STUDY FOR FE

FE ELECTRICAL AND COMPUTER EXAM PREPARATION PLANNER

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"The journey of a thousand miles begins with a single step."

Famous Proverb

3-Step Pyramid Approach

The 3-Step Pyramid approach discussed here forms basis of most projects. FE Electrical and Computer exam preparation shall be considered a project because like any other project it requires investment of time, effort and money. Project objective is to pass the exam in first attempt with most efficient use of our resources.

1. Setting the right mindset forms foundation of this approach.
2. Planning the work is a crucial step.
3. Working the plan is the final and most important phase.

Execution

Planning

Mindset

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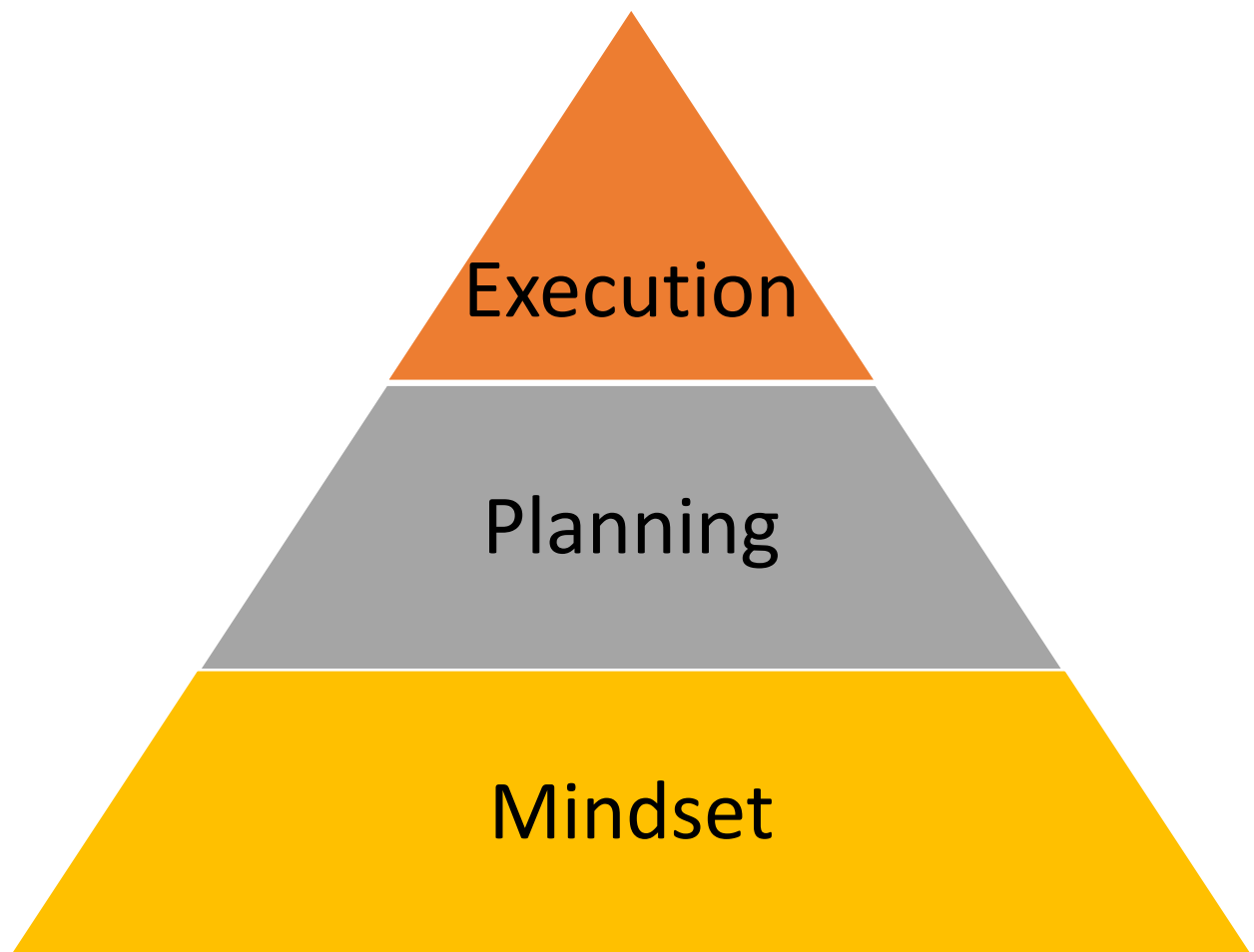
SECTION #1:
THE RIGHT MINDSET

Section #1 includes:

- Benefits of PE license
- FE Electrical & Computer exam overview
- **FE-Style Sample Problems**
- FE Electrical & Computer exam challenges
- Playing to win attitude
- Leaving no stone unturned

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Benefits of PE license:

Why discuss benefits of PE license? What does it have to do with the mindset. Well, it is important to fully appreciate the fact that your project goal carries significant benefits. Otherwise, what is the point of going through all the trouble?

