
Contents

Abstract	iii
Declaration	ix
Certificate	xi
Certificate	xiii
Acknowledgment	xv
1 Introduction	1
1.1 Current Status of Neutrino	3
1.1.1 Theoretical Advancements:	3
1.1.2 Experimental Advancements:	5
1.2 Standard Model	6
1.2.1 The Electroweak sector	7
1.2.2 Masses of Fermions and Gauge Bosons	10
1.2.3 Shortcomings of Standard Model	12
1.3 Neutrino Oscillation	13
1.3.1 Neutrino Oscillation in Vacuum:	14
1.3.2 Neutrino Oscillation in Matter:	15
1.3.3 Neutrino mass: Dirac and Majorana	16
1.3.4 Neutrino Mass Models	17
1.4 Baryon Asymmetry of the Universe	21
1.4.1 Resonant Leptogenesis	22
1.5 Dark Matter	23
1.6 Neutrinoless double beta decay ($0\nu\beta\beta$): Lepton Number Vi-	
olation	26

1.7	Lepton Flavor Violation (LFV)	27
1.8	Flavor Symmetry in Particle Physics	29
1.8.1	Abelian Z_N group	30
1.8.2	A_4 Discrete Symmetry Group	30
1.8.3	Modular Symmetry	32
1.8.4	$\Gamma(3)$ Modular Group	34
1.9	Thesis Outline	35
2	Neutrinoless Double Beta Decay (NDBD) and Lepton Flavor Violation (LFV) using A_4 Modular Symmetry in Minimal Inverse Seesaw	39
2.1	Introduction	40
2.2	Description of the Model	42
2.3	Lepton Number Violation	46
2.4	Non-Unitarity	47
2.5	Lepton Flavor Violation	47
2.6	Numerical Analysis and Results	48
2.6.1	Variation between $\sum m_\nu$ and mixing angles	50
2.6.2	Relation among the Yukawa modular forms	51
2.6.3	Corelation between Yukawa forms and components of τ	52
2.6.4	Variation between virtual momentum (p) and m_{ee}	54
2.6.5	Corelation between BR ($\mu \rightarrow e\gamma$) and RHN M_2	55
2.7	Conclusion	55
3	Dark Matter and Baryon Asymmetry of the Universe in a A_4 Modular Symmetric Model in ISS(2,3)	57
3.1	Introduction	58
3.2	Description of the Model	60
3.3	Leptogenesis in ISS(2,3)	63
3.3.1	Computation of CP asymmetry	63
3.4	Dark matter	65
3.5	Numerical Analysis and Results	66
3.5.1	Relation between the components of τ and mixing angles	67
3.5.2	Corelation between $\sin^2\theta_{12}$ and Yukawa modular forms	68
3.5.3	Corelation between $\sin^2\theta_{13}/\sin^2\theta_{23}$ and Yukawa modular forms	69

3.5.4	Contribution of η to BAU	69
3.5.5	Corelation between BAU and lightest RHN M_1	70
3.5.6	Relation of relic density of DM and $\langle \sigma v \rangle$ with M_1	72
3.5.7	Variation between m_{eff} and $\sum m_\nu$	73
3.6	Conclusion	74
4	Texture Zeros using Discrete Flavor Symmetry in ISS(2,3)	75
4.1	Introduction	75
4.2	The Model	77
4.3	Texture Zero Structures of the Matrices	80
4.4	Results and Discussions	83
4.4.1	Possible Values of Model Parameters	85
4.4.2	Analysis of DM for M_{D3} and M_{D6}	86
4.5	Conclusions	86
5	Conclusion and Future Prospects	89
	References	97