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Research Approval Assessment: An Approach to Cultivate Engineering Student's Attention towards Engineering Curriculum

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Abstract

Engineering society required an important renovation in educational order. The twenty first century has brought a flood of challenges to technical specialists. Because of integration of advance technologies has made the current power system more interconnected and complex. Indeed it should be an essential step for engineering student to understand the innovative and complex system. In engineering academics the students are oblige to deal with complex and real harmony of the circuits and somehow they are also called main stream builder of the nation. Unfortunately, this profession is under threat because the numbers of students are rapidly declining engineering major. At the mean time the engineering specialist's man-power in industry is retiring due to looming age factors. Hence, this paper adapted an interactive research approval assessment methodology to keep students stick with their major and learn their passionate research studies for the graduation requirements. The assessment was applied in high voltage engineering laboratory of Wuhan University to fulfill student's graduation requirement in interactive manners. The study evidenced of the successful implementation of methodology. Where, the comprehensive initiative was achieved by bridging a friendly learning environment between teacher and students. The students precisely enhanced their knowledge

though simulating their desired research topics using engineering software to solve complex power circuits. Moreover this study provided enough motivation to students during weekly meetings that improved their communication skills and hence it reflected in their final presentation.

Keywords: Ferroresonance, Pakistan Power Distribution system, Electrical Engineering (EE) education, PSCAD/EMTDC, transformer's core saturation, mid-term research assessment

1. INTRODUCTION

Engineering students are mandatory to absorb professional and collaborative skills during their university education as they prerequisites to dealt innovative challenges and the power enterprises are also imagining their future workforce must be more proficient to operate and design advance power system. The absorption of the skills and the attentiveness to pursue high achievements in academic themes will provoke them to serve as delightful engineers in future. The power Human Resources Management (HRM) point of view, to be a competent engineer means is having an extraordinary academic achievements and strong collaborative skills because the forthcoming shortage for human resources due to aging of professional engineers and the complexity of 21st century Power System (PS) anxieties are also ultimatum more compatible workforce. The statement in ref [1] indicted that United Kingdom (UK) and United State (US) will face unavailability of skillful engineers because of high percentage of their power grid workforce will reach at the age of retirement over the coming 10-15 years. Moreover, these challenges are not only for developed countries but also the developing countries are facing similar situation.

The guesstimate continues to determine the growing placement for electrical engineers, yet the graduation rate of EE students is lower than demand since the dropout issues in engineering universities is more worsening, because the students faced numerous dares that enforce them to decline EE major. In ref [2] the Romanian school investigated the factors that was caused of

EE students dropout, the main factors was wrong choice of major, lack of motivation, failure in exams, influenced by teacher, lack of communication, complexity of EE major, and finance problems. The motivation factor and failure in exams was declared as high rate of influencing origins. In ref [3] an engineering school of US reported the absence of belonging in engineering major, poor coaching, and the complexity of engineering curriculum as average influencing factors. Additionally, this study also indicated the lack of belonging caused higher dropout than others. Since, the dropout rate and the influencing causes are exposed in many articles but the retention of students into EE major is still threatening this profession.

The complexity of EE curriculum has always remained challenging for students; because they are involve in complex mathematical equation, solving electrical circuit problems, sketching line diagram and writing programs for circuit simulation in software that might need not only bookish knowledge but also more technical skills to comprehend it. The ref [4] provided free open source software (FOSS) practice to enhance deep learning skills of undergraduate and graduate students through employing their academic knowledge in FOSS to do power system load flow analysis and design a comparative best solution to load flow complexity that somehow triggered their deep learning and designing skills, and the students successfully completed the assigned project but they were facing difficulties while choosing software and finding ways how to compile their projects. Furthermore the complexity conditions are still unsatisfied for students that can entice dropout factor. The involvement of software in EE education seems active way of learning, a methodology implemented in ref [5] to develop research skills and project based learning skills of EE students, firstly they was advised to search references article on given key words, secondly write a report as a review journal arrangement and thirdly apply their acknowledged data in EMPT software. Although the procedure indicated optimistic results on students learning but there was communication gap between students and instructor and students wasn't fully independent to choose their interesting topics that can be dropout factor as cited previously. Author in ref [6] executed an project based learning technique to enhance practical, scientific, professional and designing skills of their students through instructing specific

electronics topics in class and as a course requirement students was asked to build a project on given electronic topics. Afterward they also exhibited their projects in school exhibition hall with projects reports. Nevertheless, above studies and many other researchers deployed their best technique to prepare students according to market demands and somehow they have been successful but the criteria of EE education is too wide and requisite more innovative techniques to empower EE students with high proficient skills.

The curiosity to empower EE students with high potential skills, to avoid student's dropout from universities and successfully complete their graduation requirements, this article detailed a Research Approval Assessment (RAA) technique that applied in a high voltage laboratory of EE School of Wuhan University. The primary criterion of graduation in the school for master degree students have to publish a science citation index journal paper for three year degree of EE. The objectives to complete the requirement and to pursue their research students are obligatory to submit a research proposal to the school in the first academic year of the course as a mid-term assessment. Thus, the proposal has to be approved by professors to complete their research. The criterion of RAA was established by a professor of high voltage laboratory. That was applied and detailed in section 2, section 3 reviewed as problem statement, research interest, and as problematic circuit identification and problematic circuit visualization using software simulation. Section 4 and 4 deliberated the approval assessment results and as RAA technique evolution and results. However section 6 and 7 made limitation, conclusion and further research suggestion.

