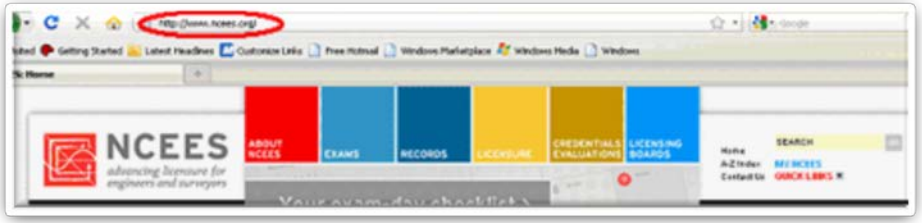
APPLYING FOR THE ENGINEER IN TRAINING EXAM

The first step in applying for the Engineer in Training Exam starts with registering on the NCEES website. This requirement just recently became a standard in Fall of 2010, and all applicants, regardless of whether they have already taken the exam and are re-filing or not, must follow this specific process.

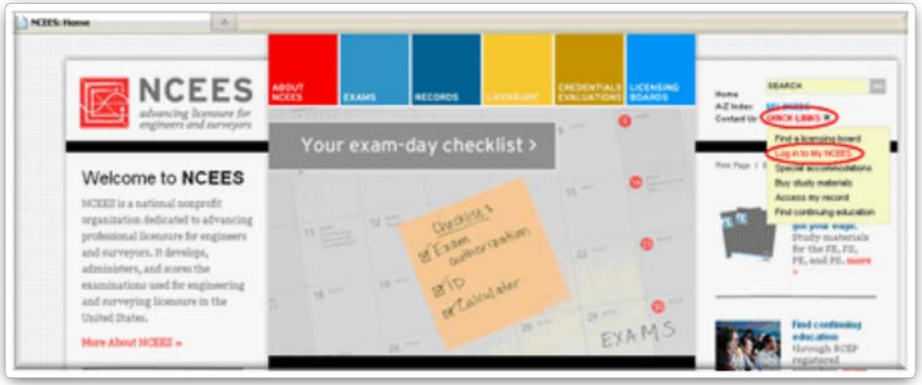
The NCEES does have a specific time frame for open registration, so refer to your State's guidelines to ensure you don't miss it. However, the registration time frame usually opens around 4 months prior to the exam date and runs up until about a month prior to the exam. As an example, say you are registering for an early October exam date, registration would typically open in early July (4 months prior) and close down in early September (1 month prior). Make sure not to procrastinate, sign up early and get it out of the way. The registration is open 24 hours a day via the internet, so you will be able to complete the process anytime and at your own convenience.

NCEES REGISTRATION PROCEDURE

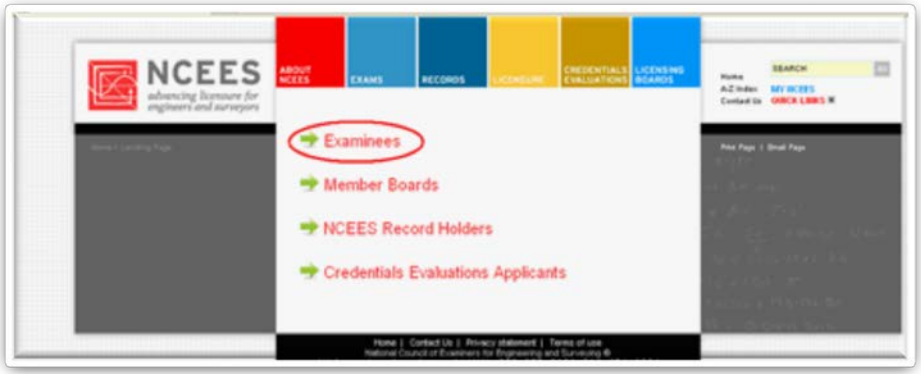
Visit the NCEES website



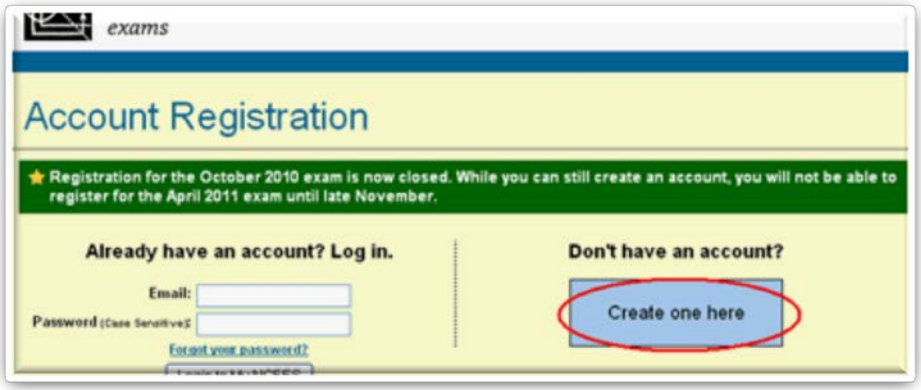
On the right hand side of the website, locate the Quick Links navigation bar and hover over it with your cursor. A drop down menu will pop up, locate and click "Log in to My NCEES"



Once you are on the NCEES sign in page, click on the first link titles "Examinees"

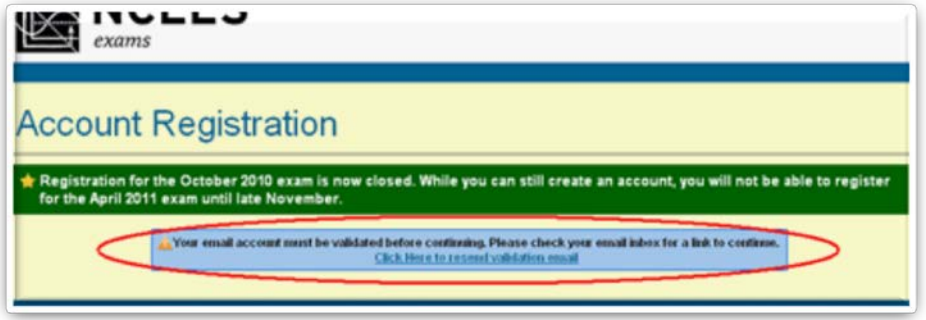


You will be routed to an Account Registration page, where you will either be able to sign in with your current account information or create a new account. We are going to create a new account to fulfill our registration requirements with NCEES. On the right side of the screen, click "Create one here"



At this point, fill out your personal information on the right side, First Name, Last Name, Birth City, etc. Once you get your password entered in, make sure to read the Terms of Use and Privacy Statement. When you agree, click to fill in the bubble that you agree, and submit your form.

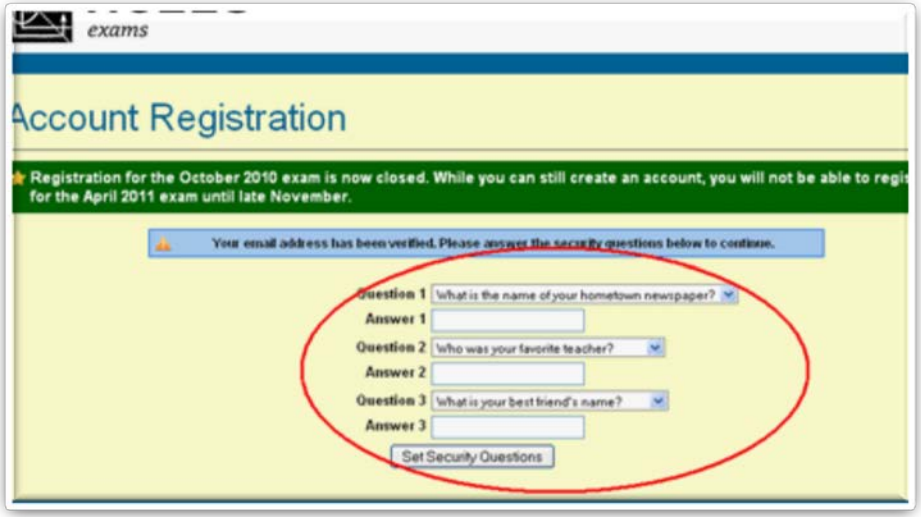
Once you submit your form, you will be redirected to a landing page informing you that a confirming email was sent to you for validation.



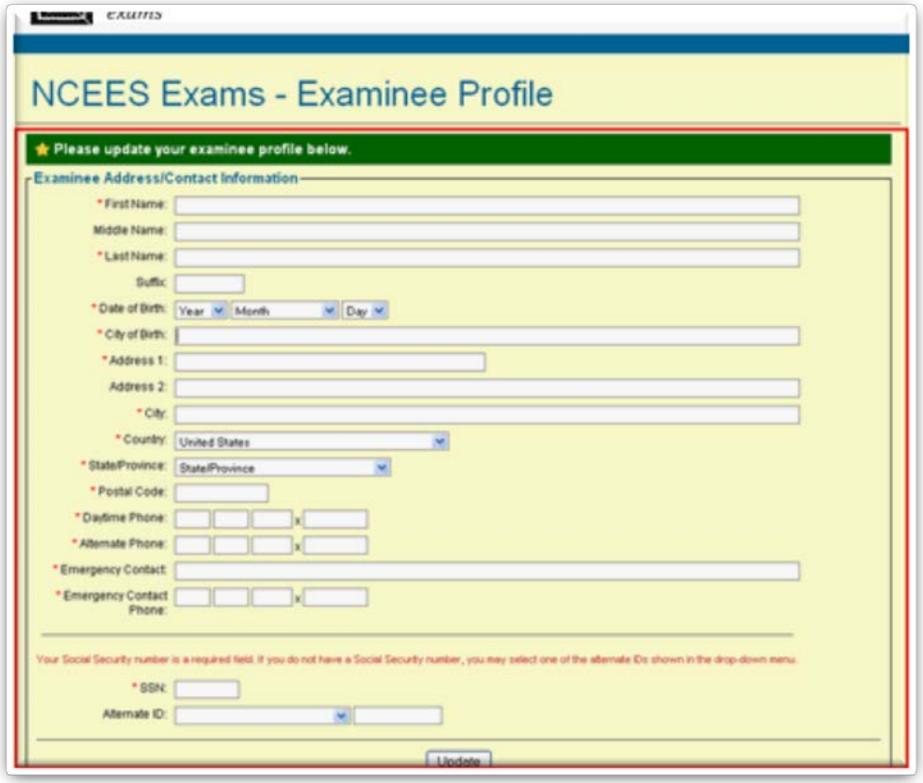
Go to your email and validate your account. When you click the link in your email, you will be taken back to the NCEES site where you will now use your newly activated account login information to sign in.

Once you login, there are a few more steps you need to take to ensure you profile is fully complete and activated.

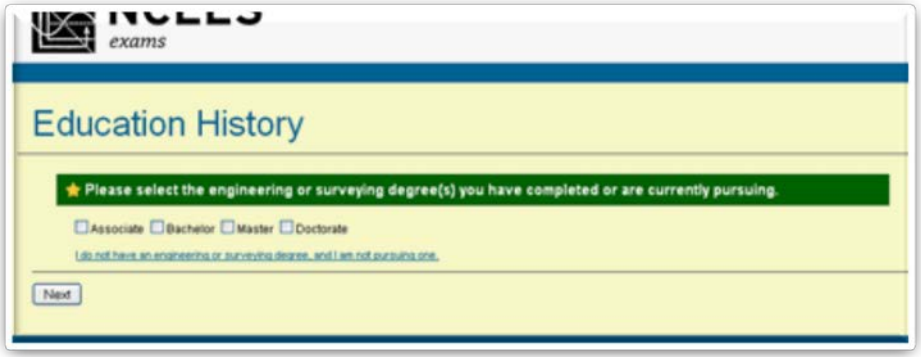
Fill in your security questions, make sure you can remember them, then click
"Set Security Questions" to move on to the next page.



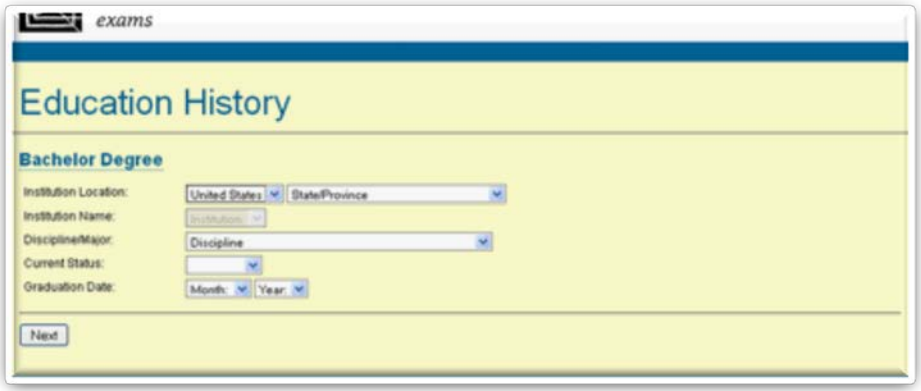
With the Security questions set, finish off you profile by filling out the remaining information NCEES requires. This includes a Social Security Number, but if you don't have one, there a few more options. Just choose the one that best fits and provide the information.



Give NCEES some information regarding the degree that you currently are pursuing or graduated with.



Fill out the information regarding you educational background and confirm when prompted.



And there you are, complete with the first step in registering for the Engineer in Training Exam registration. Remember, the NCEES registration is open around the clock during the open registration period, but this period of registration is limited, so make sure to determine early when this period is so you don't miss out.

If the current registration is open, you can now move on to registering with your State Board.

REGISTERING WITH THE STATE

The second step in applying for the Engineer in Training Exam is to register through your State Board of Engineer's. This can be done at any point in time after registering with the NCEES.

> ***Make sure your registration/application is postmarked prior to the final filing date as defined by your Board, don't test it.***

Again, be sure not to delay registering, that filing date comes fast and furious.

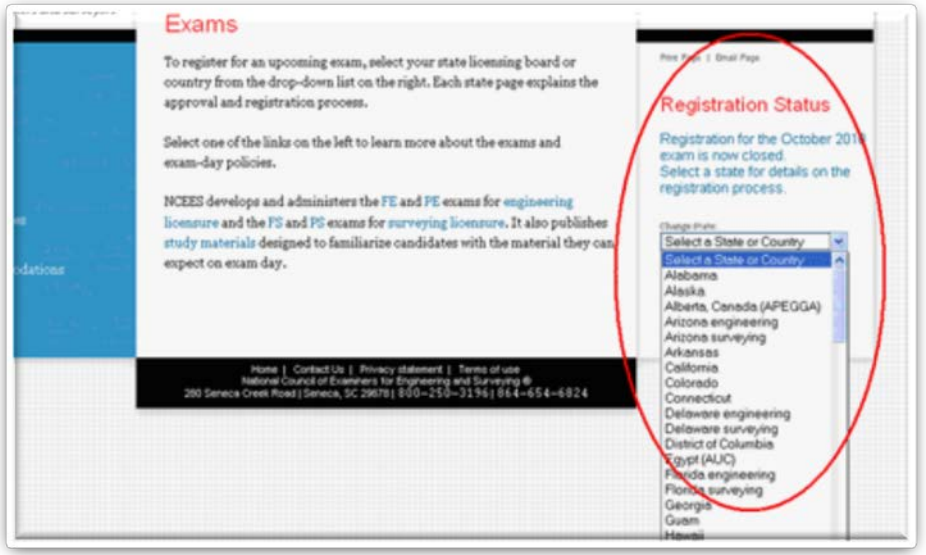
The following is the process of registering through the California Board. The particulars of the process may be different for other states, but the concepts will remain the same.

