The University of Queensland - IIT Delhi Academy of Research (UQIDAR) Joint PhD Project Proposal Template

1. Project details

Project title	**Flexibility Assessment and Strengthening of existing conventional power grids for large-scale renewable energy integration – Theoretical/ Modelling based research**

Project ID	**UQIDAR- 00109**

2. Supervision team

Please visit the IITD website www.iitd.ac.in and UQ website http://researchers.uq.edu.au/ to highlight potential collaborators that would be best suited for the proposed project. Complete where possible – advise if you'd like assistance establishing contacts.

	University of Queensland	IIT Delhi	External/Industry (if applicable)
Supervisor name and title	*Prof Tapan Saha*	*Prof Nilanjan Senroy*	
School or department (or company, if applicable)	*School of Information Technology and Electrical Engineering*	*Department of Electrical Engineering*	
Phone number	*+61 7 33653962*	*+91 11 26597016*	
Email-ID	*saha@itee.uq.edu.au*	*nsenroy@ee.iitd.ac.in*	
URL for more info	*http://researchers.uq.edu.au/researcher/83*	*http://web.iitd.ac.in/~nsenroy/*	

3. Other supervisors

Please provide information about other associate supervisors below.

Full name and title(s):
School/department/company details:
Phone:
Email:
URL:

Additional Associate supervisors will be added from both UQ and IIT-D in due course.

2. Field Of Research (FOR) codes

Specify up to four four-digit FOR codes for your project – see **here** for more detail on FOR codes.

1. 0906	3.
2.	4.

3. Keywords

Please choose up to 4 keywords for your project. E.g. Nanotechnology, data science, novel batteries, etc. Keywords will assist in classifying project and presenting projects to students on the applications portal.

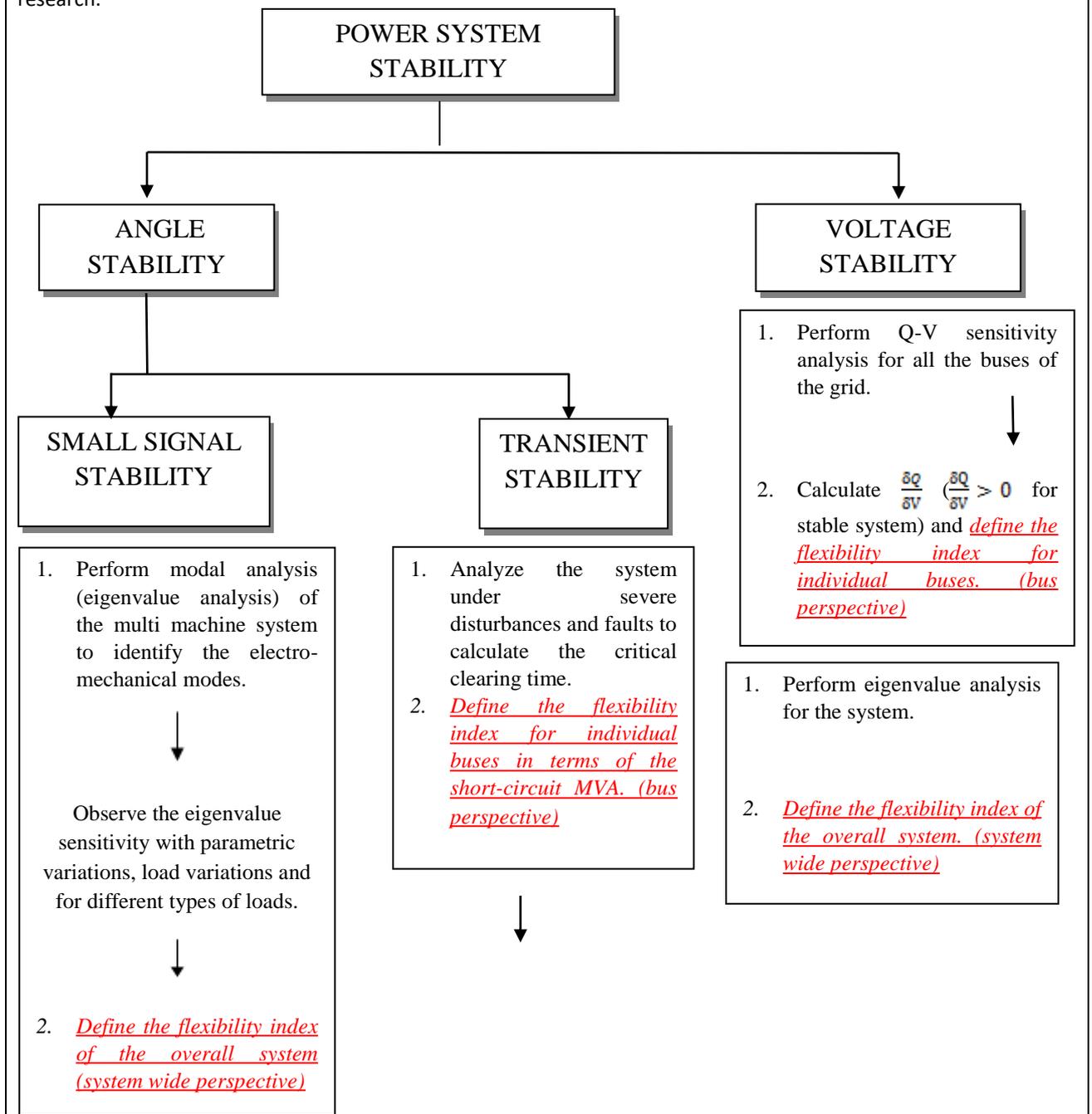|	
1. Renewable energy	3. Power system strength
2. Grid integration	4. Frequency response