2. ASSESSMENT CRITERIA AND METHODOLOGY

EE students must fulfill the requirement conditions for employment based on their academic knowledge and professional skills. The initiative to bridge student's professional skills the number of researcher took a part to provide compatible best methodologies Such as, in [7] author has used educational software to teach students to solve complexity of power system that triggered problem solving skills and practical thinking abilities of students. A project-based learning methodology applied to teach students Electronics to Aeronautical

Engineering students in [6] that enhanced team working skill, problem-based learning skills and software skills. Another study was executed to enhance project based learning and research skills of students in Wuhan University that triggered research skills, thinking skills and make them used to E-library database [5]. Although, these all articles preserved their techniques to trained their students as future demands and somehow, the students also engaged with their targeting prospective but the main factors found common in literatures that the interest of students didn't considered, the communication between teacher and students also reviewed rarely and encouragement (motivation) also found diversely that can distract their learning that earlier cited as the failure factor leading to drop out from collage.

Considering all the failure factors, power industry anxieties and to bridge EE students collaborative skills the RAA methodology designed and applied in high voltage laboratory that consist of eleven master degree students under one supervisor. They were asked to submit their research proposals in their first academic year of their master's degree, the proposal approval criteria was defined by supervisor that consist of four different process shown in Figure 1. The main features of methodology are indicated as below;

- Discover acknowledged studies and relates their interesting topics for future research.
- Offer a friendly environment where students and teacher can interact straightforwardly.
- Encourage their achievements because motivation factor cited as one cause of dropout.
- Enhancement of their software skills so the complicity of EE circuits can be visualize.
- To improve professional skills, Problem Base Learning (PBL) and constructive learning skills
- To bridge favorable technique that can be helpful to achieve success.

2.1Research Interest

In initial step, students were advised to submit a report about their undergraduate studies, projects, graduation thesis and the software skills they have learnt. The purpose of this report was to evoke their

undergraduate studies and to know their interest of research. After submitting the report they were advised to relate their previous research with situate with present assessment, and according learn desired engineering software. Where, they were asked to draw a line diagram of their problematic in one of the engineering software. After this process student had discussion with supervisor for recommendation and suggestion.

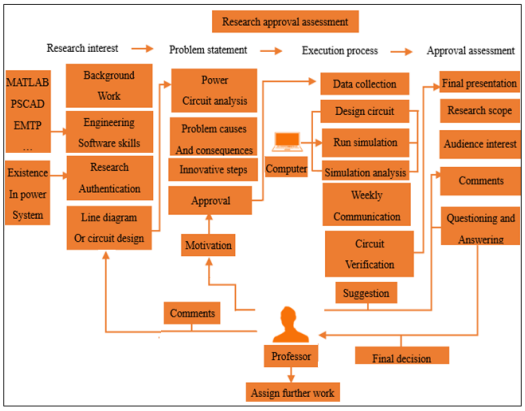

Figure 1 Research Assessment Process

2.2Problem statement

After inquiring the direction of student's research the approval process moved to next step. Students were advised to cite their problematic circuit's line-diagrams using Wuhan University E-library database and provides citation of their research. Additionally, they were asked to elaborate the detail consequences and causes of their problematic circuits according to current situation. The purpose of this report was to train them for their graduation dissertations and further studies. After submission, the meeting has been called by supervisor for detailed communication. Furthermore, the innovative ideas were provided by supervisor to groom their research.

2.3Execution process

Third step was the implementation of their problematic circuits in their practiced software for the realization of causes and consequences and to figure out new techniques with batter solution in future. To achieve this goal students was advised to search references and study in details that can be relates their circuits or can prove their circuits

with standard citation, the prospective of this approach is to exhibit a supportive way to implement their topics in software for simulation analysis and effective research, and to know how professional researcher deal their research. During all process students was required to attend weekly seminars to discuss difficulties about their research, and to get favorable suggestion and motivation according to their achievements. Through arguments and dialoging they was assessed and promoted for final approval.

2.4Approval Assessment

Forth step was based on the evaluation process. To investigate the research progression and to approve the proposal for further research, students were required to prepare a multimedia presentation and final reports about their research work. As mid-term assessment they were required to deliver a multimedia briefing on their research work in front of their classmates and selected committee. For the judgments and to approve the proposal audience was asked to comments on student's presentation on the base of performance, asked question, research scope and their interest. The final approval and suggestion was the act of professor that was dependent on quality of research and performance.

Although, assessment technique was applied on all the students who was the part of laboratory with the same standards but this article covers single example of (Pakistani student) execution process.

3. REPORTED OVERVIEW OF PAKISTAN POWER SYSTEM AND PROBLEMATIC STATEMENTS

From the past three decades, Pakistan is facing electricity shortfall, where demand of electricity is increasing rapidly but the electricity generation is unable to meet the total demand [8]. In the results, electricity distribution companies are forced to schedule power outage for all costumers in different timing.