The first stage in applying with your Board is to head over to the NCEES website and sign in using the information you created in the previous section of the registration process. If you didn't sign out and are going straight through both of the registration steps of this process, then you will be

redirected at the final step of the NCEES registration form to a print out a PDF document for your specific state.

If you did sign out though, revisit the homepage of NCEES and click on “Exams” to get started.

Once on the Exam page, refer to the right column where you will see a drop down menu of all the States, choose yours.



On the page following, you will be prompted for your sign in information. If the registration is open, it will allow you to sign in where you can then print and/or download your Application.

Run through the steps that are outlined in your application making sure to keep your handwriting legible for reviewers to process efficiently.

In your application, when prompted, choose one of the seven disciplines to be your main focus for the afternoon

portion of the exam. The module you choose to take does not affect or determine the branch of engineering in which you are eligible to apply for when you go to become a Professional Engineer; so choose whichever one you feel most comfortable with at this time in your career. I personally chose to take the General portion of the exam even though I went on to become registered as a Mechanical Engineer.

Modules to choose from: Other, Chemical, Civil, Electrical, Environmental, Mechanical, or Industrial Engineering.

When you are completed with filling out your application, take a copy of it for your records, there is always a chance that your application could be lost in the shuffle.

After you have all your paperwork situated, submit the completed and signed State application together with a check (or money order) in the amount set forth by your Board to the noted address on the application. Most states will notify you when your application is received if you include a self-addressed and stamped postcard with your application.

I recommend that you do this, as it will take a lot of stress of your shoulders knowing that your application wasn't lost in transit.

Otherwise, you can expect to receive a notice via email, to the address provided during your NCEES Open Registration process, 2-3 weeks prior to the exam. This email will confirm your entry in to the exam as well as provide you with login

When you mail your application make sure you provide ample postage to get it to the destination. Applications received requiring postage due will not be accepted by your Board office. These applications will be sent back, but the final filing dates will not be extended for this situation. I have personally known people who get slapped for this and it's devastating to say the least.

If after you submit your application you change your home or email address, make sure to notify the Board immediately. If it is a change in your home address, use the resources and processes of your State Board to officially update it. If you change you email, update it electronically through NCEES and your Board website. Keeping these

records up to date will ensure you do not miss out on any pertinent information related to the exam. This is an avoidable obstacle, make sure to avoid it.

SPECIAL ACCOMMODATIONS:

If for any reason you have the need for special testing accommodations due to Religious beliefs or for reasons falling under the Americans with Disabilities Act (ADA), don't hesitate to contact your State Board. All requests must be submitted to NCEES for approval prior to the final filing date. If you have already submitted a request for special accommodations on a previous exam, you must reapply for the most current regardless of whether or not the situation has changed.

WHAT TO EXPECT ON EXAM DAY

The Engineer in Training exam is an 8 hour exam taken during a 1 day period at a specified testing facility within your State. You can see where each exam site is by visiting your State Board website; find your State's Information here.

The test is 180 multiple choice questions in length and is broken up in to two 4 hour sessions, a morning and an afternoon. During the morning session, you will be asked to answer 120 multiple choice questions, each question worth one point, covering a broad range of engineering topics, ranging from general Mathematics and Calculus to Engineering Dynamics and Fluid Mechanics. During this morning session, all people taking the exam will receive the same test covering the same general engineering topics; this session is designed to verify the engineer's overall knowledge of the core engineering disciplines as a whole. Each examinee can acquire 120 total points during this session of the test.

In the afternoon session, another 60 multiple choice questions are answered, each worth two points, covering a specific discipline usually chosen by the examinee prior to the exam; typically one in line with their undergraduate engineering background. Most States require this discipline to be chosen prior to the exam, during the application process, but others allow the candidates to identify and choose the subject area during the examination.

> ***If you don't go after what you want, you'll never have it. If you don't ask, the answer is always no. If you don't step forward, you're always in the same place - Nora Roberts***

The questions on the PM portion of the EIT exam are tailored to hone in on the specified discipline and are completely stand-alone from those on the AM portion. This session is designed to verify the engineer's in depth knowledge of their dedicated engineering discipline. Each examinee can acquire 120 total points during this session of the test, for a total of 240 points possible for the exam as a whole.

AM SESSION (BREADTH PORTION COVERING 12 SUBJECT AREAS)

The 12 subject areas that follow outline and further define what to expect when you sit to take the AM portion of the Engineer in Training Exam. Each subject area is broken down in to the subtopics and can be used to focus your studies when preparing for the exam.

The percentage next to the subject is approximately how much of the total content of the AM session that particular subject will make up. This breakdown is as outlined by NCEES on their website.

I. Mathematics (15%)

A. Analytic geometry
B. Integral calculus
C. Matrix operations
D. Roots of equations
E. Vector analysis
F. Differential equations
G. Differential calculus

II. Engineering Probability and Statistics (7%)

A. Measures of central tendencies and dispersions (e.g., mean, mode, standard deviation)

B. Probability distributions (e.g., discrete, continuous, normal, binomial)
C. Conditional probabilities
D. Estimation (e.g., point, confidence intervals) for a single mean
E. Regression and curve fitting
F. Expected value (weighted average) in decision-making
G. Hypothesis testing

III. Chemistry (9%)

A. Nomenclature
B. Oxidation and reduction
C. Periodic table
D. States of matter
E. Acids and bases
F. Equations (e.g., stoichiometry)
G. Equilibrium
H. Metals and nonmetals

IV. Computers (7%)

A. Terminology (e.g., memory types, CPU, baud rates, Internet)
B. Spreadsheets (e.g., addresses, interpretation, "what if," copying formulas)
C. Structured programming (e.g., assignment statements, loops and branches, function calls)

V. Ethics and Business Practices (7%)

A. Code of ethics (professional and technical societies)
B. Agreements and contracts
C. Ethical versus legal
D. Professional liability
E. Public protection issues (e.g., licensing boards)

VI. Engineering Economics (8%)

A. Discounted cash flow (e.g., equivalence, PW, equivalent annual FW, rate of return)
B. Cost (e.g., incremental, average, sunk, estimating)
C. Analyses (e.g., breakeven, benefit-cost)
D. Uncertainty (e.g., expected value and risk)

PM SESSION (IN DEPTH DISCIPLINE SPECIFIC)

The following breakdown represents the 7 specific modules you are able to choose from for the PM portion of the Engineer in Training Exam. It is good to take a hard look at each discipline, as you may be better fit to choose a module that you wouldn't usually choose. Again, the percentage

next to the subject is approximately how much of the total content of the PM session that particular area will make up. This breakdown is as outlined by NCEES on their website.

CHEMICAL PM

The following is a breakdown of the 11 topics covered in the Chemical PM portion of the Engineer in Training Exam.

The percentage next to the subject is approximately how much of the total content of the PM session that particular subject makes up. This breakdown is as outlined by NCEES on their website.

I. Chemistry (10%)

A. Inorganic chemistry (e.g., molarity, normality, molality, acids,
bases, redox, valence, solubility product, pH, pK, electrochemistry)
B. Organic chemistry (e.g., nomenclature, structure, qualitative and quantitative
analyses, balanced equations, reactions, synthesis)

II. Material/Energy Balances (15%)

A. Mass balance
B. Energy balance
C. Control boundary concept (e.g., black box concept)
D. Steady-state process
E. Unsteady-state process
F. Recycle process
G. Bypass process
H. Combustion

III. Chemical Engineering Thermodynamics (10%)

A. Thermodynamic laws (e.g., 1st Law, 2nd Law)
B. Thermodynamic properties (e.g., internal thermal energy, enthalpy, entropy, free energy)
C. Thermodynamic processes (e.g., isothermal, adiabatic, isentropic)
D. Property and phase diagrams (e.g., T-s, h-P, x-y, T-x-y)
E. Equations of state (e.g., van der Waals, Soave-Redlich-Kwong)
F. Steam tables
G. Phase equilibrium and phase change
H. Chemical equilibrium

I. Heats of reaction
J. Cyclic processes and efficiency (e.g., power, refrigeration, heat pump)
K. Heats of mixing

IV. Fluid Dynamics (10%)

A. Bernoulli equation and mechanical energy balance
B. Hydrostatic pressure
C. Dimensionless numbers (e.g., Reynolds number)
D. Laminar and turbulent flow
E. Velocity head
F. Friction losses (e.g., pipe, valves, fittings)
G. Pipe networks
H. Compressible and incompressible flow
I. Flow measurement (e.g., orifices, Venturi meters)
J. Pumps, turbines, and compressors
K. Non-Newtonian flow
L. Flow through packed beds

V. Heat Transfer (10%)

A. Conductive heat transfer
B. Convective heat transfer
C. Radiation heat transfer
D. Heat transfer coefficients
E. Heat exchanger types (e.g., plate and frame, spiral)
F. Flow configuration (e.g., cocurrent/countercurrent)
G. Log mean temperature difference (LMTD) and NTU
H. Fouling
I. Shell-and-tube heat exchanger design (e.g., area, number of passes)

VI. Mass Transfer (10%)

A. Diffusion (e.g., Fick's 1st and 2nd laws)
B. Mass transfer coefficient
C. Equilibrium stage method (efficiency)
D. Graphical methods (e.g., McCabe-Thiele)
E. Differential method (e.g., NTU, HETP, HTU, NTP)
F. Separation systems (e.g., distillation, absorption, extraction, membrane processes)
G. Humidification and drying

VII. Chemical Reaction Engineering (10%)

A. Reaction rates and order
B. Rate constant (e.g., Arrhenius function)
C. Conversion, yield, and selectivity
D. Series and parallel reactions
E. Forward and reverse reactions
F. Energy/material balance around a reactor
G. Reactions with volume change
H. Reactor types (e.g., plug flow, batch, semi-batch, CSTR)

I. Homogeneous and heterogeneous reactions
J. Catalysis

VIII. Process Design and Economic Optimization (10%)

A. Process flow diagrams (PFD)
B. Piping and instrumentation diagrams (P&ID)
C. Scale-up
D. Comparison of economic alternatives (e.g., net present value, discounted cash flow, rate of return)
E. Cost estimation

IX. Computer Usage in Chemical Engineering (5%)

A. Numerical methods and concepts (e.g., convergence, tolerance)
B. Spreadsheets for chemical engineering calculations
C. Statistical data analysis

X. Process Control (5%)

A. Sensors and control valves (e.g., temperature, pressure)
B. Dynamics (e.g., time constants, 2nd order, underdamped)
C. Feedback and feedforward control
D. Proportional, integral, and derivative (PID) controller concepts
E. Cascade control
F. Control loop design (e.g., matching measured and manipulated variables)
G. Tuning PID controllers and stability (e.g., Method of Ziegler-Nichols, Routh Test)
H. Open-loop and closed-loop transfer functions

XI. Safety, Health, and Environmental (5%)

A. Hazardous properties of materials (e.g., corrosive, flammable, toxic), including MSDS
B. Industrial hygiene (e.g., noise, PPE, ergonomics)
C. Process hazard analysis (e.g., using fault-tree analysis or event tree)
D. Overpressure and underpressure protection (e.g., relief, redundant control, intrinsically safe)
E. Storage and handling (e.g., inerting, spill containment)
F. Waste minimization
G. Waste treatment (e.g., air, water, solids)

CIVIL PM

The following is a breakdown of the 9 topics covered in the Civil PM portion of the Engineer in Training Exam.

The percentage next to the subject is approximately how much of the total content of the PM session that particular subject makes up. This breakdown is as outlined by NCEES on their website.

I. Surveying (11%)

A. Angles, distances, and trigonometry
B. Area computations
C. Closure
D. Coordinate systems (e.g., GPS, state plane)
E. Curves (vertical and horizontal)
F. Earthwork and volume computations
G. Leveling (e.g., differential, elevations, percent grades)

II. Hydraulics and Hydrologic Systems (12%)

A. Basic hydrology (e.g., infiltration, rainfall, runoff, detention, flood flows, watersheds)
B. Basic hydraulics (e.g., Manning equation, Bernoulli theorem, open-channel flow, pipe flow)
C. Pumping systems (water and wastewater)
D. Municipal water distribution systems
E. Reservoirs (e.g., dams, routing, spillways)
F. Groundwater (e.g., flow, wells, drawdown)
G. Sewer collection systems (storm and sanitary)

III. Soil Mechanics and Foundations (15%)

A. Index properties and soil classifications
B. Phase relations (air-water-solid)
C. Laboratory and field tests
D. Effective stress (buoyancy)
E. Retaining walls (e.g., active pressure/passive pressure)
F. Shear strength
G. Bearing capacity (cohesive and noncohesive)
H. Foundation types (e.g., spread footings, piles, wall footings, mats)
I. Consolidation and differential settlement
J. Seepage
K. Slope stability (e.g., fills, embankments, cuts, dams)
L. Soil stabilization (e.g., chemical additives, geosynthetics)

IV. Environmental Engineering (12%)

A. Water quality (ground and surface)
B. Air quality
C. Solid/hazardous waste
D. Sanitary sewer system loads
E. Basic tests (e.g., water, wastewater, air)
F. Environmental regulations
G. Water treatment and wastewater treatment (e.g., primary, secondary, tertiary)

V. Transportation (12%)

A. Streets and highways

1. geometric design
2. pavement design
3. intersection design

B. Traffic analysis and control

1. safety
2. capacity
3. traffic flow
4. traffic control devices

VI. Structural Analysis (10%)

A. Force analysis of statically determinant beams, trusses and frames
B. Deflection analysis of statically determinant beams, trusses and frames
C. Stability analysis of beams, trusses and frames
D. Column analysis (e.g., buckling, boundary conditions)
E. Loads and load paths (e.g., dead, live, moving)
F. Elementary statically indeterminate structures

VII. Structural Design (10%)

A. Codes (e.g., AISC, ACI, NDS, AISI)
B. Design procedures for steel components (e.g., beams, columns, beam-columns, tension members, connections)
C. Design procedures for concrete components (e.g., beams, slabs, columns, walls, footings)

VIII. Construction Management (10%)

A. Procurement methods (e.g., design-build, design-bid-build, qualifications based)
B. Allocation of resources (e.g., labor, equipment, materials, money, time)
C. Contracts/contract law
D. Project scheduling (e.g., CPM, PERT)
E. Engineering economics
F. Project management (e.g., owner/contractor/client relations, safety)
G. Construction estimating

IX. Materials (8%)

A. Concrete mix design
B. Asphalt mix design
C. Test methods (e.g., steel, concrete, aggregates, asphalt)
D. Properties of aggregates
E. Engineering properties of metals

MECHANICAL PM

The following is a breakdown of the 8 topics covered in the Mechanical PM portion of the Engineer in Training Exam.

The percentage next to the subject is approximately how much of the total content of the PM session that particular subject makes up. This breakdown is as outlined by NCEES on their website.