Based on multiple surveys across the country, some of the most important benefits of PE license include:

Proof of commitment to profession – The rigorous process of obtaining PE license clearly demonstrates licensee's commitment to engineering profession. It serves as an obvious differentiator for employers and clients.

Career Progression – PE license can open many doors, both within and outside of your current job. It demonstrates your willingness to take career ownership which translates into increased confidence in your abilities on part of the employer. In fact, many job positions specifically identify PE license as a requirement.

Ability to sign and seal – Only a PE have the authority to sign and seal engineering design, plans and specifications. It is a serious crime to call yourself a PE and act as such without having authentic designation.

Job security – In present day's fast changing economies, every industry is undoing a revolution. Outsourcing is mainstream and automation is the future. PE license not only provides greater job security to licensees but also offers a competitive edge.

Higher Salary - PE license results in frequent promotions and higher salary. Professional Engineers take additional responsibilities which is recognized and compensated accordingly in both public and private organizations.

FE Electrical & Computer exam overview

It is important to discuss this topic briefly to educate ourselves about the scope of this project. Fundamentals of Engineering (FE) Electrical and Computer exam is focused on 4-year undergraduate Electrical and Computer Engineering college coursework. Technical competency of candidate is evaluated through Computer-based Testing (CBT) exam which was introduced in 2014.

The exam consists of 110 questions which can asked in the form of multiple choice, fill in the blank, selecting a point of graph etc. It is a timed test and candidates have 5 hours and 20 minutes to complete the test. It gives the candidates approximately 2 minutes and 54 seconds per question which includes the time to:

- Read the question ~ 30 seconds   Timer – 00:30
- Review the options (if given) ~ 10 seconds   Timer – 00:40
- Think about solution ~ 20 seconds   Timer – 01:00
- Find equation/concept ~ 20 seconds   Timer – 01:20
- Perform calculations ~ 40 seconds   Timer – 02:00
- Select correct answer ~ 20 seconds   Timer – 02:20

It can be observed that even under best case scenario, candidate will be pressed for time. This doesn't consider the fact that you will have to undergo this process 110 times in 5 hours and 20 minutes neither does it account for the stress, nervousness and fatigue that is generally experienced during exams.

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FE-Style Sample Problems
(See solutions at the end of planner)

Problem 1) Find the equation of a straight line passing through points (2, 10) and (3, 12).
(A) $y = 3x + 12$ (B) $y = 2x + 10$
(C) $y = 2x + 6$ (D) $y = 3x + 10$

Problem 2) A retired couple is considering 20-year term annuity with their $200,000 cash savings at 6% annual interest rate. The yearly annuity amount they can expect to receive is _____.

Problem 3) The capacitance of parallel plate capacitor is 100 µF. Initial voltage across capacitor was 5 V. Calculate constant charging current if voltage across capacitor is recorded as 10 V after 3 minutes.
(A) 5.4 µA   (B) 2.7 µA
(C) 16.6 mA   (D) 8 mA

Problem 4) Find the equivalent resistance between terminals A-B of the circuit shown below.
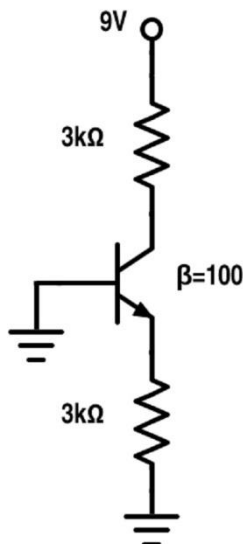

(A) 7 kΩ   (B) 3.5 kΩ
(C) 1.5 kΩ   (D) 5 kΩ
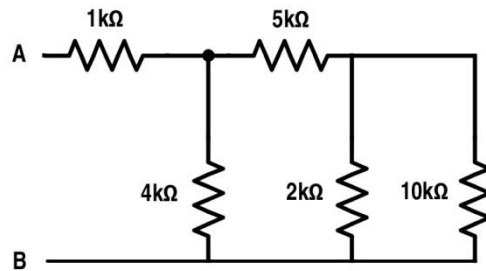
Problem 5) Find the Laplace transform of following function.
$$f(t) = e^{-at}u(t-1)$$
(A) $\dfrac{1}{s+a}$ (B) $\dfrac{e^{-(s+a)}}{s+a}$
(C) $\dfrac{s^2}{s-a}$ (D) $\dfrac{e^{-(s-a)}}{s-a}$

Problem 6) Determine the state of transistor shown in the circuit given below.