Unsustainability in power supply transports a proportion of challenges including electrical power infrastructure, protection equipment, economic and power insecurity. Power distribution system that is characteristically comprise of transmission lines, transformers

(TF), bus bars, and protection devices are become victim of many faults during planned or unusual load shedding or unnecessary tripping [9]. The consistency of the power system is dependent. Owning to non-linear behavior of TF core during unusual tripping/load shedding, these devices fetch countless hazards on power system profile and sustainability. The penalties of these exposures might be foundation of unnecessary damages, protection system failure and system black out [10]. In developed countries the range of Distribution Transformer (DTF) failure ratio is lower than 2% but PAK distribution system reported every year thousands of DTF failure or other problems [11]. The damages in PPS might cause of unusual tripping that may lead to interruption/ permanently damage of transformers core and affects other distribution system parameters.

3.1Power interruption consequences on transformer profile

Distribution System is considered as a back bone of power system that is responsible to provide electricity to consumers end. Typically, Distribution system is the combination of Inductive elements such as transformers, Protection devices Circuit Breaker (CB), Relays, Chokes, Fuse, generators, transmission lines and capacitive elements such as grounding, capacitors, line to ground capacitance, CB grading capacitance [12]. Although, these elements are used to ensure the reliability but these are also the major reasons of distortion during transient condition with the changing behavior of circuit. They are prone to occurrence of unnecessary voltage and current [13]. The Changing behavior of circuit is the circumstance of interaction between saturate able inductances (Power and instrument transformer and capacitance (Transmission line, CB Grading, Bus-bar, shunt capacitor and grounding). When transient condition appears (Temporary fault, fault clearance, tripping, load fluctuation or no load) in electrical circuit non-linear TF core become victim of saturation that is called Ferro-resonance (FR), once the TF core saturated the circuit can run into high non-linear resonance during transient state. The existence of sustained saturation in TF core can cause harmonic distortion, power losses, irregular heating, shortage lifespan of element, and noise [14].

The conditions of FR occurring can exist anywhere in electrical system. Where, TF configured at load side but Distribution system is hot destination for FR occurring. The scenario of PAK distribution system is more worse shown in figure 2, where the oscillation of load can be normally found, tripping is common practice many times a day and single/ three phase fault situation also can be seem as routine practice. Underground or overhead network, common neutral system, no or low load transformer and load variation are the hot contents for occurring of FR [15]. Another hot content for FR occurrence is long length transmission lines connected with low loss TF; opposing TF core drive into saturation during switching operation produces enough capacitance through grounding [16]. Thus, determined that TF used even as measurement, step-up/step down or switching purpose always connected at load side where situation varies on demand, so any instance (Low load, no load, usual tripping and fault) can drive the TF core into saturation and common natural /grounding circuit provide a side path and complete the FR circuit.

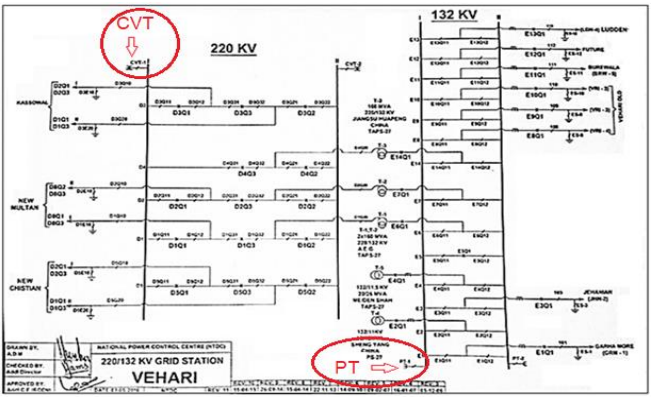

Figure 2 Line Diagram indicating Potential Transformer (PT) and Capacitive Voltage transformer (CVT) installation in 220/132 KV Grid Station

3.2Problematic Circuit Implementation in Engineering software

3.2.1Double source FR circuit

Double source supply used in Pakistan to maintain the sustain power supply. Because government supply caused high interruption, many business enterprises installed their own resources of supply to

maintain their productivity hence these kind of circuits found ordinary in Pakistan. Another example of double source supply is the configuration likewise Government has contracted with Iran power sector to fulfill electricity demands of Pakistan, configuration of PAK-IRAN lines shown in [17]. The examining circuit configuration from PAK power sector the FR circuit for double source supply was developed as local configuration using PSCAD/EMTDC software shown in Figure3.

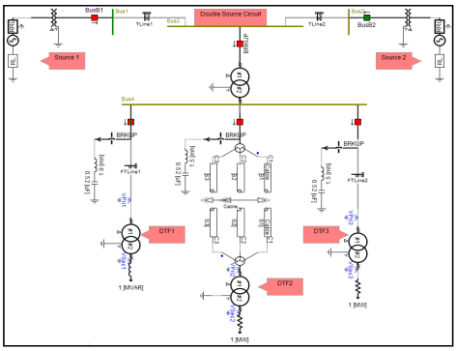

Figure 3 Double source FR circuit

In order to expose the FR in TF core, there was need to enable TF non-linear Characteristics that can oppose TF core into saturation during fault operation. For this purpose PSCAD/EMTDC TF non-linear activation function was used. The main parameters of core saturation are air core reactance (pu), knee voltage (pu) and magnetizing current (%) delivers three degrees of freedom to the shaping of the continuous core characteristic [18]. Utilizing the parameters and situation characteristics, the following operation was done to initiate FR during the time (0.1-0.6 sec).