I. Mechanical Design and Analysis (15%)

A. Stress analysis (e.g., combined stresses, torsion, normal, shear)
B. Failure theories (e.g., static, dynamic, buckling)
C. Failure analysis (e.g., creep, fatigue, fracture, buckling)
D. Deformation and stiffness
E. Components (e.g., springs, pressure vessels, beams, piping, bearings, columns, power screws)
F. Power transmission (e.g., belts, chains, clutches, gears, shafts, brakes, axles)
G. Joining (e.g., threaded fasteners, rivets, welds, adhesives)
H. Manufacturability (e.g., fits, tolerances, process capability)
I. Quality and reliability
J. Mechanical systems (e.g., hydraulic, pneumatic, electro-hybrid)

II. Kinematics, Dynamics, and Vibrations (15%)

A. Kinematics of mechanisms
B. Dynamics of mechanisms
C. Rigid body dynamics
D. Natural frequency and resonance
E. Balancing of rotating and reciprocating equipment
F. Forced vibrations (e.g., isolation, force transmission, support motion)

III. Materials and Processing (10%)

A. Mechanical and thermal properties (e.g., stress/strain relationships, ductility, endurance, conductivity, thermal expansion)
B. Manufacturing processes (e.g., forming, machining, bending, casting, joining, heat treating)
C. Thermal processing (e.g., phase transformations, equilibria)
D. Materials selection (e.g., metals, composites,

ceramics, plastics, bio-materials)
E. Surface conditions (e.g., corrosion, degradation, coatings, finishes)
F. Testing (e.g., tensile, compression, hardness)

IV. Measurements, Instrumentation, and Controls (10%)

A. Mathematical fundamentals (e.g., Laplace transforms, differential equations)
B. System descriptions (e.g., block diagrams, ladder logic, transfer functions)
C. Sensors and signal conditioning (e.g., strain, pressure, flow, force, velocity, displacement, temperature)
D. Data collection and processing (e.g., sampling theory, uncertainty, digital/analog, data transmission rates)
E. Dynamic responses (e.g., overshoot/time constant, poles and zeros, stability)

V. Thermodynamics and Energy Conversion Processes (15%)

A. Ideal and real gases
B. Reversibility/irreversibility
C. Thermodynamic equilibrium
D. Psychrometrics
E. Performance of components
F. Cycles and processes (e.g., Otto, Diesel, Brayton, Rankine)
G. Combustion and combustion products
H. Energy storage
I. Cogeneration and regeneration/reheat

VI. Fluid Mechanics and Fluid Machinery (15%)

A. Fluid statics
B. Incompressible flow
C. Fluid transport systems (e.g., pipes, ducts, series/parallel operations)
D. Fluid machines: incompressible (e.g., turbines, pumps, hydraulic motors)
E. Compressible flow
F. Fluid machines: compressible (e.g., turbines, compressors, fans)
G. Operating characteristics (e.g., fan laws, performance curves, efficiencies, work/power equations)
H. Lift/drag
I. Impulse/momentum

VII. Heat Transfer (10%)

A. Conduction
B. Convection
C. Radiation
D. Composite walls and insulation

E. Transient and periodic processes
F. Heat exchangers
G. Boiling and condensation heat transfer

VIII. Refrigeration and HVAC (10%)

A. Cycles
B. Heating and cooling loads (e.g., degree day data, sensible heat, latent heat)
C. Psychrometric charts
D. Coefficient of performance
E. Components (e.g., compressors, condensers, evaporators, expansion valve)

INDUSTRIAL PM

The following is a breakdown of the 8 topics covered in the Industrial PM portion of the Engineer in Training Exam.

The percentage next to the subject is approximately how much of the total content of the PM session that particular subject makes up. This breakdown is as outlined by NCEES on their website.

I. Engineering Economics (15%)

A. Discounted cash flows (equivalence, PW, EAC, FW, IRR, loan amortization)
B. Types and breakdown of costs (e.g., fixed, variable, direct and indirect labor, material, capitalized)
C. Analyses (e.g., benefit-cost, breakeven, minimum cost, overhead, risk, incremental, life cycle)
D. Accounting (financial statements and overhead cost allocation)
E. Cost estimating
F. Depreciation and taxes
G. Capital budgeting

II. Probability and Statistics (15%)

A. Combinatorics (e.g., combinations, permutations)
B. Probability distributions (e.g., normal, binomial, empirical)
C. Conditional probabilities
D. Sampling distributions, sample sizes, and statistics (e.g., central tendency, dispersion)
E. Estimation (point estimates, confidence intervals)
F. Hypothesis testing
G. Regression (linear, multiple)
H. System reliability (single components, parallel and series systems)

I. Design of experiments (e.g., ANOVA, factorial designs)

III. Modeling and Computation (12%)

A. Algorithm and logic development (e.g., flow charts, pseudo-code)
B. Spreadsheets
C. Databases (e.g., types, information content, relational)
D. Decision theory (e.g., uncertainty, risk, utility, decision trees)
E. Optimization modeling (decision variables, objective functions, and constraints)
F. Linear programming (e.g., formulation, primal, dual, graphical solution)
G. Math programming (network, integer, dynamic, transportation, assignment)
H. Stochastic models (e.g., queuing, Markov, reliability)
I. Simulation (e.g., event, process, Monte Carlo sampling, random number generation, steady-state vs. transient)

IV. Industrial Management (10%)

A. Principles (e.g., planning, organizing) and tools of management (e.g., MBO, re-engineering)
B. Organizational structure (e.g., functional, matrix, line/staff)
C. Motivation theories (e.g., Maslow, Theory X, Theory Y)
D. Job evaluation and compensation
E. Project management (scheduling, PERT, CPM)

V. Manufacturing and Production Systems (13%)

A. Manufacturing systems (e.g., cellular, group technology, flexible, lean)
B. Process design (e.g., number of machines/people, equipment selection, and line balancing)
C. Inventory analysis (e.g., EOQ, safety stock)
D. Forecasting
E. Scheduling (e.g., sequencing, cycle time, material control)
F. Aggregate planning (e.g., JIT, MRP, MRPII, ERP)
G. Concurrent engineering and design for manufacturing
H. Automation concepts (e.g., robotics, CIM)
I. Economics (e.g., profits and costs under various demand rates, machine selection)

VI. Facilities and Logistics (12%)

A. Flow measurements and analysis (e.g., from/to charts, flow planning)

B. Layouts (e.g., types, distance metrics, planning, evaluation)
C. Location analysis (e.g., single facility location, multiple facility location, storage location within a facility)
D. Process capacity analysis (e.g., number of machines/people, trade-offs)
E. Material handling capacity analysis (storage & transport)
F. Supply chain design (e.g., warehousing, transportation, inventories)

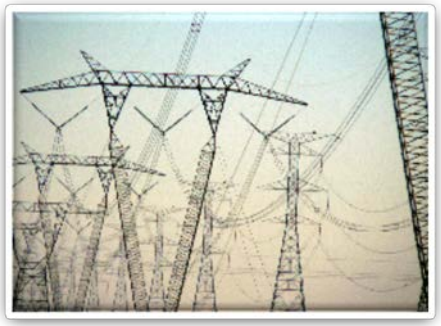
VII. Human Factors, Productivity, Ergonomics, and Work Design (12%)

A. Methods analysis (e.g., improvement, charting) and task analysis (e.g., MTM, MOST)
B. Time study (e.g., time standards, allowances)
C. Workstation design
D. Work sampling
E. Learning curves
F. Productivity measures
G. Risk factor identification, safety, toxicology, material safety data sheets (MSDS)
H. Environmental stress assessment (e.g., noise, vibrations, heat, computer-related)
I. Design of tasks, tools, displays, controls, user interfaces, etc.
J. Anthropometry, biomechanics, and lifting

VIII. Quality (11%)

A. Total quality management theory (e.g., Deming, Juran) and application
B. Management and planning tools (e.g., fishbone, Pareto, quality function deployment, scatter diagrams)
C. Control charts
D. Process capability and specifications
E. Sampling plans
F. Design of experiments for quality improvement
G. Auditing, ISO certification, and the Baldridge award

ELECTRICAL PM



The following is a breakdown of the 9 topics covered in the Electrical PM portion of the Engineer in Training Exam.

The percentage next to the subject is approximately how much of the total content of the PM session that

particular subject makes up. This breakdown is as outlined by NCEES on their website.

I. Circuits (16%)

A. KCL, KVL
B. Series/parallel equivalent circuits
C. Node and loop analysis
D. Thevenin/Norton theorems
E. Impedance
F. Transfer functions
G. Frequency/transient response
H. Resonance
I. Laplace transforms
J. 2-port theory
K. Filters (simple passive)

II. Power (13%)

A. 3-phase
B. Transmission lines
C. Voltage regulation
D. Delta and wye
E. Phasors
F. Motors
G. Power electronics
H. Power factor (pf)
I. Transformers

III. Electromagnetics (7%)

A. Electrostatics/magnetostatics (e.g., measurement of spatial relationships, vector analysis)
B. Wave propagation
C. Transmission lines (high frequency)

IV. Control Systems (10%)

A. Block diagrams (feed forward, feedback)
B. Bode plots
C. Controller performance (gain, PID), steady-state errors
D. Root locus
E. Stability

V. Communications (9%)

A. Basic modulation/demodulation concepts (e.g., AM, FM, PCM)
B. Fourier transforms/Fourier series
C. Sampling theorem
D. Computer networks, including OSI model
E. Multiplexing

VI. Signal Processing (8%)

A. Analog/digital conversion
B. Convolution (continuous and discrete)

C. Difference equations
D. Z-transforms

VII. Electronics (15%)

A. Solid-state fundamentals (tunneling, diffusion/drift current, energy bands, doping bands, p-n theory)
B. Bias circuits
C. Differential amplifiers
D. Discrete devices (diodes, transistors, BJT, CMOS) and models and their performance
E. Operational amplifiers
F. Filters (active)
G. Instrumentation (measurements, data acquisition, transducers)

VIII. Digital Systems (12%)

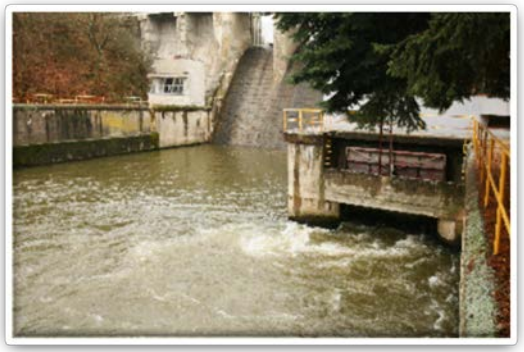
A. Numbering systems
B. Data path/control system design
C. Boolean logic
D. Counters
E. Flip-flops
F. Programmable logic devices and gate arrays
G. Logic gates and circuits
H. Logic minimization (SOP, POS, Karnaugh maps)
I. State tables/diagrams
J. Timing diagrams

IX. Computer Systems (10%)

A. Architecture (e.g., pipelining, cache memory)
B. Interfacing
C. Microprocessors
D. Memory technology and systems
E. Software design methods (structured, top-down bottom-up, object-oriented design)
F. Software implementation (structured programming, algorithms, data structures)

ENVIRONMENTAL PM

The following is a breakdown of the 5 topics covered in the Environmental PM portion of the Engineer in Training Exam.



The percentage next to the subject is approximately how much of the total content of the PM session that particular subject makes up. This breakdown is as outlined by NCEES on their website.

I. Water Resources (25%)

A. Water distribution and wastewater collection
B. Water resources planning
C. Hydrology and watershed processes
D. Fluid mechanics and hydraulics

II. Water and Wastewater Engineering (30%)

A. Water and wastewater
B. Environmental microbiology/ecology
C. Environmental chemistry

III. Air Quality Engineering (15%)

A. Air quality standards and control technologies
B. Atmospheric sciences

IV. Solid and Hazardous Waste Engineering (15%)

A. Solid waste engineering
B. Hazardous waste engineering
C. Site remediation
D. Geohydrology
E. Geotechnology

V. Environmental Science and Management (15%)

A. Industrial and occupational health and safety
B. Radiological health and safety
C. Radioactive waste management
D. Environmental monitoring and sampling
E. Pollutant fate and transport (air/water/soil)
F. Pollution prevention and waste minimization
G. Environmental management systems

OTHER PM

The following is a breakdown of the 9 topics covered in the Other PM portion of the Engineer in Training Exam.

The percentage next to the subject is approximately how much of the total content of the PM session that particular subject makes up. This breakdown is as outlined by NCEES on their website.

I. Advanced Engineering Mathematics (10%)

A. Differential equations
B. Partial differential calculus
C. Numerical solutions (e.g., differential equations, algebraic equations)
D. Linear algebra
E. Vector analysis

II. Engineering Probability and Statistics (9%)

A. Sample distributions and sizes
B. Design of experiments
C. Hypothesis testing
D. Goodness of fit (coefficient of correlation, chi square)
E. Estimation (e.g., point, confidence intervals) for two means

III. Biology (5%)

A. Cellular biology (e.g., structure, growth, cell organization)
B. Toxicology (e.g., human, environmental)
C. Industrial hygiene [e.g., personnel protection equipment (PPE), carcinogens]
D. Bioprocessing (e.g., fermentation, waste treatment, digestion)

IV. Engineering Economics (10%)

A. Cost estimating
B. Project selection
C. Lease/buy/make
D. Replacement analysis (e.g., optimal economic life)

V. Application of Engineering Mechanics (13%)

A. Stability analysis of beams, trusses, and frames
B. Deflection analysis
C. Failure theory (e.g., static and dynamic)
D. Failure analysis (e.g., creep, fatigue, fracture, buckling)

VI. Engineering of Materials (11%)

A. Material properties of:

1. metals
2. plastics
3. composites
4. concrete

VII. Fluids (15%)

A. Basic hydraulics (e.g., Manning equation, Bernoulli theorem, open-channel
flow, pipe flow)
B. Laminar and turbulent flow
C. Friction losses (e.g., pipes, valves, fittings)
D. Flow measurement
E. Dimensionless numbers (e.g., Reynolds number)
F. Fluid transport systems (e.g., pipes, ducts, series/parallel operations)
G. Pumps, turbines, and compressors
H. Lift/drag

VIII. Electricity and Magnetism (12%)

A. Equivalent circuits (Norton, Thevenin)
B. AC circuits (frequency domain)

C. Network analysis (Kirchhoff laws)
D. RLC circuits
E. Sensors and instrumentation
F. Electrical machines

IX. Thermodynamics and Heat Transfer (15%)

A. Thermodynamic properties (e.g., entropy, enthalpy, heat capacity)
B. Thermodynamic processes (e.g., isothermal, adiabatic, reversible, irreversible)
C. Equations of state (ideal and real gases)
D. Conduction, convection, and radiation heat transfer
E. Mass and energy balances
F. Property and phase diagrams (e.g., T-s, h-P)
G. Tables of thermodynamic properties
H. Cyclic processes and efficiency (e.g., refrigeration, power)
I. Phase equilibrium and phase change
J. Thermodynamic equilibrium
K. Combustion and combustion products (e.g., CO, CO2, NOX, ash, particulates)
L. Psychrometrics (e.g., humidity)

PREPARING FOR THE ENGINEER IN TRAINING EXAM

The most frequent obstacle in the way of people passing the Engineer in Training exam is the simple task of preparation. Failing to employ effective study techniques or simply ignoring them all together is the root cause for most unsuccessful exam takers. We are engineers, gifted with the ability to retain an inordinate amount of technical information. We all have what it takes to pass the exam, but if you are like many, the prospect of sitting for 8 hours while being milled with questions covering all the subjects we were taught in our college years can be a bit overwhelming. If you are asking yourself, “Where do I even start studying for the EIT exam?”, then reading the suggestions below will provide you with a simple guideline

to becoming more effective in the upcoming months of pounding books.

THE MINUTIA UP FRONT

The following are my suggestions of what to do immediately prior to setting forth on your journey of dominating the Engineer in Training exam.

ENGINEER IN TRAINING EXAM REVIEW BOOK

Before anything, you should consider getting your hands on a quality review manual. Having a concise resource composed with all relevant information really helps focus your studies. Most any manual should suffice, as the roots of the Engineering discipline is what it is, and doesn't evolve away from the basics. Though, if you are purchasing new, having the most updated version never hurts. I used Michael Lindeburg's FE Review Manual and found that it was worth every penny I spent. You can read reviews and purchase the book from Amazon HERE.