FE Electrical & Computer exam challenges

Are there any other challenges involved in FE exam? Yes, quite a few as a matter of fact:

- The biggest challenge involved in FE exam preparation is the **breadth of topics**. You are tested quite literally on all 4 years of ECE undergraduate coursework.
- Typically, exam questions are relatively straightforward and stretch problems are generally exception rather than norm (especially when compared to PE exam). You may even come across plug and play type of questions.
- **Time management** for FE exam preparation can be difficult. The main reason is that individual sections of FE Electrical and Computer CBT exam specification don't necessarily complement each other. For instance, Digital Systems will have little to no overlap with Signal Processing Similarly Circuit Analysis will have little to no overlap with Electromagnetics. As you progress through your exam preparation you will be climbing lots of small mountains (each topic is a new challenge) rather than climbing one big mountain.
- There is no substitute for studying hard and by putting in conscious effort you will only increase you chance of success. But equally important is studying smart. I've authored multiple books for FE Electrical & Computer CBT exam and created online course but even when I was preparing for FE exam I strategically allocated my time and effort towards different sections to maximize my chance of success.

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Playing to win attitude

Ideally, we all want to pass every test in first attempt whether it is driving license (failed three times to before I got driver's license) or PE license for obvious reasons. However, failures are encountered along the way before reaching goals by every successful individual or company. The important thing to remember is that, with every attempt you are getting closer to the finish line. Hopefully very soon you will find that the time and efforts spent were worth your while in the long run.

If you've done well in school will help you in reviewing key knowledge areas much faster than others who struggled in core courses. To fully capitalize on past performance, practice as many questions as you can to gain complete proficiency in solving problems on FE exam. There is a significant difference between 'Playing to Win' and 'Playing not to lose' mindset. The former is characterized with a sense of fearlessness and fighting instinct where all your mental and physical faculties are actively rising to the challenge. The latter is characterized by sense of fear and flight instinct where all your mental and physical faculties are trying to escape the challenge.

Constantly thinking about failure avoidance during the exam can be distracting and draining. It is important that you maintain your composure even in the face of most difficult problems during exam because if you are finding questions brutal then chances are that others are finding it as such too.

Based on the year statistics published by NCEES®, failure rates among second time FE and PE exam takers are quite high but in my opinion, through proper planning and utilization of right resources chances of passing the exam can be greatly improved regardless of your past failures.

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Leaving no stone unturned

Half-hearted approach towards FE exam is most likely going to result in disappointment. If you have made the decision to take this exam and pursue the goal of PE license then it is strongly recommended to leave no stone unturned in your quest.

Even a partial exam preparation effort will cost you significant time and hard costs (such as exam fees, books) and maybe optional costs (such as courses, tutoring etc.). The fact is that anything less than a 100% commitment will simply increase the odds against you. As discussed earlier, it is worth noting that according to the statistics available at www.ncees.org second attempters have a higher failing rate for both FE and PE exam.

It is not difficult to get stuck in a vicious cycle of self-doubt and poor exam performance after a failed attempt even though as explained earlier past attempt should help improve future performance however broadly speaking that's not what the stats shown.

Leaving no stone unturned means giving your 100% effort. It does not imply using all resources in the world to pass this exam but being able to assure yourself that you are making best use of whatever is available to you towards your goal.

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Exercise

Keep this work sheet around your study area to help you stay focused and motivated.

List the ideal employers that will be willing to hire you after obtaining PE license?

What will be your job title after obtaining PE license?

Research your expected annual salary after becoming PE?

Notes

"By failing to plan, you are planning to fail."

Benjamin Franklin

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The theoretical explanations, example solutions and quizzes will streamline your efforts towards the goal.