- Single pole phase break fault when the feeder was supplying to industrial Load.
- Single pole phase break fault when feeder was supplying to house hold customer.

3.2.2.PT and CVT FR Circuiting

Instrument Transformers (CVT & PT) are called high liable protection device for power system. These transformers generate signals to operate protective relays and measurement devices during abnormal operation. In other words, power system consistency is highly depends

on quality signals of instrument transformer. In Pakistan CVTs are configured in 500/220KV power grids and the PT in 132 KV grids already shown in line diagram 2. Unfortunately, PAK power sector is the compound of problems such as load variation, faults, and unsatisfied maintenance and tripping [15]. Hence, the condition of FR exists in unstable circuit [16] and satisfied for occurrence of this phenomena because CVT or PT secondary always connected as open circuit, in the case of any disturbance transformer core can run into high saturation that pose high risk for whole power system.

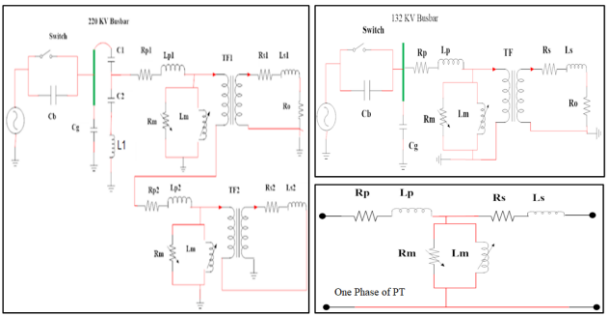

Figure 4 FR circuit Line diagram of 220 Bus-bar CVT connection and 132 KV Bus-bar PT connection

Considering all the condition CVT and PT circuit was modeled in PSCAD/EMTDC software. The circuit diagram for CVT was adapted from [14] and applied as PAK local voltage circuiting of CVT. The configuration of the circuit consist of Capacitive Voltage Divider (CVD), compensation reactor (CR) and Step down Transformer (STD). The function of CVD is to decrease the input voltage about 5-15 KV to make able for relaying operation, STD is used to step down the voltage for measurement devices and CR is the part of circuit to provide reliability of phase shift between primary and secondary of STD. The CVT circuit is implemented on 220/132 KV grid station shown in Figure 2 where CVT is applied on 220 KV busbar with CB and the busbar is energized though three different lines (NEW MULTAN, KASSOWAL, and NEW CHISTIAN). Assuming, 220 KV grid station configurations, the CVT FR circuit applied on bus bar with the connection of CB. For FR initiation switching operation was done during the time (0.05-0.8 sec).

The connection of PT in PAK distribution grid has already shown in Figure 2. PT circuit build in PSACD/EMTDC environment

consist of STD and non-linear inductance coil has shown in Figure 4. Where PT is connected to bus bar (132 KV) through CB (CB circuit consist of parallel connected capacitor (Cb) that is used to provide accurate breaking capacity during the switching time) and Cg (grading capacitor) assume as bus bar grading capacitance due to air ionization between bus and ground. For the simulation of FR phenomenon correctly, there must build a non-linear model for PT excitation characteristics that adopted from [18]. where *R1*, are *L1* are the primary leakage reactance of primary side and *R2*, *L2* are secondary leakage reactance, the variable *Rm*, *Lm* are the values of excitation circuit. For FR initiation switching operation was done during the time (0.05-0.8 sec).

Determining all the conditions of FR and evidencing PAK distribution system parameters failure might be the cause of FR. In order to figure out the effects of FR on TF life and circuit behavior during FR operation this study contain three different circuit configurations based on PAK local installation. The circuit was built using PSCAD/EMTDC software package and evidencing the Total Harmonic Distortion (THD) PSCAD/EMTDC function Fast Fourier Transform (FFT) is used. The circuit configuration and input parameters for FR model are summarized in TABLE I, II, III, and IV.

Table I Double Source Circuit parameters with Domestic load

Name	Parameter Name	Ratings
Source one	TF1, Bus1, TLine1	500MVA 220/132KV, 132KV, 300KM 132KV
Source Two	TF2, Bus2, TLine2	500MVA 220/132KV, 132KV, 300KM 132KV
Source one	TF1, Bus1, TLine1	500MVA 220/132KV, 132KV, 300KM 132KV
D-Substation	Bus3, TF3, Bus4	132KV, 300 MVA 132/11KV, 11KV
Feeder1	FTLine1, DTF1, Load	130KM, 50MVA11/0.220KV, 1MW
Feeder2	Ground Line, DTF2, Load	30KM, 50MVA 11/0.220KV, 1MW
Feeder3	FTLine2, DTF3, Load	130KM, 50MVA11/0.220KV, 1MW