ENGINEER IN TRAINING EXAM SAMPLE QUESTIONS

Practice exams are a vital part in successfully preparing for the Engineer in Training Exam. Being able to apply what you learn against a structured practice exam is beyond

valuable. Not only does it allow you to prepare yourself for what to expect on the test, but it also mentally prepares you for working under the timed conditions. The timing factor is something people tend to overlook, you have 120 total problems on the EIT exam and 480 minutes to complete them; that breaks down to 4 minutes per problem. I used Michael Lindeburg's FE/EIT Sample Examinations in my preparation. You can read reviews and purchase the book from Amazon HERE…

> **TIP:** ***You are unable to use any of your personal books for the Engineer in Training Exam. However, their is a huge resource that NCEES provides you prior to taking the exam, the NCEES Reference Manual. Knowing from the beginning what information is inside this manual is a must and will pay dividends in your preparation. Over time, you will learn how to be efficient in finding the information you need. Remember, you have 4 minutes to solve each problem, no need to waste that time flipping pages. You can purchase or download the Engineer in Training FE Exam HERE.***

SETTING YOURSELF UP FOR SUCCESS

After you have gathered all your resources together, it is time to sit down and prepare yourself for the journey. It is important not to just jump in without a plan. There is a lot of information to cover, delving full force into the content with no strategic planning can feel productive at first, but eventually prove to be debilitating to the success of your studies. This planning doesn't have to take days or weeks, but the time you do spend up front will render benefits through the extent of your studying.

SO WHAT IS YOUR GOAL?

I know this is probably an obvious question and one easy to answer..."I want to pass the Engineer in Training exam!" There, so, I answered it for you, good let's move on, or not.

> ***Begin with the end in mind***
> **- Stephen Covey**

The process of becoming a Professional Engineer is a serious endeavor taking pure dedication and commitment to a long journey that lasts more than the short period of time you study for the EIT exam. We are Engineers, and it's not easy becoming one, if it was, everyone would do it. So ask yourself, are you committed for this journey? Do you have a support group around you that understands the undertaking of such a journey? Think long term, think about the ultimate goal. Doing this will allow your mind to focus on the big picture, helping you keep steady when you encounter the small obstacles along the way.

Think about this, your goal has already partially been set and you have already been making progress even if you don't realize it. You have made it through an Engineering program that is formulated to test your limits daily. We all know there are 'weed out' classes, we made it through them, dominated them. Preparing for the Engineer in Training exam is no different, it's just another test of your limits, a 'weed out' process, to ensure only the best are left

to be registered as Professional Engineers. I know that you have what it takes, believe in yourself.

WHY DO YOU WANT TO GO THROUGH THIS?

You have established the goal in taking the Engineer in Training exam and acknowledged the commitment it takes to dominate the journey. You have also placed the task in to perspective, enveloping the exam into the bigger goal of obtaining a Professional Engineer License, which will help you weather the small obstacles along the way.

Now you must assess your motivation.

> ***Why is it you want to take on this journey? Are you motivated by the money that comes from it in the end? Are you pressured from outside expectations, such as family members, employers, etc? These are motivations, but the root of them is negative, and is not sustainable for the long haul.***

Be honest with yourself and assess what naturally is coming from within. Define your positive natural motivations that do exist. Our society tends to push the negatives ahead of the positives, but transcend that trend, and re-work your mind to think positive. Doing this will uncover the motivations that will sustain the long haul of the journey.

DO YOU HAVE ANY CONSTRAINTS THAT WILL NEED TO BE MANAGED TO ENSURE SUCCESS?

Think about the time that you have until the planned Engineer in Training exam date. This finite piece of information will be the driving factor in how your studies are designed. There will be other factors that will contend for your time and are in need of definition. Are you working a full time job? Do you have a Family to support? Do you have classes to attend and other exams to take? Write down what these constraints are so you can define a realistic study plan moving forward.

> ARE YOU PREPARED TO FAIL?
>
> ***A little blunt, I know. But this is something I had to ask myself prior to taking the exam. Ask yourself this question and use it, as I did, as motivation to stay on track and focused on the goal to dominate the exam.***

SCHEDULING FOR SUCCESS

You are probably thinking right about now that there is way too much up front groundwork to the actual real preparation for the Engineer in Training exam. I know, but from going through the process, hear me out. It's typical for us Engineers to think this way, to want to jump past all the "fluff" and get on to meat of the business; hold that thought.

Think about the times that you were successful in your past

Engineering projects. I am sure for the most part, all the engineering projects we have worked on were of some success or another. But were they completed efficiently and in productive manner? For the ones that were, I bet there was a common characteristic that was shared; that being solid scheduling.

When we sit back and brainstorm how to get from point A to point B, we are setting ourselves up with a greater probability for success. By scheduling, we have the opportunity to expose possible obstacles, processes, and other restraints that are ineffective in getting the job done. We are able to effectively weed out the "fluff" that will really bog up the end result.

Preparing for the Engineer in Training exam is no different, scheduling how you are going to get from being uncertified to a certified EIT is worth your time.

DEFINE PRACTICAL MILESTONES FOR YOUR STUDY SCHEDULE

So far we have determined that we want to:

A. Start Studying for the Engineer in Training exam

B. Take the EIT exam and pass.

This is our starting and ending point, but dang, there is a lot of space in between, we need to define realistic steps for success. The most logical way to define milestones while studying for the Engineer in Training exam, and the way I did it, is by using the chapters in Michael Lindeburg's FE Review Manual. This defines for us 17 steps that we have to work with, starting with "Units and Fundamental Constants" to "Engineering Ethics". Reaching success of a goal is always easier when broken up in to

increments. Could you imagine doing a Marathon without first testing yourself in a 5K, 10K, Half Marathon, etc?

FILL IN YOUR SCHEDULE

Now that you have defined your milestones, you can move forward with filling in the space between your start and end points. How you complete this step can vary and is mostly dependent on the amount of time you have until your exam date. For simple explanation purposes, I am going to propose we use 4 months (16 weeks) as our time between point A and point B.

> ***In most cases, the Engineer in Training exam is on a Saturday. I wouldn't suggest any studying be done the day before the exam, so run your schedule back a bit so your Point B falls on that Thursday prior to the exam.***

This gives you 16 full weeks (Thursday to Thursday) open for studying. Use the 17 milestones, as explained above, to fill in each block (week) of time, further defining what material will be covered in your studies during each period. For example:

Week 1: Units of Fundamental Constants and Conversion Factors

Week 2: Mathematics

Week 3: Statics

Week 4: Dynamics

Week 5: Mechanics of Materials

And so on…

Continue until you have filled in your schedule through the Thursday prior to your exam date.

Producing a schedule like this will not only put the task at hand in to perspective, but help you maintain a grasp on your progress. It will give you a tangible product that you can gauge against, helping you adjust or reinforce your focus if you fall behind or get slightly ahead. This also releases the mind from worry, reassuring you that you have the time scheduled to cover all the subjects prior to the exam.

Defining your studies graphically on a calendar, spreadsheet, or any other document is the way to put massive tasks in to perspective. Being able to break down your journey in to a number of smaller milestones allows

you to stay focused on your priorities, calm when difficulties arise, and productive for longer periods of time. It also ensures that time is being used most effectively, and allows you to recognize when you need to adjust without wasting too much time spinning your wheels.

PRACTICE EXAM

Take a baseline practice exam at the beginning of you preparation. I guarantee when you go to take that final practice exam before the test, you will feel a lot better going through it, giving you the added confidence you need going in to the Engineer in Training exam.

DEVELOPING SELF DISCIPLINE

With your resources in hand and study schedule close by, you are well on your way to dominating the Engineer in Training exam even without having done one second of actual review. To use an analogy, you have taken off from the airport and the wheels are locked in, but now is the time to assess your gauges, your study habits, to ensure the flight continues to be smooth as you trek towards your goal.

> ***He who conquers himself has won a greater victory than he who conquers a city*** **- Proverbs**

Disciplined study habits can be a skill in itself. If you have them, you are good to move forward, but if you don't have them, it may take some thought as to how you are going to bear down for your journey. Practicing discipline may seem like pulling teeth, but it shouldn't be, as controlling tasks in your preparation could be the difference between you passing or failing the Engineer in Training exam. As you control tasks, you build self-discipline. As you build self-discipline, you build time management. As you build time management, you build self-confidence. And self-confidence is the key to succeed.

With that, take into account the following tips to build self-discipline and keep it in check and on point throughout your studies:

TIME MANAGEMENT

Consider when the best time period you have to study to ensure all distractions are at a minimum and your study environment is most conducive to retaining knowledge. Develop smaller blocks of time during this period, say 50 minutes, and hit the books. After 50 minutes, get up and take a break (10 minutes), stretch, get some food, anything really just to revive your mind. Shorten the time block if you find yourself getting anxious after 30 minutes, 45 minutes, etc. The point is to stay actively involved in your studies for the allotted time you set aside to ensure you are maximizing the time you have.

Keep a note of your study sessions and adjust accordingly. Write down the times you are most efficient (Morning, Night). How long are you sessions? What block of time makes for a good break for you? Are you able to control your breaks and return to studying?

DISTRACTIONS AND ESCAPES

Do not deny that distractions and other escapes exist. You're Blackberry, iPhone, computer, TV, magazines, and environment can all be distractions to progressing in your studies. Come to grips with these temptations and do your best to minimize them. You will be better off, distracting activities will be more enjoyable later without the pressure of the Engineer in Training Exam hanging over your head.

EMOTIONS

Emotions definitely got to me when I sat down to study for the Engineer in Training Exam. I was overwhelmed, and at times, I found myself stalling and doing near nothing to progress in my studies. It's best to admit when these emotions of being overwhelmed, frustrated, etc arise. Doing so will allow you to realize that you have a problem, allowing your mind to naturally adjust while giving yourself a sense of control because you know you are doing something about it.

STUDY SPACE

This reemphasizes a few checks from above. I struggled with defining an ideal place to study that was free from the distractions at first. It wasn't until I realized that I was

spending more time chatting with my buddies on IM and falling behind in my defined study calendar. Always have a backup space, maybe a space that you switch out to every other day or two. A library, coffee shop, keep it fresh and distraction free.

ROUTINE

Are you allocating many hours on one day to studying and little to none on other days? Develop a routine where you are dedicating the same amount of time every day to studying for the Engineer in Training Exam and hold firm on starting and stopping at the specified times. This will give you a boost in your studies and your mental state, producing progress in constant small increments. Choppy progress (a lot one day, none the next) can really kill momentum, so establish the momentum through routine and develop the habit, and then let the habit take it from there.

Routine gives you a clear idea of what you want to achieve for the day from the start, because it is clear, the probability is high that you will be able to proactively accomplish your tasks.

As an added strategy for your routine, begin with a difficult subject or task. You'll be fresh, and have more energy to take it on when you are at your best. What subject has always caused you problems?

DISCOURAGEMENT

There will be without a doubt at times during your studies that you will become discouraged. Don't let it wreck shop in your mind. This is something that is natural, acknowledge it, and take a break from studying for a day or so to recharge your mind and get back on track to dominating your studies.

ROLE MODELS

Take a minute to think about the people in your life that have great self-discipline. See how it interconnects with their daily tasks and how it helps them accomplish their goals. Approach them with some questions, ask for advice on how they go about setting up their daily tasks and let them help guide you in your goals.

IDENTIFY MENTORS

A mentor could be your greatest asset in dominating the Engineer in Training exam. They can assist you with questions that you otherwise wouldn't tend to seek answers for. I developed this site as a means to close the gap between you and a mentor. Don't hesitate to approach me with any of your questions or concerns regarding the exam, I am here to help you succeed.

Have a question burning on your mind? Let me help you out, shoot me an email now!

DOMINATE YOUR STUDIES

I have touched on this a couple of times throughout my guide, and I will stress the importance once again. Practice Exams are a must in your preparation for the Engineer in Training Exam. There is no point to going in to arguably one of the most important exams of your life blind, with no knowledge of what the format and type of questions will be asked.

> ***Twenty years from now you will be more disappointed by the things that you didn't do than by the ones you did do. So throw off the bowlines. Sail away from the safe harbor. Catch the trade winds in your sails. Explore. Dream. Discover*** **- Mark Twain**

Practice exams should be used early and often throughout your studies. Prior to opening up your book for your first study session, set aside a good couple of hours to sit down and take a high quality practice exam. This will not only set a baseline for where you started in your studies, but also give you a metric to compare against as you progress. The results of these exams will show you where you stand and how much you need to work on in the certain areas you lack knowledge.

GET STARTED!

There is a Chinese proverb that states that the longest journey is started with a simple first step. In this they mean that it isn't until you start a project, or in this case hitting the books, that you really understand how much of what needs to be done to complete it. There is only so much theory one can develop, details aren't always evident until you are in the midst of it all.

There is another proverb that states that "perfection is the enemy of good". This is especially true when this perfection holds you back from starting something. Are you waiting to get out of that certain class to start studying? Maybe you are waiting to see if you get promoted to that new position? What's holding you back from taking the first step, to commit to dominating the Engineer in Training exam?

What I am getting at here is simple, at this point, you have all the planning, you have thought out your journey, get something done! Given that you have ample time to prepare for the exam, you will be able adjust on the fly as needed after you begin.

So before we go any further, what can you get done today? Open that book, turn to the first chapter, and crank out some review, get those wheels rolling, let's do this together.

> ***Only those who will risk going too far can possibly find out how far one can go* - T. S. Elliot**

DOMINATE THE BOOK

TAKE GOOD NOTES

I am sure we can all go pro when it comes to taking notes. Through all the college classes we have had, we could probably all publish a thousand books each. I know it's a basic concept, but stemming from my experience with the Engineer in Training exam, it's one point the must be rehashed. Here are some tips on maintaining good notes throughout your studies.

- Take notes during all your study sessions. Use a single large spiral bound notebook to consolidate all your notes in to one easy to reference location.
- Give high priority to vocabulary. I make this point because language is a fundamental tool that can make or break you on exam day. If you run through an exam problem and don't know what a term

means, you are going to spend unnecessary time boggling it in your mind. This can be a huge handicap in your efficiency.

- Cruise through the chapter you will be studying and give it a cursory review to get a gist of what you will be covering in your session. When you have finished, return to the beginning and review it in more detail making sure to focus on understanding the concepts. Don't just read the words, engage in the concepts. If you come across a term you don't understand, write it down in your notes and look it up using the internet or some other resource.

- Don't write down every word that you read, but at the same time, don't leave out major theories and/or topics just to save space. If you feel the information you are reading is something that needs to be retained, write it down. Focus on capturing the sequence of the subject starting with the main topic, flowing into each subtopic and on to their subsequent equations, definitions, etc.

- Write your notes down in an outline type format. The organization of the theories is as significant as the substance of those theories.

- Color highlight the important points in both your book and written notes to reemphasize and further retain.

It may also be useful to you to write notes, points, or reminders in the margins of each chapter.

Stay organized with your note taking, if you are confused, it can become your worst enemy and a major roadblock to any progress.

REVIEW YOUR NOTES

Wax on, wax off. Sometimes it's hard for us to grasp just how important repeating a task can be. In sports they say practice makes perfect, but it's not just practice, its perfect practice that makes perfect. Writing notes and forgetting about them can be seen as sloppy practice. You aren't really doing much to retain the information that you are flagging as important. To maximize the information you retain, dedicate time before each study session to sit down and rehash your written notes.

There is research out there that proves that reviewing notes within 24 hours of being exposed to the information will increase you rate of retention by 60%! Think about the progress that can be made within a couple of days; you will rapidly be building a knowledge empire in your mind. If you

want to significantly cut down on the time spent studying, this is the task to start incorporating.

On top of reviewing prior to every study session, dedicate some time weekly to do a full review of what was covered in the week prior. If you developed a study schedule based of my recommendations, then you will be starting a new section every Wednesday. With that, take time on the Tuesday prior to starting the new week to review your notes and assess your overall understanding.