SECTION #2:
PLANNING
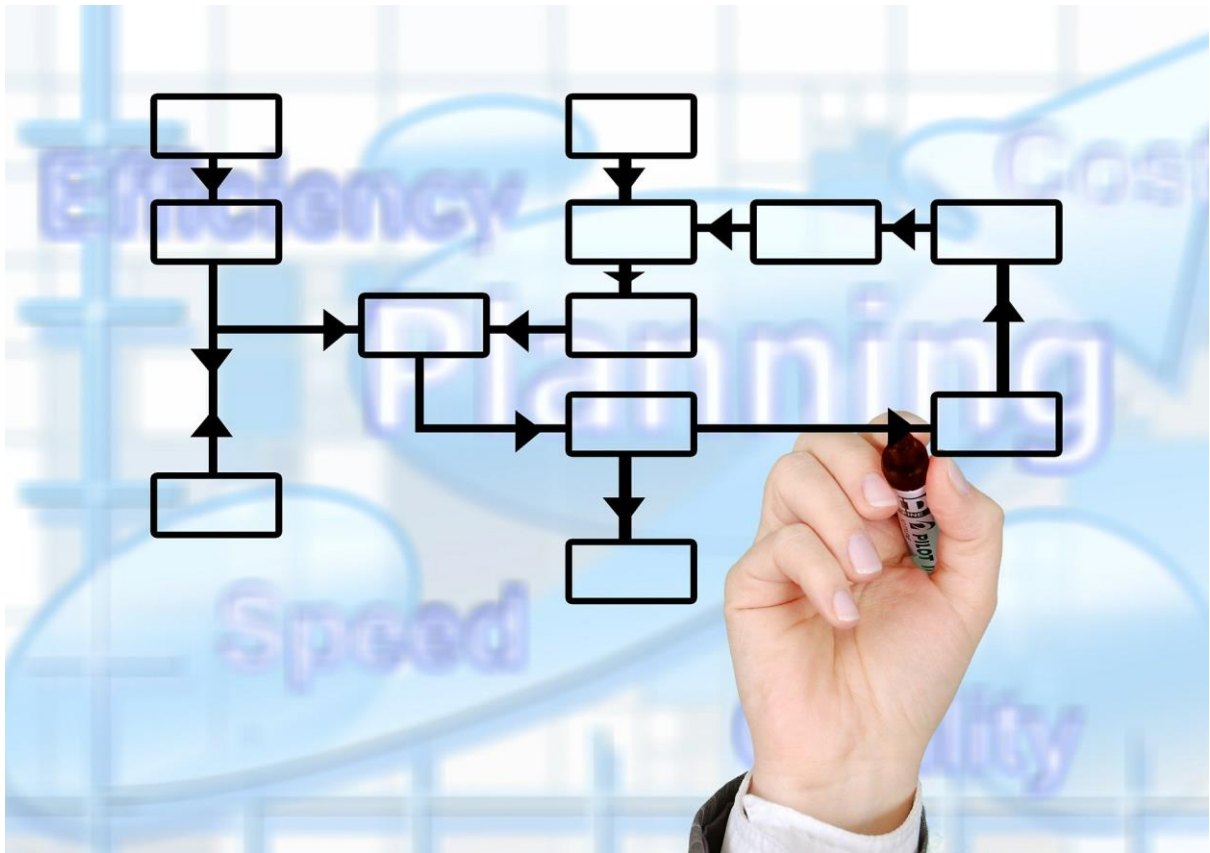
Section #2 includes:

- The 4-month schedule

- Synergies between sections

- Significance of Practice Exams

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The 4-month schedule:

It took me approximately 3-4 months to prepare for FE Electrical exam. Having said that, please take a deep dive into FE exam preparation and ascertain the timeline based on your own judgment. I averaged around 10 hours per week for first 2 months and 20 hours per week for the last 2 months.

It needs to be pointed out that this timeline shall be used as reference only which can change depending on factors such as number of years you have been out of school, time availability, your starting point, experience with similar exams computer-based testing exams such as GRE, GMAT etc. and most importantly level of commitment. You may be able to reduce this 4-month preparation schedule by:

- Streamlining exam preparation (discussed in this section)
- Staying organized (discussed in next section)
- Maintaining momentum (discussed in next section)

4-month exam preparation formula is given in the form of 4 monthly calendars on following pages. Each day carries action items based on FE Electrical and Computer exam specification. Daily tasks fall into one of three categories:

- Reviewing theoretical concepts
- Practicing relevant problems
- Attempting practice exams

Hopefully, by following this schedule you will be able to approach exam preparation is systematic manner and avoid being overwhelmed by enormity of this challenging project.

Month # 1 - First Review Cycle						
Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
Theoretical Review Mathematics	**Theoretical Review** Mathematics	**Theoretical Review** Mathematics	**Theoretical Review** Probability & Statistics	**Theoretical Review** Probability & Statistics	**Theoretical Review** Probability & Statistics	**Theoretical Review** Engineering Economics Ethics
Theoretical Review Engineering Economics Ethics	**Practice Problems** Mathematics Probability and Statistics Engineering Econ Ethics	**Practice Problems** Mathematics Probability and Statistics Engineering Econ Ethics	**Theoretical Review** Properties of Electrical Materials	**Theoretical Review** Properties of Electrical Materials	**Theoretical Review** Properties of Electrical Materials	**Practice Problems** Properties of Electrical Math Engineering Economics
Theoretical Review Circuit Analysis	**Theoretical Review** Circuit Analysis	**Theoretical Review** Circuit Analysis	**Practice Problems** Circuit Analysis	**Theoretical Review** Linear Systems	**Theoretical Review** Linear Systems	**Practice Problems** Linear Systems Circuit Analysis
Theoretical Review Signal Processing	**Theoretical Review** Signal Processing	**Theoretical Review** Signal Processing	**Practice Problems** Signal Processing Probability	**Theoretical Review** Electronics	**Theoretical Review** Electronics	**Theoretical Review** Electronics