Table II Double Source Circuit parameters with industrial load

Name	Parameter Name	Rating
Source one	TF1, Bus1, TLine1	500MVA 11/220KV, 220KV, 300KM 220KV
Source Two	TF2, Bus2, TLine2	500MVA 11/220KV, 220KV, 300KM

		220KV
D-Substation	Bus3, TF3, Bus4	220KV, 500MVA 220/132KV, 132 KV
Feeder1	FTLine1, DTF1, Load	130KM, 50MVA, 132/11KV, 10MW
Feeder2	Ground Line, DTF2, Load	30KM, 50MVA, 132/11KV, 10MW
Feeder3	FTLine2, DTF3, Load	130KM, 50MVA, 132/11KV, 10MW

Table III PT and CVT Circuit Input parameters

PT Circuit Parameters		***CVT Circuit Parameters***	
Cg	*13.134 µf*	*Cg*	*13.134 µf*
Cb	*13.034 µf*	*Cb*	*13.034 µf*
Rp	*2.05* Ω	*C1*	*15.345 µf*
LP	*6.1147 mh*	*C2*	*15.345 µf*
Ls	*0.00047 mh*	*Lcamp*	*22.234 mh*
Rs	*0.00012* Ω	*Rp*	*2.05* Ω
Rm	*220* Ω	*LP*	*6.1147 mh*
Lm	*120 mh*	*Ls*	*0.00047 mh*
Ro	*0.002* Ω	*Rs*	*0.00012* Ω
		Rm	*220* Ω
		Lm	*120 mh*
		Ro	*0.02*

3.3.FR Simulation analysis;

3.3.1.FR in Double source circuit

Using the local configuration of PPS circuits were discussed previously. However to impose FR in circuit the perimeters are used as Table I, II and III. The switching operation was done during the time (0.1-0.6 sec) for Double source and (0.05-0.8 sec) for PT and CVT saturation. The results are shown in figures 5 and 6 for double circuits, and 7&8 for PT and CVT. The behavior of these wave shapes are discussed in compression Table IV.

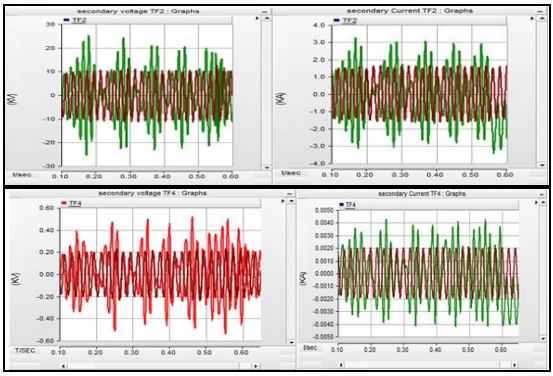

Figure 5 Domestic and industrial Feeders Transformers saturation results

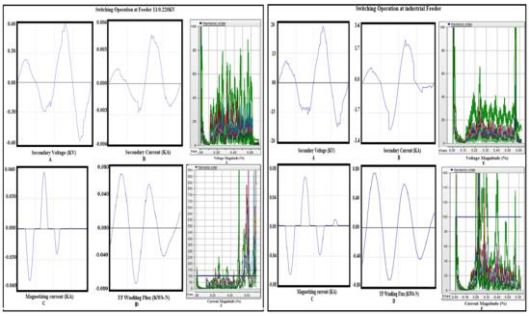

Figure 6 Domestic and industrial Feeders respectively FR non-sinusoidal waveform for two cycles and individual Harmonic Distortion spectrum (IHD) for Secondary Current and voltage, *(A) Secondary Voltage, *(B) Secondary Current, *(C) Magnetizing Current, *(D) Magnetic Flux of winding, *(E) Voltage IHD spectrum for 15 harmonic orders, *(F) Current IHD spectrum for 15 harmonic order

3.3.2.FR in PT and CVT

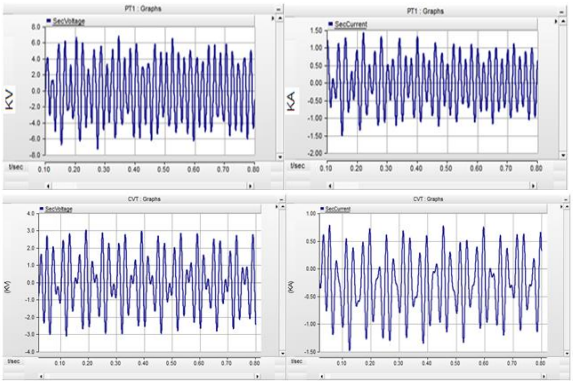

Figure 7 CVT and PT FR Overvoltage and Current waveform for Secondary

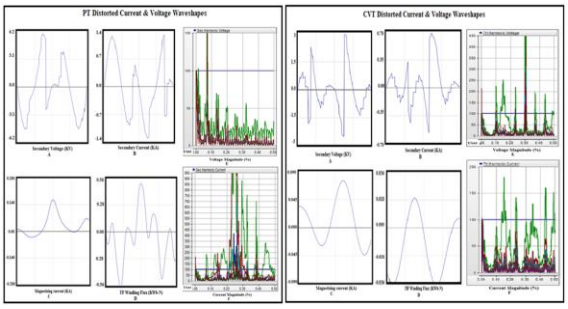

Figure 8 CVT and PT respectively FR non-sinusoidal waveform for two cycles and individual Harmonic Distortion spectrum (IHD) for Secondary Current and voltage, *(A) Secondary Voltage, *(B) Secondary Current, *(C) Magnetizing Current, *(D) Magnetic Flux of winding, *(E) Voltage IHD spectrum for 15 harmonic orders, *(F)