PREPARING FOR EXAM DAY

Maintaining and reviewing your notes is the foundation in the process of retention. If I may use another sports analogy, your notes preserve your progress, they are the Starting Pitcher of the study process. The Closer, however, is the practice problems that are found throughout and at the end of each chapter. These practice problems are written in a manner to reiterate the important fundamentals outlined in each section. They are designed to hammer home theories and further infuse the information deep in to your memory banks. Introducing this form of engagement mixes up the delivery of information, reinforcing your overall ability to comprehend in any way it's presented. Make sure to work each and every problem, taking your time to completely understand them from the beginning to the end, treating them as if they are true exam questions. The following are some other ways to reinforce your studies.

> ***Do not go where the path may lead, go instead where there is no path and leave a trail*** - **Ralph Waldo Emerson**

To dominate in your preparation for the Engineer in Training exam, you must maintain an active mind throughout your studies. An active mind, as opposed to a passive mind, is one that is continually engaging in the information it is receiving, manipulating it into multiple formats that can be easily recognized and understood. Engaging in the material you are studying in as many ways possible maximizes your ability to pull it to the forefront instantly when called upon.

INDEX CARDS

When you reach a solid point that must be memorized, write it down on an index card. On one side, write down

the point, and on the opposite side, write down the definition or key points in full. Use the cards to quiz yourself when you are sitting at lunch or have any other spare time. This is a good flexible way to cash in on some extra studying throughout your day.

EXPAND YOUR INDEX CARDS

Go further than just the basic points and start defining symbols on index cards to help you better recall them at the time of the exam.

DREAM ABOUT YOUR STUDIES

I started doing this sometime while in college. Prior to falling asleep, I would take out my notes and run through them one last time while I was lying in bed. I would then throw them on the ground and hit the sack. It's a miracle, but my brain would actually continue to process the information, and somehow, I would wake up the next day with more knowledge retained than the day before.

DIAGRAMS

If the subject matter includes diagrams (i.e. statics, electrical circuits, etc), practice drawing them using different configurations. Free Body diagrams are basic, but it's amazing how many people freeze up when asked to produce one, you will be asked, so practice now.

PUT THE MIND TO THE TEST

Challenge yourself as much as you can, don't reference back to your book for definitions, equations, etc, make you mind work and see what comes from it.

Bottom line, knowledge is not retained when you become stagnate. Keep your mind moving, keep it fresh, and continue to reiterate your knowledge through consistent review of notes in as many different formats as possible.

INGEST NOTES FOR BREAKFAST

To nail down even more information, go over your notes immediately upon waking while you lie in bed, it works.

YOUR FINAL DAYS

Going in to the final days before the exam, you need to have confidence that you have put in your time. What you know on the Thursday prior to the Engineer in Training exam is what you will know they day of the exam. Trust that you have prepared yourself through your journey, now is not the time to panic. This is a time to reassure yourself of your knowledge, worth and build your self-confidence going in to the exam. Assert to yourself "I have studied hard and know my stuff, I am ready for this exam" and "Others can pass, so can I". The power of positive thinking is real, use it.

Don't attempt to "cram" during every spare moment you have leading in to the Engineer in Training Exam. Doing so will only increase the feeling of desperation which will lead to panic; panic will lead to test anxiety. Test anxiety will most likely lead to you feeling that you need to pull a mega session, or even an all-nighter, the day prior to the exam. You probably already know, but if you don't, trust me that pulling an all-nighter prior to exam day will be virtually ineffective, and destructive to your chances of success. What you may gain from extra study time won't compensate for the loss of alertness and ability to concentrate due to the lack of sleep you received prior to test day. With 8 hours and 180 questions, alertness and concentration are your allies; make sure you have them on your side.

If you have established well organized notes during your studies, spend the Thursday prior to the exam running through them. This kind of memory reinforcement not only improves your performance on the test, it also improves your long-term memory of the material. Leave everything alone on that Friday prior to the exam. Let things simmer, your body and mind need a bit of recovery before you take your seat the next day.

> ***All that we are is the result of what we have thought* - Buddha**

When you awake on exam day, make yourself a high quality breakfast, this will ensure that your energy levels are sustained while you take your exam. Give yourself ample

time to mitigate any travel issues that may come up, you don't want to be rushing to your exam. Keep things even keel, focusing on staying in a confident mindset, reinforcing yourself that you have done all that you can, and that you are prepared to dominate the exam.

If you get to the exam site with extra time prior to the test, don't go and begin cramming. This will produce the same feeling of desperation, panic, and test anxiety as it would any other time. Let the mind free and maintain those positive thoughts. They say 1 positive thought can destroy 99 negative thoughts, make it happen.

HIT THE HEAD

This may seem a little ridiculous, but make it a priority to go to the bathroom just before the exam. Once you begin, you will be able to use the restroom, but its one person at a time, so you may be waiting, with the thoughts going through your head just how bad you need to go. This kills concentration and destroys the already minimal time you have to answer the questions, nip it up front.

RESOURCES

- **EngineerInTrainingExam.com Practice Exam** - Throughout my studies, I found that many of the resources I was spending my money on were falling short in some keys areas important to us aspiring engineers. Recognizing this, I decided to fill a portion of this void by developing a Practice Exam targeting expansion of these weak points. I am not going to give you some fluff sales pitch, this is practice exam developed with you in mind, and what you want is a high quality, well organized exam to practice with that doesn't require you to empty your wallet…you got it.
- **YouTube Video Reviews** (http://www.youtube.com/user/EngineerInTrainingTV)
- **iTunes Podcast**
- **EngineerInTrainingExam.com on Facebook**

EIT ACADEMY | **MATHEMATICS**

A Note from Me to You:

The study schedule I summarized above takes a huge overwhelming task in preparing for the Engineer in Training exam and breaks it down in to a manageable set of stepping stones. Breaking the process down in to something that I could wrap my head around is how I was able to set myself up for success on my journey, and precisely how I got moving.
Successfully preparing for this exam is done one step at a time, period. If you never get moving, you'll definitely never get there…**You need a "Quick Win"**

Whenever we start on a journey, regardless of what it is, we need to **establish a "Quick Win" to help build our morale and give us a sense of achievement and enhanced momentum towards our ultimate goal.** But where can we find that "Quick Win" when it comes to preparing for the Exam? I can suggest one area to consider.

Take a quick look at the specifications of the exam, specifically the breakdown of each topic and its proportion within the exam; which topics initially stand out the most. The first 5 subject areas are Mathematics (15%), Engineering Probability and Statistics (7%), Chemistry (9%), Computers (7%), and Ethics and Business Practices (7%)…and so on.

Right here we are **looking at 45% of the AM exam, 22% of which is straight Math**. So am I saying that getting Math down would be the "Quick Win"? Well the final 55% of the AM exam are the topics of Engineering Economics, Engineering Mechanics, Strength of Materials, Materials Properties, Fluid Mechanics, Electricity and Magnetism, and Thermodynamics. How many do you feel have elements of Math…I would suggest that 100% have some sort of Math included…and that's just the AM session of the Exam.

But let's hold our conclusion and take a look at the first 5 subject areas from the "Other" PM session of the Exam, they are: Advanced Engineering Mathematics (10%), Engineering Probability and Statistics (9%), Biology (5%), Engineering Economics (10%), and Application of Engineer Mechanics (13%)…and so on.

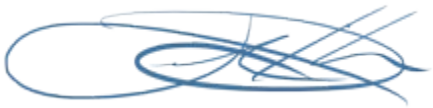
In looking at 47% of the PM 'Other' portion of the exam, chalk it up to another 19% of which is pure Math.
The remaining 53% of the PM exam are the topics of Engineering Materials, Fluids, Electricity and Magnetism, and Thermodynamics and Heat Transfer.

Is Math something that is prevalent in any of these subject areas?

I think we have established where our "Quick Win" lies, and this would be more than a "Quick Win", it would be, proportionally speaking, a "Huge Win".

But where do you Start? Math is huge, yes, Math can be intimidating, yes, but that's precisely why I am creating the most impactful and valuable Math review course you will ever get your hands, to be released soon!

You need to start small. Very small, one subject at a time, from the basics and build on it until eventually (faster than you may think) you have the subject dominated. Let me get you started right now, my gift to you, the complete first module of the yet to be released EngineerInTrainingExam.com EIT Academy Math course. Packed full to the brim, nothing held back, just pure content of value aimed to get you where you need to be NOW. With 2 hours of videos and 44 practice problems with the most in depth solutions, it's guaranteed that this will be the most prized preparation resource you will ever come by.
When you are done, please take a moment and Contact me and let me know what you think! Enjoy!



Justin Dickmeyer, PE

EIT ACADEMY | MATHEMATICS

MODULE 1|ANALYTICAL GEOMETRY

(The following modules and subject material are included in the full EIT Academy Mathematics Course)

MODULE 2|ALGEBRA

Matrix Addition and Subtraction

Matrix Multiplication

Matrix Transpose and Determinate

Elementary Row Operations

Matrix Echelon Form

Dot Product

Cross Product

Simultaneous Linear Equations

Arithmetic Sequences and Series

Geometric Sequences and Series

Power Series

Taylor and Maclaurin Series

MODULE 3 | PROBABILITY AND STATISTICS

Combinations

Permutations

Laws of Probability

Counting Principle

Measures of Central Tendency

Measures of Dispersion

Binomial Distribution and Probability

Normal Distributions

T Distributions

Confidence Intervals

Hypothesis Testing

Linear Regression

MODULE 4 | DIFFERENTIAL CALCULUS

Derivatives

Critical Points

Partial Derivatives

Curvature

L'Hopital's Rule

Integration by Parts

Integration by Substitution

Partial Fractions

MODULE 5 | DIFFERENTIAL EQUATIONS

Bernoulli Differential Equations

Higher Order Homogenous Differential Equations

Higher Order Non-Homogenous Differential Equations

First Order Linear Differential Equations

Separable Differential Equations

LINES | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 21 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

One example of a general class of equations are linear equations in two variables. The two variables are usually *x* and *y*, but obviously don't need to be. Linear equations adhere to the following rules:

1. The variables (usually *x* and *y*) appear only to the first power
2. The variables may be multiplied only by real number constants
3. Any real number term may be added (or subtracted, of course)
4. Nothing else is permitted!

So if any equation contains things like x^2, y^2, $\frac{1}{x}$, xy, square roots, or any other function of x or y, then it is not a straight line.

To define a line we need to specify two distinct pieces of information concerning that line. A line can be defined by specifying two distinct points that the line passes through, or it can be defined by giving one point that it passes through and somehow describing how the "sloped" of the line is.

The *slope* of a line is a measure of how "tilted" the line is and can be equated using the standard formula:

$$m = \frac{rise}{run} = \frac{y_2 - y_1}{x_2 - x_1}$$

Where (x_1, y_1) and (x_2, y_2) are any two distinct points on the line. It makes no difference which two points are used for point 1 and point 2. If they were switched, both the numerator and the denominator of the fraction would be changed to the opposite sign, giving exactly the same result. A horizontal has no slope, or:

$$m = \frac{rise}{run} = 0$$

Specify two distinct pieces of information concerning a line, there are a number of standard equations that can be used to define the line in whole.

SLOPE-INTERCEPT FORM:

If a linear equation in two unknowns is written in the standard form:

$$y = mx + b$$

Where *m* and *b* are any two real numbers, and defines the straight line with a slope of *m* and a *y* intercept equal to *b*.

POINT-SLOPE FORM:

Using the point-slope formula:

$$y - y_1 = m(x - x_1)$$

A line can be defined if one distinct point and the slope of the line is given.

TWO-POINT FORM:

Another way to completely specify a line is to give two different points that the line passes through. If it is given that a line passes through the points (x_1, x_2) and (x_2, y_2),then the two-point formula states that:

$$y - y_1 = \left(\frac{y_2 - y_1}{x_2 - x_1}\right)(x - x_1)$$

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Determine the equation in slope-intercept form for the line that passes through the points (-1,2) and (2,1)

Solution:

Recall that to define a line we need to specify two distinct pieces of information concerning that line. In this case, we have two points, which is sufficient in defining the line that runs through them.

So the first step is to calculate the slope:

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1-2}{2-(-1)} = -\frac{1}{3}$$

Now determine the intercept by taking one of the points and plugging it in to the general slope-intercept equation:

$$b = y_1 - mx_1 = 2 - \left(-\frac{1}{3}\right)(-1) = \frac{5}{3}$$

Now that we have defined m and b, we can plug these values in to define the line in slope-intercept form:

$$y = -\frac{1}{3}x + \frac{5}{3}$$

LINES | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-lines

LINES | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

The y-intercept of a line is 3 and the x-intercept is 2, determine the equation of the line in slope-intercept form.

Problem 2:

Given the following equation of a line in point-slope form:

$$y+1=3(x-2)$$

Determine the y-intercept.

Problem 3:

Find the line parallel to the line $y=2x-1$ which passes through the point (-5, 1).

Solution 1:

Recall that to define a line we need to specify two distinct pieces of information concerning that line. Although maybe not initially obvious, in this case, we have two points, which is sufficient in defining the line.

The two points are (0,3) and (2,0). Using these points, define the slope, which is:

$$m = \frac{3-0}{0-2} = -\frac{3}{2}$$

At this point, we typically would plug in a point, along with the slope, and solve for the y intercept. The problem, however, already gives the y intercept as 3. Plugging this information in to the general slope-intercept equation, we get:

$$y = -\frac{3}{2}x = 3$$

Solution 2:

To determine the y-intercept, simply multiply out the right hand side of the equation and subtract 1 from each side to get it in to the more familiar slope-intercept form:

$$y + 1 = 3(x - 2)$$
$$y + 1 = 3x - 6$$
$$y = 3x - 7$$

Therefore, the y-intercept is -7.

Solution 3:

Parallel lines have the same slope, so if the slope of the line that is given is equal to 2, then:

$$m = 2$$

The line with a slope of 2 also passes through the point (-5,1), plugging the values in to get the intercept gives us:

$$b = 1 - 2(-5) = 11$$

So the equation of the line parallel to the line $y = 2x - 1$ which passes through the point (-5, 1) is:

$$y = 2x + 11$$

QUADRATIC FORMULA | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 21 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

The standard form of a quadratic equation is:

$$ax^2 + bx + c = 0$$

A quadratic equation can be solved by factoring if, after writing it in standard form, the quadratic expression factors. Completing this process can be broken in to 5 steps.

1. Simplify each side:

   This involves things like removing parentheses, fractions, adding like terms, etc.

2. Write in standard form $ax^2 + bx + c = 0$:

   If it is not in standard form, move any terms to the appropriate side by using the addition/subtraction property of equality. Also, make sure that the squared term is written first left to right, the *x* term is second and the constant is third and it is set equal to 0.

3. Factor:

4. Use the Zero-Product Principle:

   If $ab = 0$, then $a = 0$ or $b = 0$. The only way a product can become 0 is if at least one of its factors is 0.

5. Solve for the linear equation set up in the previous step

The quadratic formula can be used to solve any quadratic equation. This is a convenient and a consistent practice due to quadratic equations being difficult to factor most of the time. The 5 steps to complete when using the quadratic formula are:

1. Simplify each side if needed.

   This involves things like removing parentheses, fractions, adding like terms, etc.

2. Write in standard form $ax^2 + bx + c = 0$:
   If it is not in standard form, move any terms to the appropriate side by using the addition/subtraction property of equality. Also, make sure that the squared term is written first left to right, the *x* term is second and the constant is third and it is set equal to 0.

3. Identify *a*, *b*, and *c*:

   When the quadratic equation is in standard form, $ax^2 + bx + c = 0$, then *a* is the coefficient in front of the x^2 term, *b* is the coefficient in front of the *x* term, and *c* is the constant term.