Month # 2 - First Review Cycle						
Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
Practice Problems Electronics	**Theoretical Review** Power Systems	**Theoretical Review** Power Systems	**Theoretical Review** Power Systems	**Practice Problems** Power Systems	**Theoretical Review** Electromagnetics	**Theoretical Review** Electromagnetics
Practice Problems Electromagnetics	**Theoretical Review** Control Systems	**Theoretical Review** Control Systems	**Theoretical Review** Control Systems	**Practice Problems** Control Systems	**Theoretical Review** Communications	**Theoretical Review** Communications
Practice Problems Communications	**Theoretical Review** Computer Networks	**Theoretical Review** Computer Networks	**Practice Problems** Computer Networks	**Theoretical Review** Digital Systems	**Theoretical Review** Digitals Systems	**Theoretical Review** Digital Systems
Practice Problems Digital Systems	**Theoretical Review** Computer Systems	**Theoretical Review** Computer Systems	**Practice Problems** Computer Systems	**Theoretical Review** Software Engineering	**Theoretical Review** Software Engineering	**Practice Problems** Software Engineering

Month # 3 - Second Review Cycle						
Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
Theoretical Review Mathematics	**Theoretical Review** Mathematics	**Theoretical Review** Probability & Statistics	**Theoretical Review** Probability & Statistics	**Theoretical Review** Engineering Economics	**Theoretical Review** Ethics	**Practice Problems** Mathematics Probability & Statistics Engineering Economics Ethics
Practice Problems Mathematics Probability & Statistics Engineering Economics Ethics	**Practice Problems** Properties of Electrical Materials	**Theoretical Review** Linear Systems	**Practice Problems** Propert of Elect Mtrl Linear Systems	**Theoretical Review** Circuit Analysis	**Theoretical Review** Signal Processing	**Theoretical Review** Circuit Analysis Signal Processing
Practice Problems Circuit Analysis Signal Processing	**Theoretical Review** Electronics	**Theoretical Review** Power Systems	**Practice Problems** Electronics Power Systems	**Practice Problems** Electronics Power Systems	**Theoretical Review** Electromagnetics Control Systems	**Theoretical Review** Electromagnetics Control Systems
Practice Problems Electromagnetics Control Systems	**Theoretical Review** Communications	**Theoretical Review** Digital Systems	**Practice Problems** Digital Systems Communications	**Theoretical Review** Computer System Computer Network	**Theoretical Review** Software Engineering	**Practice Problems** Computer System Computer Network Software Engineering

Month # 4 - Practice Exams						
Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
NCEES Sample 100 questions in exam like setup	**Review** Areas of weakness	**Review** Areas of weakness	**Review** Areas of weakness	**Review** Areas of weakness	**Review** Areas of weakness	**Rest Day**
Practice Exam 1 110 questions in exam like setup	**Review** Areas of weakness	**Review** Areas of weakness	**Review** Areas of weakness	**Review** Areas of weakness	**Review** Areas of weakness	**Rest Day**
Practice Exam 2 110 questions in exam like setup	**Review** Areas of weakness	**Review** Areas of weakness	**Practice Exam 3** 110 questions in exam like setup	**Review** Areas of weakness	**Review** Areas of weakness	**Review** Areas of weakness
Floater	**Floater**	**Floater**	**Floater**	**Floater**	**Floater**	**Floater**

Synergies between sections

In case you are not bothered by non-sequential approach, it may be possible to further improve your exam preparation strategy by studying some sections in 4 – 6 to make use of internal synergies between such sections. For instance, following sections can be looked as individual blocks:

- Block # 1 - Math, Probability and Statistics, Engineering Economics, Ethics, Properties of Electrical Materials
- Block # 2 -, Circuit Analysis, Electronics, Linear Systems
- Block # 3 - Power, Electromagnetics
- Block # 4 - Signal Processing, Communications
- Block # 5 - Controls, Digital Systems
- Block # 6 -Computer Networks, Computer Systems, Software Development

You can observe that Block # 1 carries the largest weight (close to 25%) as an individual aggregate. As such, my recommendation would be to invest proportional efforts in that area.
ECE is a very diverse engineering discipline (which is part of the challenge in preparing for FE exam).