3.3.3.Comparative FR Circuits analysis

Table IV FR simulation analysis

Power TF circuit FR behavior	*PT Circuit FR behavior*	*CVT Circuit FR behavior*
Power TFs import electricity through long transmission lines and delivers to consumers according to the demands voltages, during abnormal conditions if the TF secondary is low/no loaded the lines capacitance and TF inductive coil interaction drive TF core into high saturation.	*PT serve as protective device for 132 KV and low voltage system but the configuration of PT with bus-bars is highly satisfied for FR occurring. Such case de-energization of bus-bar can impose saturation in core through Cg and Cb capacitance interaction with PT inductance.*	*CVT facilitate the PS as protective device, which are install in high voltage system. The configuration of CVT is prone to occurrence of FR, as like the de-energization of line/busbar the Cg and Cb capacitance interrelate with TF non-linear core which oppose TF core into saturation.*
Transmission lines capacitance reinforced the FR instance. Since slight changes in length of line can cause different shapes of FR states.	*The values of bus capacitance Cg and Cb and variables Lm and Rm values are critical, the minor changes showed dissimilar steady states.*	*CVT configuration has capacitive voltage divider (C1 & C2) and variables Rm and Lm values that played key part to upsurge FR harmonics voltage and current.*
The occurrence of FR in power TF was the cause of any kind of fault (No or Low load, CB opening or line fault). However, it just appears during fault duration but it showed high distorted waveform, FR overvoltage and overcurrent that can damage the TF core badly.	*The switching instance to break the circuit between PT and bus appeared a high sustained FR overvoltage and current that can permanently destroy the PT.*	*The CVT bus de-energization also resulted high sustained FR overvoltage and current and non-sinusoidal waveform that can be dangerous for safe operation and also may cause other damages in system.*
Temporary fundamental and sub-harmonic FR overvoltage and current appeared during fault operations.	*PT FR switching shown high sustained fundamental FR mode containing damaging effects.*	*CVT bus de-energization also resulted sustain fundamental FR mode.*
FR contains distorted harmonic frequency order such as in case 2 3^{rd}, 5^{th} , 7^{th}, 9^{th} 13^{th}, 15^{th}	*PT appeared 3^{rd}, 5^{th}, 9^{th} and 15^{th} harmonic orders during FR operation*	*CVT FR resulted lower harmonic orders than PT as 3^{rd}, 7^{th}, 15^{th}*
In this scenario, any kind of tripping such as normal cut off or abnormal cut of supply leads TR core intro saturation that can cause high voltage loss, heating process and humming for short term but for long term it can damage TF permanently.	*PT Circuits configuration in Pakistan power system is as distribution grids protective system, thus it showed high saturation during any kind of break-down causing abnormal wave shapes lead to voltage loss, TF core damage and heating.*	*CVT configuration as high voltage protective system operation is also in threat due to FR phenomenon. The schedule tripping or forced tripping both can oppose TF core into saturation.*

4. APPROVAL ASSESSMENT

Final approval was bases on the audience comments on student's presentation. Where, the audience was the combination of professors as school body to assess the mid-term research work and research presenters. Hence, final approval of the research was the act of professors. However, to know the quality of research topic the students were asked to comments on presentation.

To investigate the individual worth of student's research, the questionnaire was designed by high voltage laboratory supervisor that presented at the end of presentation. The students were advised to give feedback on the base of questionnaire. Although the

questionnaire was asked after each performance and the feedback also given but this article only consider the feedback and the questionnaire of Pakistani student presentation that has detailed below.

Q1. What did you have learn from the presentation?
Q2. What do you think about FR phenomena?
Q3. Have you ever experienced to evidence FR?
Q4. How do you rate the FR subject for future research?
Q5. Is the involvement of software left any effects to understand FR phenomenon?

Table V students (S) responses and prescription on PAK PS presentation

No.	*Comments*
S1	*"Although, I had experience to hear transformer humming but I never thought it was the cause of FR and the existence of this phenomena in a circuit is too dangerous for all system. I personally want to say thanks to software developer they did a fabulous job to provide such kind of opportunities to visualize such a complex system that even in real life cannot be seeable. The FR initiation in power system is to harmful it should be Settle down in future".*
S2	*"Pakistan power system is so complex and favorable for TF core saturation, that can make all system disorder, as FR can be sustained in TF core and let circuit continue run during FR operation this might have more damaging effects on TF core. Although, I have little knowledge about non-linear LC circuit computing so, I can understand all the process of FR occurring and consequences on TF core. In order to preserve a stable operation of power system there should be need a detail study to introduce prevention circuits".*
S3	*"It was shocking for me when I though the life without electricity in PAK. FR presence in power system just is pushing all the system into darkness. I should admit that to understand FR from actual experiments is to complex, the involvement of PSCAD/EMTDC made it understandable its existence in TF core. Although resonance is not new subject but survival of this phenomenon in many circuit enforced to be study in detail"*
S4	*"I'm pleased to express that I got enough knowledge through evidencing the presentation about today's hot topic and talking about the PAK power system, it's seems people are still living in 18^{th} century. The FR presence in unhealthy infrastructure is not a new subject but FR happening is still unknown for official's is strange. There should be need to build a cost effective suppression circuit"*
S5	*"Capacitance has significant effects during all FR setup, the imagination to occurring of these phenomena in long feeder's line as PAK distribution system contains, have much limitation and the load shedding idea provide a strong trail to this happening in TF core that already resulted as failure of high rates of TF burning or failure. The question about FR topic as future research have worth a lot but there should be include a comparison part to evidence developed countries dealing for this phenomenon".*