4. Plug the values *a*, *b*, and *c* into the quadratic formula:

   $$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

5. Simplify the results if possible

When a quadratic equation is in standard form, $ax^2 + bx + c = 0$, the expression, $b^2 - 4ac$, that is found under the square root part of the quadratic formula is called the discriminant.

The discriminant tells us how many solutions there will be and if the solutions are real numbers or complex imaginary numbers. The following table defines the possibilities:

Discriminant, $b^2 - 4ac$	Solutions for quadratic equation
$b^2 - 4ac > 0$	Two distinct real solutions
$b^2 - 4ac = 0$	One real solution
$b^2 - 4ac < 0$	Two complex distinct imaginary solutions

To find the discriminant, the same process is used for populating the quadratic formula.

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Determine the roots of the following quadratic equation:

$$x^2 + 2x = 7$$

Solution:

The quadratic formula can be used to solve any quadratic equation. Let's follow the 5 step process:

1. Simplify each side if needed.

   This involves things like removing parentheses, fractions, adding like terms, etc.

   The equation is simplified as given.

2. Write in standard form $ax^2 + bx + c = 0$:

If it is not in standard form, move any terms to the appropriate side by using the addition/subtraction property of equality. Also, make sure that the squared term is written first left to right, the *x* term is second and the constant is third and it is set equal to 0.

All that needs to be done to get the equation in to standard form is to subtract 7 from each side so that:

$$x^2 + 2x - 7 = 0$$

3. Identify *a*, *b*, and *c*:

   When the quadratic equation is in standard form, $ax^2 + bx + c = 0$, then *a* is the coefficient in front of the x^2 term, *b* is the coefficient in front of the *x* term, and *c* is the constant term.

   For the given equation, a=1, b=2, and c=-7

4. Plug the values *a*, *b*, and *c* into the quadratic formula:

$$x = \frac{-2 \pm \sqrt{(2)^2 - 4(1)(-7)}}{2(1)} = \frac{-2 \pm \sqrt{32}}{2}$$

5. Simplify the results if possible

   To simplify, first reduce the square root and then do some canceling so that the roots are:

$$x = \frac{-2 \pm \sqrt{(16)2}}{2} = \frac{-2 \pm 4\sqrt{2}}{2} = \frac{2(-1 \pm 2\sqrt{2}}{2} = -1 \pm 2\sqrt{2}$$

QUADRATIC FORMULA | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-review-%E2%80%93-quadratic-equations/

QUADRATIC FORMULA | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

Determine the roots of the following quadratic equation:

$$3q^2 + 11 = 5q$$

Problem 2:

Determine the roots of the following quadratic equation:

$$7t^2 = 6 - 19t$$

Problem 3:

Determine the solutions to the equation:

$$\frac{3}{y-2} = \frac{1}{y} + 1$$

Solution 1:

Use the 5 step process to finding the roots using the quadratic formula.

1. Simplify each side if needed.

   This involves things like removing parentheses, fractions, adding like terms, etc.

   The equation is simplified as given.

2. Write in standard form $ax^2+bx+c=0$:

   If it is not in standard form, move any terms to the appropriate side by using the addition/subtraction property of equality. Also, make sure that the squared term is written first left to right, the *x* term is second and the constant is third and it is set equal to 0.

   All that needs to be done to get the equation in to standard form is to subtract 5q from each side so that:

   $$3q^2-5q+11=0$$

3. Identify *a*, *b*, and *c*:

   When the quadratic equation is in standard form, $ax^2+bx+c=0$, then *a* is the coefficient in front of the x^2 term, *b* is the coefficient in front of the *x* term, and *c* is the constant term.

   For the given equation, a=3, b=-5, and c=11

4. Plug the values *a*, *b*, and *c* into the quadratic formula:

$$q=\frac{-(-5)\pm\sqrt{(-5)^2-4(3)(11)}}{2(3)}=\frac{5\pm\sqrt{-107}}{6}=\frac{5\pm\sqrt{107}\,i}{6}$$

5. Simplify the results if possible

   To simplify, first reduce the square root as much as you can and then do some canceling if possible, the roots are:

$$q = \frac{5 \pm \sqrt{107}\, i}{6}$$

Solution 2:

Use the 5 step process to finding the roots using the quadratic formula.

1. Simplify each side if needed.

   The equation is simplified as given.

2. Write in standard form $ax^2 + bx + c = 0$:

   All that needs to be done to get the equation in to standard form is to subtract $6 - 19t$ from each side so that:

$$7t^2 + 19t - 6 = 0$$

3. Identify *a*, *b*, and *c*:

   For the given equation, a=7, b=19, and c=-6

4. Plug the values *a*, *b*, and *c* into the quadratic formula:

$$t = \frac{-19 \pm \sqrt{(19)^2 - 4(7)(-6)}}{2(7)} = \frac{-19 \pm \sqrt{529}}{14}$$

5. Simplify the results if possible

The roots are $t = \frac{2}{7} and -3$

Solution 3:

Use the 5 step process to finding the roots using the quadratic formula.

1. Simplify each side if needed.

   This equation has fractions in it, so the first thing we must do is to get rid of these. To do that, identify the least common denominator, which is:

   LCD: $y(y-2)$

   Multiply both sides by the LCD:

   $$y(y-2)(\frac{3}{y-2}) = (\frac{1}{y}+1)y(y-2)$$
   $$3y = y-2+y(y-2)$$
   $$3y = y-2+y^2-2y$$

2. Write in standard form $ax^2+bx+c=0$:

   All that needs to be done now to get the equation in to standard form is to combine terms on the left side of the equation so that:

   $$y^2-4y-2=0$$

3. Identify *a*, *b*, and *c*:

   For the given equation, a=1, b=-4, and c=-2

4. Plug the values *a*, *b*, and *c* into the quadratic formula:

$$y = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(1)(-2)}}{2(1)} = \frac{4 \pm 2\sqrt{6}}{2}$$

5. Simplify the results if possible

   The solutions are then:

$$y = 2 \pm \sqrt{6}$$

PARABOLAS | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 21 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

The most general form of a quadratic function is,

$$f(x) = ax^2 + bx + c$$

The graph of a quadratic equation is called a parabola and generally takes the shape of a "U". Every parabola has an imaginary line that runs down the center of it called the axis of symmetry; where one each side is a mirror image of the other. If one point on one side of the parabola is known, then the point directly on the other side is known based on the axis of symmetry.

The highest or lowest point of a parabola is called the vertex and the parabola may open up or down and may or may not have *x*-intercepts but they will always have a single *y*-intercept.

There are two forms of the parabola to be familiar with. This first form will make defining the characteristics of the parabola fairly easy, however, most parabolas are not given in this form. The second form is the more common form and will require a little more work to define its characteristics.

The first form of the parabola:

$$f(x) = a(x-h)^2 + k$$

There are two pieces of information about the parabola that we can instantly get from a function in this form. First, if *a* is positive then the parabola will open up and if *a* is negative then the parabola will open down. Secondly, the vertex of the parabola is the point (h,k).

Most parabolas aren't given in this form. The more common form we see is the general form:

$$f(x) = ax^2 + bx + c$$

The sign of *a* will still determine whether or not the parabola opens upwards or downwards. To determine the vertex, the following equations are used:

$$\left(-\frac{b}{2a}, f(-\frac{b}{2a})\right)$$

To get the vertex, compute the *x* coordinate from *a* and *b* and then plug the result into the function to get the *y* coordinate.

The *y*-intercept is:

$$f(0) = a(0)^2 + b(0) + c \Rightarrow (0, c)$$

It's important to note that an equation given in the general form can be converted in to the first form by using the process of completing the squares.

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Determine the vertex of the following parabola

$$f(x) = x^2 + 4$$

Solution:

Recall that to determine the vertex, the following equations are used:

$$\left(-\frac{b}{2a}, f(-\frac{b}{2a},)\right)$$

We first compute the *x* coordinate from *a* and *b* and then plug the result into the function to get the *y* coordinate.

In this problem, a=1 and b=0, therefore:

$$-\frac{b}{2a} = -\frac{0}{2(1)} = 0$$

Now,

$$f\left(-\frac{b}{2a}\right) = f(0) = (0)^2 + 4 = 4$$

So the vertex is located at (0,4)

PARABOLAS | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-parabolas-part-1/

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-parabolas-part-2/

PARABOLAS | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

Determine the vertex of the following parabola:

$$f(x)=x^2+4x+4$$

Problem 2:

Convert each of the following into the form $f(x)=(x-h)^2+k$

$$f(x)=2x^2-12x+3$$

Problem 3:

Convert each of the following into the form $f(x)=(x-h)^2+k$

$$f(x)=-x^2+10x-1$$

Solution 1:

Recall that to determine the vertex, the following equations are used:

$$\left(-\frac{b}{2a}, f(-\frac{b}{2a},)\right)$$

We first compute the *x* coordinate from *a* and *b* and then plug the result into the function to get the *y* coordinate.

In this problem, a=1 and b=4, therefore:

$$-\frac{b}{2a}=-\frac{4}{2(1)}=-2$$

Now,

$$f\left(-\frac{b}{2a}\right)=f(-2)=(-2)^2+4(-2)+4=0$$

So the vertex is located at (-2,0)

Solution 2:

The first thing to do is to complete the square. To do this, we need to ensure that there is a coefficient of 1 on the x^2 term, such that:

$$f(x)=2\left(x^2-6x+\frac{3}{2}\right)$$

Now take one half of the coefficient of x term and square it:

$$\left(-\frac{6}{2}\right)^2=(-3)^2=9$$

To maintain the integrity of the original equation, make sure to add and subtract this quantity within the parenthesis so that:

$$f(x) = 2(x^2 - 6x + 9 - 9 + \frac{3}{2}$$

The next step is to factor the first three terms:

$$f(x) = 2\left((x-3)^2 - \frac{15}{2}\right)$$

Finally distribute the 2 back through the equation:

$$f(x) = 2(x-3)^2 - 15$$

The original equation is now in the form $f(x) = (x-h)^2 + k$

Solution 3:

The first thing to do is to complete the square. To do this, we need to ensure that there is a coefficient of 1 on the x^2 term, such that:

$$f(x) = -(x^2 - 10x + 1)$$

Now take one half of the coefficient of x term and square it:

$$\left(-\frac{10}{2}\right)^2 = (-5)^2 = 25$$

To maintain the integrity of the original equation, make sure to add and subtract this quantity within the parenthesis so that:

$$f(x) = -\left(x^2 - 10x + 25 - 25 + 1\right)$$

The next step is to factor the first three terms:

$$f(x) = -\left((x-5)^2 - 24\right)$$

Finally distribute the 2 back through the equation:

$$f(x) = -(x-5)^2 + 24$$

The original equation is now in the form $f(x) = (x-h)^2 + k$

HYPERBOLAS | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 21 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

There are two standard forms for the hyperbola defined by the following characteristics:

Standard Form	$\frac{(x-h)^2}{a^2}-\frac{(y-k)^2}{b^2}=1$	$\frac{(y-k)^2}{b^2}-\frac{(x-h)^2}{a^2}=1$
Center	(h,k)	(h,k)
Orientation	Opens left and right	Opens up and down
Vertices	$(h+a,k)$ and $(h-a,k)$	$(h,k+b)$ and $(h,k-b)$
Slope of Asymptotes	$\pm\frac{b}{a}$	$\pm\frac{b}{a}$
Equations of Asymptotes	$y=k\pm\frac{b}{a}(x-h)$	$y=k\pm\frac{b}{a}(x-h)$

Hyperbolas are two parabola-like shaped pieces that open either up and down or left and right. Just like parabolas, each of the pieces has a vertex.

There are also two lines that may be illustrated along with the Hyperbola, these are called asymptotes. The asymptotes are not officially part of the the hyperbola. The point where the two asymptotes cross is called the center of the hyperbola.

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Determine the equations for the asymptotes of the ellipse defined by the equation:

$$\frac{(x-3)^2}{25}-\frac{(y+1)^2}{49}=1$$

Solution:

When working towards the equation of the asymptotes, it's important to recall the following characteristics of a hyperbola:

Standard Form	$\frac{(x-h)^2}{a^2}-\frac{(y-k)^2}{b^2}=1$	$\frac{(y-k)^2}{b^2}-\frac{(x-h)^2}{a^2}=1$
Center	(h,k)	(h,k)
Orientation	Opens left and right	Opens up and down
Vertices	$(h+a,k)$ and $(h-a,k)$	$(h,k+b)$ and $(h,k-b)$
Slope of Asymptotes	$\pm\frac{b}{a}$	$\pm\frac{b}{a}$
Equations of Asymptotes	$y=k\pm\frac{b}{a}(x-h)$	$y=k\pm\frac{b}{a}(x-h)$

The *y* term has the minus sign and so it's known that the hyperbola will be opening left and right.

The equation is also already in its standard form, so the first thing that can be defined is the center, which is:

(h,k)=(3,-1)

The vertices are then:

(8,-1) and (-2,-1)

Next determine the slopes of the asymptotes. These are given as $\pm\frac{b}{a}$, where $b=7 and a=5$, therefore the slopes are:

$$\pm\frac{7}{5}$$

With the center and the slopes defined, define the equations of the asymptotes as:

$$y=-1+\frac{7}{5}(x-3) \quad \text{and} \quad y=-1-\frac{7}{5}(x-3)$$

HYPERBOLAS | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-hyperbola/

HYPERBOLAS | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

Determine the equations for the asymptotes of the ellipse defined by the equation:

$$\frac{y^2}{9}-(x+2)^2=1$$

Problem 2:

Define the characteristics of the hyperbola defined by:

$$\frac{(x-2)^2}{36}-\frac{(y+3)^2}{64}=1$$

Problem 3:

Determine the equations for the asymptotes of the ellipse defined by the equation:

$$\frac{x^2}{9}-\frac{y^2}{16}=1$$

Solution 1:

When working towards the equation of the asymptotes, it's important to recall the following characteristics of a hyperbola:

Standard Form	$\frac{(x-h)^2}{a^2}-\frac{(y-k)^2}{b^2}=1$	$\frac{(y-k)^2}{b^2}-\frac{(x-h)^2}{a^2}=1$
Center	(h,k)	(h,k)
Orientation	Opens left and right	Opens up and down
Vertices	$(h+a,k)$ and $(h-a,k)$	$(h,k+b)$ and $(h,k-b)$
Slope of Asymptotes	$\pm\frac{b}{a}$	$\pm\frac{b}{a}$
Equations of Asymptotes	$y=k\pm\frac{b}{a}(x-h)$	$y=k\pm\frac{b}{a}(x-h)$

The x term has the minus sign and so it's known that the hyperbola will be opening up and down.