For us to pass this exam, we must stay as close to average in each section as possible while trying for perfect scores in areas of strength. To do so, I suggest categorizing each FE section into one of following areas:

• High Competency
• Moderate Competency
• Low Competency

One general strategy can involve adopting synergy blocks approach as suggested above.

Significance of Practice Exams

Practice exams will help you establish your exam readiness. They form a very important component of overall exam preparation strategy. I hope that my full-length practice exams for FE Electrical and Computer engineering exam based on latest specification will provide you additional practice.

Having said that, NCEES practice exam (https://account.ncees.org/exam-prep/store/category/FE) is the closest thing to actual FE exam that you can find. It is for this reason that I have recommended allocation of about a week for NCEES practice exam in the study plan.

It is hoped that once you go through multiple practice exams and review weak areas thoroughly, you will be able to:

- Fine tune your revision plan
- Develop greater confidence going into the exam
- Convert weaknesses into strengths

Practice exams will also help you develop the skill of attempting problems from different sections quickly in exam like setting. Once you have attempted practice exams and reviewed all weak areas, you would have consolidated most knowledge areas which is extremely important skill for passing exam

Exercise

Complete this exercise to develop your own schedule based on answers to following questions.

How many hours you are willing to spend on exam preparation each week? Multiply this number by 4 to obtain hours per month (4-month schedule given above is based on 15 hours per week average)

When do you plan on taking the exam?

Divide 250 by your estimated exam preparation hours per month to calculate typical exam preparation time based on your study hours per week. Then compare this number with your planned exam date.

Notes

"If you cannot measure it, you cannot manage it."

Presidential Medal of Freedom winner – Peter Drucker

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SECTION #3:
EXECUTION

Section #3 includes:

- Maintaining momentum
- Managing time and energy
- Staying organized
- Exam week strategy
- Exam taking strategy
- **Solutions - FE Exam Sample Problems**

Maintaining momentum:

> "I do not think that there is any other quality so essential to success of any kind as the quality of perseverance. It overcomes almost everything, even nature."
> John D. Rockefeller

Perseverance in the context of FE exam preparation is all about maintaining your momentum. It is an investment of your time, money and effort. Candidates take this exam in final year of their study, upon graduation or after working in industry for some time. In these cases, they are pressed for time unless you take a break from other commitments such as final year studying, job search after graduation or full-time job, you will inevitably have to prepare for this exam on part-time basis with some full-time commitment. It means that throughout FE exam preparation, you will be faced with conflicting priorities in the shape of work, personal life and exam preparation. Therefore, maintaining a consistent study routine while addressing other aspects of your life is quite challenging ordeal.

Here are some tips that can help you sustain your momentum:

- Dedicate at least 15 minutes daily on FE exam preparation even during your rest days. It will ensure that you stay in touch with the project. You may even find yourself studying over an hour.
- Measure your progress on weekly and monthly basis.
- Frequently remind yourself of your goal. It will help you keep your eyes on the prize,
- Reward yourself on achieving mini-milestones along the project.

Hopefully, by adopting such techniques you will be able to sustain your momentum during the entire lifecycle of this project.

Managing time and energy

"Time is what we want most, but what we spend worst."

William Penn

If you have started FE exam preparation then you can relate to the never-ending sense of timelessness and if you've not started exam preparation you will soon find out that it's a fact. I have included time and energy management in same sentence because one is incomplete without other.

3 hours of study time after a 9-5 grind at work are not the same as 3 hours of study time on a weekend morning. Although we are talking about same amount of time but you would probably agree that the actual efficiency will be very different. The missing piece of the puzzle is 'energy'. In the first example, we will most likely fail at accomplishing any significant progress during our study session because our energy is already drained by a tough day at work. However, in the second example, we are more likely to achieve great progress due to higher energy level.

In previous section we discussed the importance of sustaining momentum during exam preparation and putting in hours on daily basis. It must be pointed out that simply putting in hours and not being able to see progress can be very counterproductive. It can lead to self-doubt and lack of confidence. Therefore, it is extremely important to make every hour count by combining it with high energy. Here are some tips that can help you sustain your momentum:

- Get better at monitoring your energy level.
- Increase energy through rest, healthy diet and exercise.
- Develop a consistent routine.
- Minimize distractions during study session.

Time Management Vs Energy Management is a relatively recent topic of research and discussion (like Emotional Quotient VS Intelligence Quotient) and there is plenty of research highlighting importance of both time and energy management.