Most appreciated student's remarks on presentation are added in Table V. The student's attendance as audience in presentation was the initiative to encourage their own learning capabilities through visualizing different research topics. It might have worth on student

competitive learning through comparing their performances with new themes will assist them to gain new ideas. The student's interest and feasibility of FR phenomena in power system means a lot and have long lasting effects not only in PAK power system but also all over the world where load variation is regularity, low loss transformer presence, and long transmission lines configured. Nevertheless, FR topic repeated in many articles with different criteria and faces, but it is still not enough understandable. Moreover, it is pure frequency phenomena where frequency varies with height of core saturation. The scenario of Pak power sector it seems more complex and more prone to occurrence of FR. So, it is urgent need to explore FR phenomena deeply and should be figure out prevention methods in future research.

5. RAA METHODOLOGY EVOLUTION

A second questionnaire was aimed to measure overall reflection of the assessment methodology on students learning that was inquired at the end of all presentation when students were successfully completed their presentation. The questionnaire was distributed to students who were involved in the approval process and advised to respond the following question (Q1 up to Q10) according to five dimensions response ((a) Agree (b) Disagree (c) Strongly agree (D) Strongly disagree (C) None) and Q11 was open ended question to respond.

Q1. Do you think the implementation of this mythology has engaged you to learn effectively? If agree how?
Q2. Were you interested to explore your previous knowledge for future research? If agree why?
Q3. Do you think the role of communication with supervisor was effective during assessment process? If yes how?
Q4. Were you interested to explore your previous knowledge for future research? If agree why?
Q5. Did you have learned any engineering software previously? If, yes how it affected the present experience?
Q6. Do you feel you have gained enough software skills during assessment process? Explain.
Q7. Do you think this methodology will help you to study comfortably for final dissertation? Share experience.

Q8. Did you enjoy recalling your past knowledge and presenting it for future research? Share your thought.
Q9. Are you fully prepared for future challenges?
Q10. Did this methodology help you to enhance your skills? Describe.
Q11. If the assessment process will implement in future can you provide any suggestion?

The responses of students on questionnaire provided enough reflection on merits or demerits of this methodology. The students deliberated their opinion on methodology through choosing 5 scale answers and accordingly they expressed their thoughts to support the process of the methodology. Where, overall responses were in support of RAA process however few of them were complaining about process and shared their thoughts in table VI.

Table VI Assessment evolution

No.	*Evolution Results and students Responses (R)*
R1	*All students were strongly agreed with the Q1 statement and the most attracting remark has added.* *"Genuinely, I admire the process of assessment was entirely constructive because it convinced me to explore my previous experience in details and apply for future research, it triggered my learning skills when I was advised to figure out consequences and causes of problematic circuit, I raised in my report that engage me throughout all the process".*
R2	*The response to Q2 was overall strongly agreed but one student was complaining to start new exposure.* *"It was dream for me to peruse my desired research topic for graduation dissertation, because previously I never allowed to do project on my choice that always divert my concentrations. Additionally, motivation and instruction from supervisor engaged me deeply with my research".*
R3	*The Q3 was designed to know the effectiveness of communication and encouragement during entire process; the overall responses were strongly agreed. The most positive comment is shown below.* *" We worked as a team and learnt from each other, while working in same laboratory whenever we felt difficulties we discussed and tried to solve by discussion and the role of supervisor was always encouraging and full of motivation and suggestion. The weekly reporting belong to my work helps me a lot because I always found some valuable suggestion of my questions that act keeps me reflective and boosted my communication and problem discussion skills".*
R4	*The Q4 was approach to know the limitation of assessment process the average responses was disagree but 2 of students was agree with the Q4 statement. The response was added as blow.* *"Our laboratory environment was friendly enough, although when I started preparing reports about my project I found some concept was missing due to little gap in studies that was resolve through communication with my undergraduate companions and lab-mates, but that was only first step after motivation from teacher I worked smoothly and enjoyed learning".*
R5	*Answer to Q5 was the query to investigate the effective role of methodology to learn software skills, generally all students were strongly agreed with the statement. The best response is*