4. Discipline background of candidate

Please outline the preferred background of your student. E.g. Organic chemistry, physiology, topology, CFD, etc. This will assist in presenting projects to applicants on the apps portal.

1. Electrical Engineering	3. Knowledge in PSS/E or PSCAD
2. Power Systems	4. Optimisation tools

5. Project description

Power system security is adversely affected by intermittent wind and the variability of solar PV based generation. High penetration of wind and solar can affect three types of stabilities, which need to be comprehensively studied to ensure a secure and highly reliable power system. The figure below shows the steps needed to conduct the research.

POWER SYSTEM STABILITY

ANGLE STABILITY

VOLTAGE STABILITY

1. Perform Q-V sensitivity analysis for all the buses of the grid.

2. Calculate $\frac{\delta Q}{\delta V}$ ($\frac{\delta Q}{\delta V} > 0$ for stable system) and *define the flexibility index for individual buses. (bus perspective)*

SMALL SIGNAL STABILITY

TRANSIENT STABILITY

1. Perform modal analysis (eigenvalue analysis) of the multi machine system to identify the electro-mechanical modes.

Observe the eigenvalue sensitivity with parametric variations, load variations and for different types of loads.

2. *Define the flexibility index of the overall system (system wide perspective)*

1. Analyze the system under severe disturbances and faults to calculate the critical clearing time.

2. *Define the flexibility index for individual buses in terms of the short-circuit MVA. (bus perspective)*

1. Perform eigenvalue analysis for the system.

2. *Define the flexibility index of the overall system. (system wide perspective)*

Project aims:

- *To derive the flexibility index of the non-conventional grid in terms of its stability margin. The indexing has to be performed in terms of Small Signal Stability, Transient Stability and Voltage Stability Model.*
- *To develop remedial techniques or methods to improve the grid flexibility, both system-wide and bus-wise. This can be done by developing controllers to enhance the damping of the system. Optimization of the parameters as well as the location of these controllers becomes very crucial in order to have maximum impact without compromising the operational and economic objectives.*
- *To integrate Renewable Energy (RE) Technologies like Solar PV (both rooftop and large-scale) and Wind Turbines to the existing non-conventional grid model to analyze their impact in the system stability and hence, the flexibility of the grid.*
- *To analyze and observe the effect of variations of the penetration levels of RE along with the location of the RE. This will help to establish the relationship between these variations of RE with the change of grid flexibility. This could be instrumental to develop accurate scheduling of the generators and implementing controllers of the renewable integrated grid.*

6. Project deliverables/outcomes

The project outcome will be as below:

- Theoretical modelling of stability behaviour of power system with wind and solar PV integrated
- Voltage stability analytic tool for renewable energy based power systems.
- Comprehensive understanding of small signal and transient stability analytics
- Control algorithms for improving system strength for high penetration renewable energy based power systems
- Theoretical modelling of frequency response under different critical contingencies

The deliverables from this project, apart from skill development and research training, are high impact publications in reputed journals and international conferences.

7. Research impact themes

Highlight the research impact theme(s) this project will address. Feel free to nominate more than one. For more information, see
http://www.uq.edu.au/research/impact

3. Resilient Environment

4. Technology for Tomorrow

8. Type of student

This project is best suited for an:

i-student	√
a-student	
i- or a-student	

Please note that:

- an i-student will be expected to spend year-1 at IIT-D, year-2 at UQ and the remaining time at IIT-D.
- an a-student will spend year-1 at UQ, year-2 at IIT-D and the remaining time at UQ.
- All students will be required to complete some amount of coursework in their first year.

9. Student capabilities and qualifications

List the ideal set of capabilities (at least 2 essential and 2 desirable) that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities. Add specific skill sets here.

Essential Capabilities:

- High GPA in Electrical Engineering degree (s) from reputed university.
- Depth knowledge in power systems analysis including stability techniques

Desirable Capabilities:

- High level of control/optimisation knowledge
- Some knowledge in power electronics

Expected qualifications (Courses/Degrees etc):

- B.Tech in Electrical Engineering with high GPA from IIT Delhi or from an similar standing institute
- Or B.Tech and M. Tech from non-IIT students, but from a reputed institute with high GPA