Staying organized

Being disciplined and organized are great qualities to have at any time and any place. But in the case of FE exam it is particularly important to stay organized for exam preparation. FE Electrical and Computer exam contains 17 sections and approximately 200 sub-sections. Retain knowledge from each of these topics and readily applying them during exam is very challenging. Moreover, for an exam of this magnitude you must be able to gain a good understanding of your areas of strength, mediocrity and weakness. This will allow you to develop and maintain a competency framework during exam.

I've included some tips that can help you stay organized and focused throughout this process:

- Keep a good record of questions and concepts that you find difficult as you go progress from one section to another. At the end of this section, you will find a checklist containing all specification sections and subsection. It will allow you to review them much more efficiently later.
- Avoid cluttering your study space with unnecessary items. Cluttering is known to cause stress and distraction. Arrange your workspace so that all exam relevant items are within your arms reach. These include:
    - Calculator
    - Copy of FE Electrical and Computer specification
    - Stationery
    - 1-2 exam preparation books
- Similarly, another reason for allocating 1 week for sample exams is to allow you to understand the 'concepts' behind questions that you get wrong so that you can successfully answer similar questions on actual exam. Time yourself while solving problems.
- Develop a habit of adding bookmarks, comments and notes that can save time in future.

Hopefully, by adopting such techniques you will be able to decrease time wastage and frustration during exam preparation.

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Exam week strategy

It is quite common to become tentative and start questioning exam readiness few days before actual exam. In my opinion, your game plan for exam week should be as follows:

- Solve all three Practice Exams (including NCEES Sample Exam) again and address weak areas
- Go through relevant sections of NCEES FE Reference Handbook Version 10.0.1 especially the new sections i.e. Computer Networks/Systems and Software Development.
- Revisit Study Guide (assuming you also use it) and solve the questions that you found challenging one last time
- Review general areas Math, Engineering Economics, Probability and Ethics.
- Lastly, if you've reviewed all sections, attempted practice exams and addressed your weak areas and decided to take this exam then go in with full confidence, otherwise reschedule it for a later date.

Also, if you are finding certain aspects of the exam (time management, tough sections etc.) challenging chances are that other exam candidates are feeling the same way.

The best thing you can do is believing in yourself and giving it your best shot.

Exam taking strategy

Strategy # 1 – Three round knock-out

- **First Round** - After reading the question classify it into one of the following three categories: 'Easy', 'Medium', 'Difficult but solvable' or 'No clue'. If it is 'Easy' or 'Medium' solve it right away otherwise flag it and move on. After completing the first round you'll be left with 'Difficult but doable' and 'No clue' questions.

- **Second Round** – Go through the list of flagged questions and try to solve 'Difficult but doable' questions. Carefully remove the flags from solved questions. After completing the second round, you'll have only 'No clue' questions left.

- **Third Round** – Depending on the amount of time left in exam either try to solve the remaining questions or apply elimination method.

Under no circumstances should you leave any question unanswered. You should use remaining time rechecking the answers.

Strategy # 2 – Relax, see and conquer

This strategy works best for bolder examinees.

The idea is to go through all questions from get go to gain big picture view of the exam. It is advisable to flag all the difficult questions during the sequential reading process but try not to solve them right away. After skimming through the entire exam section (there is a morning and afternoon portion to exam), you will hopefully feel relaxed and confident since the fear of unknown will subside. Now you should start solving non-flagged questions followed by flagged questions. Any time remaining should be spent rechecking your answers.

I adopted first strategy while taking FE CBT – Electrical and Computer Engineering exam in October 2014 which and passed it in first attempt. Strategy # 2 was adopted while taking PE – Power Exam in April 2015 and I passed it in first attempt as well.

Exercise

Scroll through the list of all 17 sections of FE Electrical and Computer specification given in NCEES® Reference Handbook. Aim to convert all sections into your areas of strength.

Identify sections that appear to have 'Easy' difficulty

Identify sections that appear to have 'Medium' difficulty

Identify sections that seem to have 'Hard' difficulty

Notes

Solutions - FE Style Sample Problems

1) CORRECT ANSWER - C

The standard form of straight-line equation is given below.
$y = mx + b$
According to problem statement, straight line passes through (2, 10) and (3, 12).
$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{12 - 10}{3 - 2} = 2$$
$y = 2x + b$
Line passes through (2, 10), therefore, $10 = 2(2) + b$
$b = 10 - 4 = 6$
Therefore, equation of a straight line passing through (2, 10) and (3, 12) is $y = 2x + 6$

2) CORRECT ANSWER - $17,440

$i\% = 6\%$ $P = \$200,000$ $n = 20 \ years$ $A = ?$
$$A = \$200,000 \times \left(\frac{A}{P}, 6\%, 20 \ years \right)$$

$A = \$200,000 \times 0.0872 = \$17,440$

Therefore, expected yearly payment of given annuity is $17,440.