	added. *"Infect, I was taught MATLAB during my undergraduate studies, but the lack of practice i didn't have much command on power system analysis in Simulink, this process provide me an environment to learn MATLAB in detail".*
R6	*Q5 and Q6 were designed for the similar purpose and the answer was strongly agreed, the response is added.* *"I can truly say that my software skills are improved and this process did a great job to enable me to visualize the power system that helped me to accept the challenges of power system and to learn these challenges deeply though applying subjective knowledge in Simulink".*
R7	*Q7 was based on student's preparation to complete their degree dissertation, the answer of six students were strongly agree and five of them was agreed, the most valued comment is added.* *"After gone through all the process I feels relax because the approval process facilitated me to address issues, make me enough competent, I start thinking critically, boosted my software skills, developed my PBL skills and provide me enough confident. So, literally, these abilities are more than enough to finish my job".*
R8	*Q8 and Q2 response was found quite matching and the answer was also similar as R2, the comment to Q8 is added.* *"The most interesting part of the assessment process was the combination of my previous project for future research that opened new ways to achieve my goals. Although, the process was a bit time consuming but it helped me to explore new challenges and bridge my PBL and software skills".*
R9	*Q9 was asked to investigate the students learning and their abilities for future research, the response to Q9 was comparative similar to Q7 because 75% of them marked strongly agree and 25% was only agree.*
Q10	*Q10 inquired to know the impact of process on student's personality and their skills, the answer was 100% strongly agreed with the statement and the most attractive comment is added.* *"In start, i thought assessment process is designed to accomplish my graduation requirements but it was the finest effort to enhance not only my knowledge but also groom my skills in all scenarios, it developed software skills while creating and simulating power circuit, enhanced my PBL skills while recalling my past project data and employing for future research, professional skills though presenting my reports, dialoging on weekly bases and presenting my research, research skills while searching effective data according to my research and discussing the problematic circuit, and technical skills while trying to solve the complicity of power circuit in PSCAD/EMTDC. Generally, I feel lucky that I was the part of this attractive process".*
R11	*Q11 was deigned to get intention from students to indicate gaps of this methodology so it can be improve for future. The valued response is added.* *"Although, the methodology was full of activities that heightened my professional skills but there was something missing because I didn't find option for me as like I was not much interested to carry my previous project for future research, but the instruction from supervisor encourage me adopt this methodology. So, in future there should be option to ask students if they want to start new research the supervisor should provide enough hot topics for future research".*

The feedback from the students on asked questions have explained the success of approval assessment but it's also catch the attention of the author that the supervisor part is more vital throughout the process. The concerned about question raised by students is more valid for future point of view, but the dose of proper instruction from

supervisor can change non-interested subject into most favorite subject that can impress engineering students belonging into engineering education.

Addressing the issue of motivation has been suspected declining factor of engineering major. Nonetheless, it showed vital role in student's attitude towards their research. Throughout the process, they have been reflecting while reporting their research works on weekly bases. The face to face conversation in interactive manners not only motivated them but also encouraged them to solve their communication barriers was also identified as big hurdle to carry engineering education. Moreover, the RRA process enforced students to communicate regularly with their mentor where students have been actively involved to solve and visualize the complexity of power circuits in engineering software. The learning process in interactive manners not only solve the decaling factors of engineering majors but also can train them to understand the complexity of future power system.

6. LIMITATION AND FURTHER WORK

Throughout the process students was engaged with their studies but it's true they been very hardworking and suspected to have many confusion about their research because the students comes from different schools and their level of knowledge was different when they required to assimilate their previous project and provide complete reports they found difficulties, because few of them have studies gaps so, it have been challenging for them to collect all of information again but that latter been solved by dialoging with their companions and teacher recommendation. Although, the methodology was developed to empower students based on their interest that been successful but two of the students was complaining. They wanted to start a new exposure instead of previous projects. Infect that was initial thoughts of both of them but the objective was similar according to their ideas to start innovative research. Afterwards they were agreed and successfully accomplished their approval process.

7. CONCLUSION AND SUGGESTION

The paper has detailed successful implementation of RAA that was specially designed to control the failure rates and to groom student's skills. Mainly, the process focused to provide free environment to learn their desire research topics through recalling past knowledge and projects. Through, this process they have been experienced to explore details of their undergraduate projects problematic areas according to the future trends and experiencing problematic circuit in software packages. The act not only fulfills the requirement of their assign tasks but also qualified them for the school graduation requirements. The most favorable prospective of this assessment is to convince the students belonging as previously and covers all factors that were suspected dropout factors. The evaluation of assessment and successful approval of student's proposal has strongly agreed that process have capability to emerge student's professional skills and serve efficiently as a professional engineer. The objective to cover the gap of engineering education trend that caused failure/dropout of EE students in colleges can be filled through launching interactive activities in engineering majors. Although, this study applied in limited students and included just one example, it is only enough to understand the methodology and state forward outcomes. In order to explore all hidden probabilities of this methodology it should implement among a huge number of students.

The scenario of FR existence in PAK power system, it has physical intimidation and serious damages. The occurrence of this phenomenon depends on system situation that decide the tallness of the saturation and vulnerabilities. The conditions of FR in PAK power system involved widely, that is not only caused of TF failure but also provide a roadmap to other problems. Nevertheless, the miner conditions are simulated for the introduction of causes and damages that just open a new era of intimidation but not insufficient for understanding that allows further research to make these occurrences understandable and according prevention steps need to be reinforced.

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