The equation can be revised a little to represent more the standard form that we are used to working with, this gives:

$$\frac{(y-0)^2}{9}-\frac{(x+2)^2}{1}=1$$

In its standard form, the center can be determined, which is:

(h,k)=(-2,0)

The vertices are then:

(-2,0) and (-2,-3)

Next determine the slopes of the asymptotes. These are given as $\pm\frac{b}{a}$, where $b=3 and\, a=1$, therefore the slopes are:

$$\pm 3$$

With the center and the slopes defined, define the equations of the asymptotes as:

$$y=3(x+2)$$

And

$$y=-3(x+2)$$

Solution 2:

From quick observation, the y term has the minus sign and so it's known that the hyperbola will be opening up and down. The characteristics that we will want to define are then:

Standard Form	$\frac{(x-h)^2}{a^2}-\frac{(y-k)^2}{b^2}=1$
Center	(h,k)
Orientation	Opens left and right
Vertices	$(h+a,k)$ and $(h-a,k)$
Slope of Asymptotes	$\pm\frac{b}{a}$
Equations of Asymptotes	$y=k\pm\frac{b}{a}(x-h)$

The equation is already in its standard form:

$$\frac{(x-2)^2}{36}-\frac{(y+3)^2}{64}=1$$

The center is located at:

(2,-3)

Note that $a=6 \, and \, b=8$ so the vertices are then:

(8,-3) and (-4,-3)

The slopes of the asymptotes are given by $\pm\frac{b}{a}$:

$$\pm\frac{8}{6}=\pm\frac{4}{3}$$

Solution 3:

When working towards the equation of the asymptotes, it's important to recall the following characteristics of a hyperbola:

Standard Form	$\frac{(x-h)^2}{a^2}-\frac{(y-k)^2}{b^2}=1$	$\frac{(y-k)^2}{b^2}-\frac{(x-h)^2}{a^2}=1$
Center	(h,k)	(h,k)
Orientation	Opens left and right	Opens up and down
Vertices	$(h+a,k)$ and $(h-a,k)$	$(h,k+b)$ and $(h,k-b)$
Slope of Asymptotes	$\pm\frac{b}{a}$	$\pm\frac{b}{a}$
Equations of Asymptotes	$y=k\pm\frac{b}{a}(x-h)$	$y=k\pm\frac{b}{a}(x-h)$

The *y* term has the minus sign and so it's known that the hyperbola will be opening left and right.

The equation can be revised a little to represent more the standard form that we are used to working with, this gives:

$$\frac{(x-0)^2}{9}-\frac{(y-0)^2}{16}=1$$

The center can now be defined as:

(h,k)=(0,0)

The vertices are then:

(0,0)

Next determine the slopes of the asymptotes. These are given as $\pm\frac{b}{a}$, where $b=4$ and $a=3$, therefore the slopes are:

$$\pm\frac{4}{3}$$

With the center and the slopes defined, define the equations of the asymptotes as:

$$y=\frac{4}{3}x$$

And

$$y=-\frac{4}{3}x$$

ELLIPSES | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 21 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

The standard form of an ellipse is given by the equation:

$$\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$$

Where the left side always must be 1 in order to be in the standard form and the point (h,k) is the center of the ellipse.

It is important to note that *a* is the square root of the number under the *x* term and is the amount that we move right and left from the center. Also, *b* is the square root of the number under the *y* term and is the amount that we move up or down from the center.

An ellipse can quickly be graphed by defining the four extreme points, the right most, left most, top most, and bottom most. To find these points, the following formulas can be used:

Right most: $(h+a,k)$
Left most: $(h-a,k)$
Top most: $(h,k+b)$
Bottom most: $(h,k-b)$

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Determine the Center of the ellipse as well as the right most, left most, top most, and bottom most point:

$$4(x+1)^2+(y+3)^2=1$$

Solution:

Recall that the standard form of an ellipse is given by the equation:

$$\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$$

The first step is to rearrange the equation that is given so that it is in a more familiar form that we are able to work with. Doing so we get:

$$\frac{(x+1)^2}{\frac{1}{4}}+(y+3)^2=1$$

Note that there isn't a variable below the *y* term, which indicates that $b^2=1$. This value can be placed in to the equation so that it replicates the exactly the standard form:

$$\frac{(x+1)^2}{\frac{1}{4}}+\frac{(y+3)^2}{1}=1$$

In the standard form, the point (h,k) is the center of the ellipse, which in this case is (-1,3). The value of $a=\frac{1}{2}$ and $b=1$. the right most, left most, top most, and bottom most points are then:

Right Most Point: $(-\frac{1}{2},-3)$

Left Most Point: $(-\frac{3}{2},-3)$

Top Most Point: $(-1,-2)$

Bottom Most Point: $(-1,-4)$

ELLIPSES | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-ellipse/

ELLIPSES | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

Determine the Center of the ellipse as well as the right most, left most, top most, and bottom most point:

$$\frac{x^2}{100}+\frac{y^2}{64}=1$$

Problem 2:

Determine the Center of the ellipse as well as the right most, left most, top most, and bottom most point:

$$25x^2+y^2=25$$

Problem 3:

Determine the Center of the ellipse as well as the right most, left most, top most, and bottom most point:

$$\frac{x^2}{49}+\frac{(y-3)^2}{4}=1$$

Solution 1:

The equation is given in the standard form:

$$\frac{x^2}{100}+\frac{y^2}{64}=1$$

The point (h,k) is the center of the ellipse, which is (0,0). The value of $a=10$ and $b=8$. The right most, left most, top most, and bottom most points are then:

Right Most Point:	(10,0)
Left Most Point:	(-10,0)
Top Most Point:	(0,8)
Bottom Most Point:	(0,-8)

Solution 2:

The standard form of an ellipse is given by the equation:

$$\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$$

Rearranging the equation we get:

$$x^2+\frac{y^2}{25}=1$$

In this form, the point (h,k) is the center of the ellipse, which is (0,0). The value of $a=1$ and $b=5$. The right most, left most, top most, and bottom most points are then:

Right Most Point:	(1,0)
Left Most Point:	(-1,0)

Top Most Point: (0,5)
Bottom Most Point: (0,-5)

Solution 3:

The standard form of an ellipse is given by the equation:

$$\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$$

For the most part, the original equation is given to us in the standard form, note that there is no value being subtracted from x, that indicates the $h=0$.

$$\frac{(x-0)^2}{49}+\frac{(y-3)^2}{4}=1$$

In this form, the point (h,k) is the center of the ellipse, which is (0,3). The value of $a=7$ and $b=2$. The right most, left most, top most, and bottom most points are then:

Right Most Point: (7,3)
Left Most Point: (–7,3)
Top Most Point: (0,5)
Bottom Most Point: (0,1)

CIRCLES | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 22 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

When given any two points (x_1, y_1) and (x_2, y_2) the distance between them is given by the Distance Formula:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

This formula can be used to define a circle composed of all the points that are a certain distance d, or r, from a given central point, (h, k). In other words, if (x, y) is any point on a circle and has a distance of r from the center, (h, k), the distance formula can be adjusted to account for this such that:

$$r = \sqrt{(x - h)^2 + (y - k)^2}$$

Or, by squaring both sides:

$$(x - h)^2 + (y - k)^2 = r^2$$

Which is the standard form of the equation of a circle with radius r centered at (h, k).

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Determine the equations of the circle with a radius of 6 and centered at (-3,4):

Solution:

The standard form of an equation of a circle with radius *r* centered at (h,k) is given by:

$$(x-h)^2+(y-k)^2=r^2$$

The center is given as (-3,4) with a radius 6, therefore:

h=-3
k=4
r=6

Plugging these values in to the standard equation gives the result:

$$(x+3)^2+(y-4)^2=36$$

CIRCLES | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-circles/

CIRCLES | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

Find the center and radius of the circle given by the equation $x^2 - 6x + y^2 + 10y + 25 = 0$

Problem 2:

Find the points of intersection between the circle defined by $x^2 + y^2 - x - 3y = 0$ and the line $y = x - 1$.

Problem 3:

Find the center and radius of the circle given by the equation $3x^2 + 3y^2 - 12x + 4 = 0$

Solution 1:

Given the equation $x^2-6x+y^2+10y+25=0$, the first step is to rearrange it so that it is in the standard form $(x-h)^2+(y-k)^2=r^2$.

Subtract the constant 25 from each side and then complete the square on both x and y such that:

$$x^2-6x+y^2+10y=-25$$
$$\left(x^2-6x+9\right)+(y^2+10y+25)=-25+9+25$$

Factoring and simplifying we get:

$$\left(x-3\right)^2+\left(y+5\right)^2=9$$

With the equation now in the standard form, both the radius, *r*, and the center, (h,k), can be defined as:

Radius $r=3$
Center $\left(h,k\right)=(3,-5)$

Solution 2:

Solve the two equations simultaneously by substituting the expression $y=x-1$ in to the equation of the circle such that:

$$x^2+(x-1)^2-x-3(x-1)=0$$
$$x^2+x^2-2x+1-x-3x+3=0$$
$$2x^2-6x+4=0$$
$$x^2-3x+2=0$$

Finally factoring:

$$(x-1)(x-2)=0$$

Which shows that the solutions where the equation will equal zero (ie intersect) is x=1 or x=2. Plugging these values in to the equation $y=x-1$ to find the y-values of the intersection points, we get:

y=0 and y=1

Therefore, the points of intersection between the circle defined by $x^2+y^2-x-3y=0$ and the line $y=x-1$ are at (1,0) and (2,1).

Solution 3:

Given the equation $3x^2+3y^2-12x+4=0$, the first step is to rearrange it so that it is in the standard form $(x-h)^2+(y-k)^2=r^2$.

Collect the x and y terms, then divide through by 3 such that:

$$x^2-4x+y^2+\frac{4}{3}=0$$

Subtract the constant from each side and compete the square on the x term:

$$\left(x^2-4x+4\right)+y^2=-\frac{4}{3}+4$$

Factoring and simplifying we get:

$$(x-2)^2+(y+0)^2=\frac{8}{3}$$

With the equation now in the standard form, both the radius, r, and the center, (h,k), can be defined as:

Radius $r = \sqrt{\frac{8}{3}}$

Center $(h,k) = (2,0)$

DISTANCE FORMULA | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 21 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

The Distance Formula can be used to quickly and efficiently determine the distance between any two points within the same plane. Given two points (x_1, y_1) and (x_2, y_2) the distance between these points is given by the formula:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

One can resort to plotting the two points, drawing the right triangle, and then using the Pythagorean Theorem to determine the hypotenuse, which will be the distance between the two points. However, this process can obviously become tedious, and the Distance Formula gives the same result with some minor tweaking of the Pythagorean Theorem to account for the two points.

It's important to note that the subscripts only indicate that there is a "first" and "second" point. Whichever one is called "first" or "second" is not important, as the result will be the same regardless.

The most common mistake made when using the Distance Formula is mixing up the *x* and *y*-values. Be conscious to not subtract an *x* from a *y*, or vice versa; make sure you've paired the numbers properly.

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Determine the distance between the points (3, –8) and (–2, –5)

Solution:

Given two points (x_1, y_1) and (x_2, y_2) the distance between these points is given by the formula:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

As defined in the problem, Substitute $(x_1, y_1) = (3, -8)$ and $(x_2, y_2) = (-2, -5)$

Plugging these points in to the distance formula:

$$d = \sqrt{((-2) - 3)^2 + ((-5) - (-8))^2}$$

Simplifying to get:

$$d = \sqrt{(-5)^2 + (3)^2} = \sqrt{25 + 9}$$

$$d = \sqrt{34}$$

The distance between the points (3, –8) and (–2, –5) is approximately 5.83 unit

DISTANCE FORMULA | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-distance-formula/

DISTANCE FORMULA | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

Determine the distance between the points $(5,15)$ and $(-10,11)$

Problem 2:

Given the points $(30,-3)$ and $(a,7)$, determine the value of a if the points the points is $\sqrt{424}$

Problem 3:

Given the points $(4,-5)$ and $(-2,a)$, determine the value of a if the points the points is $\sqrt{85}$

Solution 1:

Given two points (x_1, y_1) and (x_2, y_2) the distance between these points is given by the formula:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

As defined in the problem, Substitute $(x_1, y_1) = (5,15)$ and $(x_2, y_2) = (-10,11)$

Plugging these points in to the distance formula:

$$d = \sqrt{((-10) - 5)^2 + (11 - 15)^2}$$

Simplifying to get:

$$d = \sqrt{(-15)^2 + (-4)^2} = \sqrt{225 + 16}$$

$$d = \sqrt{241}$$

The distance between the points $(5,15)$ and $(-10,11)$ is approximately 15.5 units

Solution 2:

This problem is worked in reverse. Given:

$$\sqrt{424} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Plug in the points $(30,-3)$ and $(a,7)$:

$$\sqrt{424} = \sqrt{(a - 30)^2 + (7 - (-3))^2}$$

Expanding and simplifying:

$$\sqrt{424} = \sqrt{a^2 - 60a + 1000}$$

$$424 = a^2 - 60a + 1000$$

Rearrange and factor:

$$a^2 - 60a + 576 = 0$$

$$(a - 48)(a - 12) = 0$$

$$a = 48 \, or \, 12$$

Therefore, the point $(48,7)$ and $(12,7)$ is $\sqrt{424}$ units away from the point $(30,-3)$

Solution 3:

Given the points $(4,-5)$ and $(-2,a)$, determine the value of a if the points the points is $\sqrt{85}$

This problem is worked in reverse. Given:

$$\sqrt{85} = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

Plug in the points $(4,-5)$ and $(-2,a)$:

$$\sqrt{85} = \sqrt{((-2) - 4)^2 + (a - (-5))^2}$$

Expanding and simplifying:

$$\sqrt{85} = \sqrt{a^2 + 10a + 61}$$

$$85 = a^2 + 10a + 61$$

Rearrange and factor:

$$a^2 + 10a - 24 = 0$$

$$(a + 12)(a - 2) = 0$$

$$a = -12 \, or \, 2$$

Therefore, the point $(-2,12)$ and $(-2,2)$ is $\sqrt{85}$ units away from the point $(4,-5)$

LAW OF SINES | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 22 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

The Law of Sines states that for any triangle, the ratio of a side length to the sine of its opposite angle is the same for all three sides, such that:

$$\frac{a}{\sin A} = \frac{b}{\sin B} + \frac{c}{\sin C}$$

Where A is the angle opposite side a, B is the angle opposite side b, and C is the angle opposite side c.

The Law of Sines allows for any unknown angles or sides of a triangle to be defined given other relevant information. Depending on what information is given, one may need to use this law in combination with others to completely solve the triangle.

Use the Law of Sines when:

- One side and it's opposite angle is known

To find:

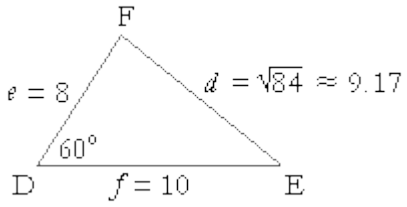
- One or more other unknown sides or angles

Once one of the Sine ratios is known, then it can be used to find other sides and angles using other given information.

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Given the following triangle:



Determine the angles E and F

Solution:

The Law of Sines states:

$$\frac{d}{\sin D} = \frac{e}{\sin E} = \frac{f}{\sin F}$$

Therefore, with the given information, we can plug in the values and solve for the Angle F:

$$\frac{\sqrt{84}}{\sin 60} = \frac{10}{\sin F}$$

$$F = \sin^{-1}\frac{10\sin 60}{\sqrt{84}} = 71^\circ$$

Knowing all angles must add up to 180 degrees, Angle E is:

$$E = 180 - 71 - 60 = 49^\circ$$

LAW OF SINES | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:
http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-law-of-sines/

LAW OF SINES | PRACTICE PROBLEMS

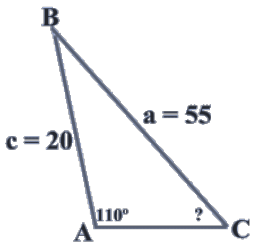
Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

Given an ABC triangle, side b and angle B, which are opposite from one another, are 14 units and 40° respectively, and side c is 12 units. Use the law of sines to determine the remaining angles and sides.

Problem 2:

In the triangle below, $a = 55$, $c = 20$, and $A = 110^{\circ}$, determine the measure of Angle C.