3) CORRECT ANSWER - B

The current-voltage relationship of a capacitor is given by following equation.
$$v_c(t) = v_c(0) + \frac{1}{C} \int_0^t i_c(\tau) \, d\tau$$
$$10V = 5V + \frac{i_c(t) \times t}{100 \times 10^{-6}F} \rightarrow i_c(180s) = \frac{(10V - 5V)(100 \times 10^{-6}F)}{180s}$$
$i_c(3min) = 2.7 \ \mu A$

4) CORRECT ANSWER - B

$R_{AB} = 1 \ k\Omega + 4 \ k\Omega || (5 \ k\Omega + 2 \ k\Omega || 10 \ k\Omega)$

$2 \ k\Omega || 10 \ k\Omega = 1.66 \ k\Omega$
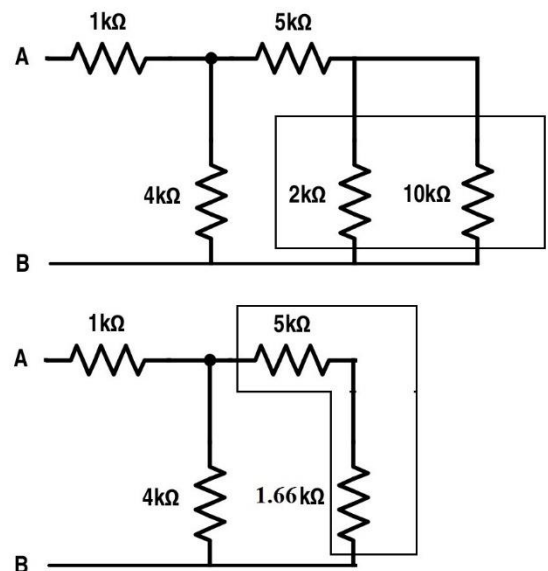
$5 \ k\Omega + 2 \ k\Omega || 10 \ k\Omega = 5 \ k\Omega + 1.66 \ k\Omega = 6.66 \ k\Omega$

$4 \ k\Omega || (5 \ k\Omega + 2 \ k\Omega || 10 \ k\Omega) = 4 \ k\Omega || 6.66 \ k\Omega = 2.50 \ k\Omega$

$1k\Omega + 4k\Omega || (5k\Omega + 2k\Omega || 10k\Omega) = 1k\Omega + 2.5k\Omega = 3.50k\Omega$

Therefore, $R_{AB} = 3.50 \ k\Omega$.

5) CORRECT ANSWER - B

$$f(t) = e^{-at} = e^{-a(t+1-1)} = e^{-a(t-1)}e^{-a} = e^{-(a)}[e^{-a(t-1)}u(t-1)]$$

According to Laplace Transform pairs provided in NCEES® FE Reference Handbook:

$$\mathcal{L}[f(t-\tau)u(t-\tau)] = e^{-\tau s}F(s) \qquad \mathcal{L}[e^{-at}] = \frac{1}{s+a}$$

It can be observed that in given case, $\tau = 1$.

$$\mathcal{L}[f(t)] = e^{-(a)}\frac{e^{-(s)}}{s+a} = \frac{e^{-(s+a)}}{s+a}$$

6) CORRECT ANSWER – Cut-off

To analyze a BJT circuit we assume a state of operation, enforce conditions and then verify assumptions.

Let us assume that transistor is operating in active region.

In active region: $V_{be} = 0.7\ V \quad I_b > 0mA \quad V_{ce} > 0.7V$

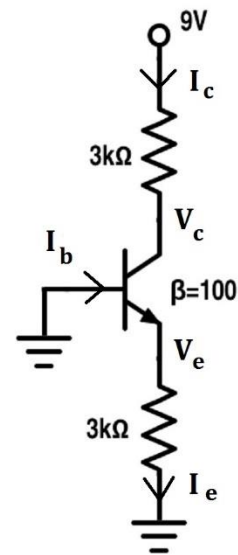Base-emitter KVL can be written as shown below:

$$0 - V_{be} - (3k\Omega)(I_e) = 0$$

$$I_e = \frac{0 - 0.7V}{3k\Omega} = -0.233\ mA$$

$$I_e = (\beta + 1)I_b$$

$$I_b = \frac{I_e}{(\beta + 1)} = -0.0023\ mA$$

Transistor is operating in cut-off region because $I_b < 0$.

$I_b = I_c = I_e = 0$.

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