

ENDORSEMENT PAGE	ii
DECLARATION OF ORIGINALITY	v
DECLARATION OF ORIGINALITY	v
PAGE OF DEDICATION	v
PREFACE	vi
CONTENTS	vii
LIST OF TABLES	x
LIST OF FIGURES	xi
NOMENCLATURE AND ABBREVIATION	xiii
INTISARI	xiv
ABSTRACT	xv
CHAPTER I Introduction	1
1.1 Background Study	1
1.2 Problem Identification	2
1.3 Aim of The Study	3
1.4 Research Limitations	3
1.5 Research Benefit	3
1.6 Writing Systematics	4
CHAPTER II Literature Review and Fundamental Theories	5
2.1 Literature Review	5
2.2 Fundamental Theories	6
2.2.1 Stability in Power System	6
2.2.2 Inverter	7
2.2.2.1 <i>Grid Following Inverter (GFLI)</i>	7
2.2.2.2 <i>Grid Forming Inverter (GFMI)</i>	8
2.2.3 LC Filter	10
2.2.4 Single Machine Infinite Bus (SMIB)	12
2.2.5 Park Transformation	12
2.2.6 Per Unit (p.u.) Calculation	13
2.2.7 Small Signal Stability	13
CHAPTER III Research Methodology	14
3.1 Final Project Tools and Materials	14
3.2 Final Project Research Method : Modeling and Simulation	14
3.2.1 Inverter Data Parameters and Specifications	14
3.2.2 Inverter Control Model	15
3.2.2.1 Power Synchronization Control	15

3.2.2.2	Voltage and Current Loop	17
3.3	LC Filter Calculation	19
3.4	SMIB System Modeling	20
3.5	Small Signal Analysis	22
3.5.1	Linearization	22
3.5.2	Linearization	23
3.5.3	Eigenvalue Analysis	23
3.5.4	Modal Analysis.....	24
3.5.5	Participation Factor	24
3.6	Testing Scenario	25
3.6.0.1	Small Signal Stability Analysis	25
3.6.0.2	Transient Analysis	27
3.7	Research Flow.....	27
CHAPTER IV Results and Discussion		30
4.1	Standalone GFM: Small-Signal Analysis.....	30
4.1.1	Effect of Grid Parameters on Small-Signal Stability	30
4.1.1.1	Effect of Grid Reactance (X_g) in Droop Control.....	30
4.1.1.2	Effect of Grid Inductance (X_g) in VSG Control	32
4.1.1.3	Effect of Grid Impedance $\frac{R}{X}$ Ratio in Droop Control	33
4.1.1.4	Effect of Grid Impedance $\frac{R}{X}$ Ratio in VSG Control.....	36
4.1.2	Effect of Power Synchronization Control Parameters on Small-Signal Stability	38
4.1.2.1	Variation of P- ω Droop Gain (m_p).....	38
4.1.2.2	Variation of Inertia Constant (H) in VSG Control	40
4.1.2.3	Variation of Damping Coefficient (D_p) on VSG Control	41
4.1.2.4	Effect of Q-V Droop Gain (n_q) on Droop and VSG Control	44
4.1.3	Effect of Voltage Control Parameters on Small-Signal Stability....	47
4.1.3.1	Variation of d-Axis Integrator Gain (K_i^d) in Droop Control	47
4.1.3.2	Variation of d-Axis Integrator Gain (K_i^d) in VSG Control	48
4.1.3.3	Variation of d-Axis Proportional Gain (K_p^d) in Droop Control	50
4.1.3.4	Variation of d-Axis Proportional Gain (K_p^d) in VSG Control	50
4.1.3.5	Variation of q-Axis Integrator Gain (K_i^q) in Droop Control	52
4.1.3.6	Variation of q-Axis Integrator Gain (K_i^q) in VSG Control	53

4.1.3.7	Variation of q-Axis Proportional Gain (K_p^q) in Droop Control	54
4.1.3.8	Variation of q-Axis Proportional Gain (K_p^q) in VSG Control	56
4.1.4	Effect of Inner Current Control Parameters on Small-Signal Stability	57
4.1.4.1	Variation of Inner Control Bandwidth in Droop Control	57
4.1.4.2	Variation of Inner Control Bandwidth in VSG Control ..	59
4.2	Parallel GFM Stability Analysis	60
4.2.1	Effect of Nonidentical P- ω Droop Gain (m_p) on the Stability of Parallel Droops	60
4.2.2	Effect of Nonidentical Damping Coefficient (D_p) on the Stability of Parallel VSGs	61
4.2.3	Effect of Nonidentical Inertia Constant (H) on the Stability of Parallel VSGs	63
4.2.4	Analysis of Power Output Variation between Parallel GFMs with Different Control Strategies (VSG-Droop)	64
4.3	Transient Analysis : Voltage Drop on Infinite Bus	67
4.3.1	Standalone GFMI Droop	68
4.3.2	Standalone GFMI VSG	68
4.4	Transient Analysis : Islanding	69
4.4.1	Standalone GFMI Droop	69
4.4.2	Standalone GFMI VSG	73
CHAPTER V CONCLUSION AND RECOMMENDATION		80
5.1	Conclusion	80
5.2	Recommendation	84
REFERENCES		85