Problem 3:

Determine the Ratio of Side p to Side q if $\sin P = \frac{1}{3}$, $\sin Q = \frac{1}{4}$, and $R = 110^{\circ}$

Solution 1:

Recall that the Law of Sines states that for any triangle, the ratio of a side length to the sine of its opposite angle is the same for all three sides, such that:

$$\frac{a}{\sin A} = \frac{b}{\sin B} + \frac{c}{\sin C}$$

We know side b and angle B, which can be used to define the ratios:

$$\frac{14}{\sin 40} = 21.8$$

Determining the remaining sides and angles of the triangle:

Angle C:

$$\frac{12}{\sin C} = 21.8$$

$$C = \sin^{-1}\frac{12}{21.8} = 33.3^{\circ}$$

Now with Angle B and C, Angle A is:

$$180 - 33.3 - 40 = 106.7^{\circ}$$

Determining the final unknown, Side a:

$$\frac{a}{\sin 106.7} = 21.8$$

Solution 2:

Given $a = 55$, $c = 20$, and $A = 110^\circ$, Angle C can quickly be defined using the law of sines, such that:

$$\frac{a}{\sin A} = \frac{c}{\sin C}$$

$$\frac{54}{\sin 110} = \frac{20}{\sin C}$$

$$\sin C = \frac{20 \sin 110}{55}$$

$$C = \sin^{-1}(.342) = 20^\circ$$

Solution 3:

To determine the Ratio of Side p to Side q, we only need to know that $\sin P = \frac{1}{3}$, $\sin Q = \frac{1}{4}$, and that the law of sines states:

$$\frac{p}{\sin P} = \frac{q}{\sin Q} = \frac{r}{\sin R}$$

Plug in the given information:

$$\frac{p}{\frac{1}{3}} = \frac{q}{\frac{1}{4}}$$

Rearranging:

$$\frac{1}{4}p = \frac{1}{3}q$$

$$\frac{1}{3} \cdot \frac{4}{1}q = p$$

Therefore:

$$\frac{p}{q} = \frac{4}{3}$$

The ratio of side p to side q is 4:3

LAW OF COSINES | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 22 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

The Law of Cosines is used to solve for any unknown angles or sides of triangles that are not right-angled, also known as oblique triangles. When two sides of a triangle and the angle between those two sides is known, the the Law of Cosines allows us to find the third side. The Law of Cosines states:

$$c^2 = a^2 + b^2 - 2ab\cos\Theta$$

Note that The Law of Cosines is an extension of the Pythagorean theorem, where if $\Theta = 90^\circ$ then we would have $c^2 = a^2 + b^2$.

Use the Law of Cosines to find:

- The third side of a triangle two sides and the angle between those sides is known
- The angles of a triangle when all three sides of the triangle are known and you need to determine a certain angle.

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

In triangle, DEF, where the side $e = 8$, the side $f = 10$, and the angle of D is 60° determine the length of side *d*.

Solution:

Given two sides and the angle between them, the Law of Cosines can be used to determine the length of the final side. Recall that the Law of Cosines states:

$$d^2 = e^2 + f^2 - 2ef\cos\Theta$$

Plugging in the given values, we get:

$$d^2 = 8^2 + 10^2 - 2(8)(10)\cos 60^\circ = 84$$
$$d = \sqrt{84}$$

Therefore, the length of side d is approximately 9.17.

LAW OF COSINES | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

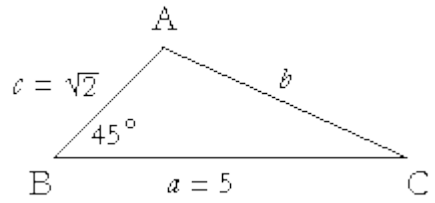
http://www.engineerintrainingexam.com/fundamentals-of-engineering-fe-eit-exam-review-law-of-cosines/

LAW OF COSINES | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

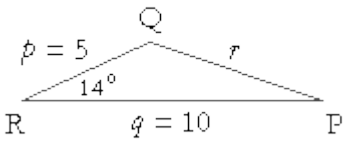
Problem 1:

In the oblique triangle ABC, determine side *b* if side $a = 5$, $c = \sqrt{2}$, and the angle between them is 45°.



Problem 2:

In the oblique triangle PQR, find side *r* if side $p = 5$, side $q = 10$, and the angle between them is 14°.



Problem 3:

Determine the largest angle of the triangle with the three sides measuring 20, 30, and 40.

Solution 1:

Recall that we use the Law of Cosines to find:

- The third side of a triangle two sides and the angle between those sides is known
- The angles of a triangle when all three sides of the triangle are known and you need to determine a certain angle.

In this case, we are given two sides and the angle between them, therefore, the Law of Cosines states:

$$b^2 = a^2 + c^2 - 2ac\cos 45^\circ$$
$$b^2 = 5^2 + (\sqrt{2})^2 - 2(5)(\sqrt{2})\cos 45^\circ = 17$$
$$b = \sqrt{17}$$

The length of side b is approximately 4.12

Solution 2:

The unknown side r is found by using the Law of Cosines, such that:

$$r^2 = 5^2 + 10^2 - 2(5)(10)\cos 14^\circ = 28$$
$$r = \sqrt{28}$$

The length of side r is approximately 5.29

Solution 3:

The largest angle is opposite the longest side, therefore, the Law of Cosines states:

$$c^2 = a^2 + b^2 - 2ab\cos C$$

Plugging in the smaller two sides as a and b gives us:

$$40^2 = 20^2 + 30^2 - 2(20)(30)b\cos C$$
$$300 = 1200\cos C$$
$$\frac{300}{1200} = \cos C$$

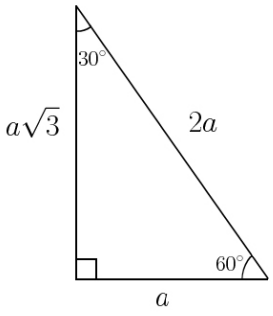
The largest angle is then:

$$C = 104^\circ$$

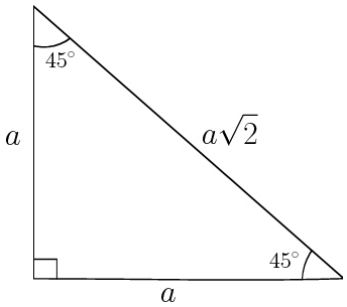
RIGHT TRIANGLES | CONCEPT INTRODUCTION

When dealing with specific cases of a right triangle, we are able to solve for missing sides and angles which we would be able to find otherwise with the Pythagorean Theorem alone. There are two special cases of note, the 30-60-90 and 45-45-90 right triangles.

In a 30-60-90 degree right triangle, the length of the hypotenuse is twice the length of the shorter leg, and the length of the longer leg is $\sqrt{3}$ times the length of the shorter leg. To illustrate this, a 30-60-90 triangle has the following general characteristics:



In a 45-45-90 degree right triangle, the length of legs are the same and the length of the hypotenuse is $\sqrt{2}$ times the length of the legs. To illustrate this, a 45-45-90 triangle has the following general characteristics:



Using the rules of these special triangles allows one to take limited information and solve for the remaining unknown characteristics.

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Determine the length of the hypotenuse of a right triangle if the lengths of the other two sides are both 3 inches.

Solution:

Recall that in a 45-45-90 degree right triangle, the length of the legs are the same and the length of the hypotenuse is $\sqrt{2}$ times the length of the legs. Since we know that the legs are the same length, we can conclude that this is a 45-45-90 degree right triangle.

Like the definition states, the length of the hypotenuse is $\sqrt{2}$ times the length of the legs. The legs are 3 inches, therefore the hypotenuse is $3\sqrt{2}$ inches.

RIGHT TRIANGLES | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-right-triangles/

RIGHT TRIANGLES | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

Determine the lengths of the other two sides of a right triangle if the length of the hypotenuse is $4\sqrt{2}$ inches and one of the angles is 45°

Problem 2:

The shortest side of a 30-60-90 degree right triangle is 4, find the lengths of the other two sides.

Problem 3:

The longest side of a 30-60-90 degree right triangle is $8\sqrt{3}$, determine the length of the hypotenuse.

Solution 1:

The problem states that this is a right triangle and that one of the angels is 45°, therefore, this is a 45-45-90 degree right triangle. In a 45-45-90 degree right triangle, the length of legs are the same and the length of the hypotenuse is $\sqrt{2}$ times the length of the legs.

If the hypotenuse is $4\sqrt{2}$ inches, then the other two sides, which are the same length, are 4 inches.

Solution 2:

In a 30-60-90 degree right triangle, the length of the hypotenuse is twice the length of the shorter leg, and the length of the longer leg is $\sqrt{3}$ times the length of the shorter leg.

The problem states that the shortest side is equal to 4, therefore, the hypotenuse is 2(4) or 8, and the longer leg is $4\sqrt{3}$.

Solution 3:

This is another 30-60-90 degree right triangle. With a longer side of $8\sqrt{3}$, the shorter side is equal to 8 and the hypotenuse is equal to 8(2) or 16.

TRIGONOMETRIC RATIOS | CONCEPT INTRODUCTION

NOTE: Topic can be referenced on page 22 of the NCEES Supplied Reference Handbook, 8th edition, 2nd revision.

There are three basic trigonometric ratios which form the foundation of trigonometry; they are known as the sine, cosine and tangent ratios. Using these ratios will allow us to find missing sides and angles of right triangles. The three basic trig functions are defined as:

Sine:

$$sin\theta = \frac{opposite}{hypotenuse}$$

Cosine:

$$cos\,\theta = \frac{adacent}{hypotenuse}$$

Tangent:

$$tan\theta = \frac{opposite}{adjacent}$$

If it's easier to recall the general trig ratio, you can remember the Indian Chief Soh Cah Toa, that is:

- (S)ine theta is equal to (O)pposite over (H)ypotenuse
- (C)osine theta is equal to (A)djacent over (H)ypotenuse
- (T)angent theta is equal to (O)pposite over (A)djacent

Given a combination of sides and angles in a right triangle, we can use these ratios to determine other unknowns within the same triangle.
Three are three other trig ratios called the reciprocal trig ratios that are not used in solving for unknowns within a triangle, but are used often in higher level mathematics, they are defined as:

Cosecant:

$$csc\theta = \frac{1}{sine} = \frac{hypotenuse}{opposite}$$

Secant:

$$sec\theta = \frac{1}{cosine} = \frac{hypotenuse}{adjacent}$$

Cotangent:

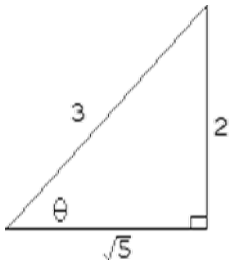
$$cot\theta = \frac{1}{tangent} = \frac{adjacent}{opposite}$$

It is important to note that the $\sin^{-1}$ (and others) key on your calculator does not represent the cosecant function, but rather the inverse sine, these are different functions.

Concept Example:

The following problem introduces the concept reviewed within this module. Use this content as a primer for the subsequent material.

Find the six trigonometric ratios of the angle θ in the following diagram:



Solution:

Recall Soh Cah Toa, that is:

- (S)ine theta is equal to (O)pposite over (H)ypotenuse
- (C)osine theta is equal to (A)djacent over (H)ypotenuse
- (T)angent theta is equal to (O)pposite over (A)djacent

Then the reciprocal of these trig ratios to determine the cosecant, secant, and cotangent. So the ratios are:

$$\sin\theta = \frac{o}{h} = \frac{2}{3} \qquad \csc\theta = \frac{h}{o} = \frac{3}{2}$$

$$\cos\theta = \frac{a}{h} = \frac{\sqrt{5}}{3} \qquad \sec\theta = \frac{h}{o} = \frac{3}{\sqrt{5}}$$

$$\tan\theta = \frac{o}{a} = \frac{2}{\sqrt{5}} \qquad \cot\theta = \frac{a}{o} = \frac{\sqrt{5}}{2}$$

TRIGONOMETRIC RATIOS | VIDEO REVIEW

In this section of the EIT Academy Math course, we will reinforce your understanding of the key concept covered in this workshop. In this video, we will discuss the topic at hand by first grasping the definition and then working through some examples.

Video Link:

http://www.engineerintrainingexam.com/fundamentals-of-engineering-exam-review-trig-ratios/

TRIGONOMETRIC RATIOS | PRACTICE PROBLEMS

Complete the following problems to reinforce your understanding of the concept covered in this module.

Problem 1:

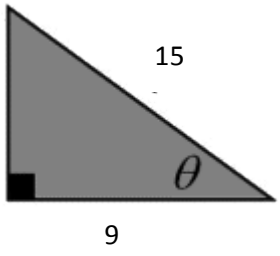
If $\cos\theta = \frac{3}{4}$, find the other five trigonometric ratios of θ.

Problem 2:

If $\sin\theta = \frac{2}{3}$ and $\cos\theta = \frac{\sqrt{5}}{3}$, determine $sec\theta$ and $cot\theta$

Problem 3:

Given the following triangle, express the exact value of the six trig functions in relation to theta.



Solution 1:

Since $\cos\theta$ is defined as the ratio of the adjacent side to the hypotenuse, we can use the Pythagorean Theorem to determine the length of the opposite side.

Recall that the Pythagorean Theorem

$$a^2 + b^2 = c^2$$

Where a is defined as 3 and the hypotenuse is equal to 4, therefore:

$$3^2 + b^2 = 4^2$$

And

$$b^2 = 16 - 9 \text{ or } b = \sqrt{7}$$

The triangle now has an angle θ with an adjacent side (a) equal to 3, the opposite side (o) equal to $\sqrt{7}$, and the hypotenuse equal to 4. Therefore, the five remaining trig ratios can be defined as:

$$\sin\theta = \frac{\sqrt{7}}{4} \quad \csc\theta = \frac{4}{\sqrt{7}}$$
$$\cos\theta = \frac{3}{4} \quad \sec\theta = \frac{4}{3}$$
$$\tan\theta = \frac{\sqrt{7}}{3} \quad \cot\theta = \frac{3}{\sqrt{7}}$$

Solution 2:

The problem states that $\sin\theta = \frac{2}{3}$ and $\cos\theta = \frac{9}{15}$.

Recall Soh Cah Toa, that is:

- (S)ine theta is equal to (O)pposite over (H)ypotenuse
- (C)osine theta is equal to (A)djacent over (H)ypotenuse

So:

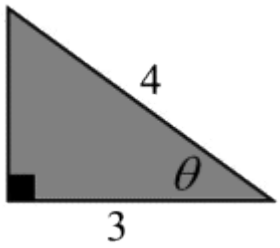
$$sin\theta = \frac{o}{h} = \frac{2}{3} \quad \text{and} \quad cos\theta = \frac{a}{h} = \frac{\sqrt{5}}{3}$$

This tells us that we are working with a triangle that has an adjacent side (a) equal to $\sqrt{5}$, and opposite side equal to 2, and a hypotenuse equal to 3. Therefore:

$$sec\theta = \frac{h}{o} = \frac{3}{\sqrt{5}} \quad \text{and} \quad cot\theta = \frac{a}{o} = \frac{\sqrt{5}}{2}$$

Solution 3:

The first step is to determine the length of the missing side by using the Pythagorean Theorem. The triangle given is:



$$a^2 + b^2 = c^2$$

Where *a* is defined as 9 and the hypotenuse is equal to 15, therefore:

$$9^2 + b^2 = 15^2$$

And

$b^2 = 225 - 81$ or $b = 12$

The triangle now has an angle θ with an adjacent side (a) equal to 9, the opposite side (o) equal to 12, and the hypotenuse equal to 15. Therefore, the five remaining trig ratios can be defined as:

$$\sin\theta = \frac{12}{15} \qquad \csc\theta = \frac{15}{12}$$
$$\cos\theta = \frac{9}{15} \qquad \sec\theta = \frac{15}{9}$$
$$\tan\theta = \frac{12}{9} \qquad \cot\theta = \frac{9}{12}$$