



## TABLE OF CONTENTS

COVER .....	i
HALAMAN PENGESAHAN.....	ii
DECLARATION .....	iii
NASKAH SOAL TUGAS AKHIR.....	iv
DEDICATION .....	v
PREFACE .....	vi
TABLE OF CONTENTS.....	vii
LIST OF FIGURES .....	x
LIST OF TABLES .....	xii
NOMENCLATURES .....	xiii
ABSTRACT.....	xv
INTISARI	xvi
CHAPTER I INTRODUCTION .....	1
1.1. Introduction .....	1
1.2. Objectives.....	4
1.3. Scope of work.....	4
1.4. Problem Limitations .....	4
1.5. Research Benefits .....	5
CHAPTER II LITERATURE REVIEW.....	6
2.1. Effects of frequency on the fatigue crack growth rate .....	6
2.2. Effect of test temperature on the fatigue crack growth rate .....	7
2.3. Effect of load ratio on the fatigue crack growth rate.....	7



CHAPTER III BASIC THEORY.....	9
3.1. Biomaterial .....	9
3.2. Ultra high molecular weight Polyethylene.....	11
3.3. Fracture Mechanics .....	13
3.4. Linear Elastic Fracture Mechanics/ Fatigue Crack Propagation .....	14
3.5. Fatigue Crack Propagation Testing .....	15
CHAPTER IV RESEARCH METHODOLOGY .....	18
4.1. Experimental Facility .....	18
4.1.1. Tools .....	18
4.1.2. Testing Machine .....	18
4.2. Ultra-high Molecular Weight Polyethylene 1000, H.O.T Tivar .....	18
4.3. Preparation .....	19
4.3.1. Dogbone specimen .....	19
4.3.2. Compact-Tension specimen .....	21
4.4. Tensile Testing Machine .....	23
4.5. Hydraulic Servopulser Testing Machine.....	24
4.6. Test Procedures .....	25
4.6.1. Tensile properties of UHMWPE .....	25
4.6.2. Fatigue crack propagation testing.....	26
4.7. Calculation and Interpretation .....	27
4.7.1. Tensile properties of UHMWPE .....	27
4.7.2. Fatigue crack propagation of UHMWPE .....	28
4.7.3. Boundary condition .....	29
4.7.4. Intepretation of the Paris regime .....	29



4.8. Research Methodology.....	30
CHAPTER V RESULTS AND DISCUSSION .....	31
5.1. Experimental Results.....	31
5.2. Tensile Properties of UHMWPE 1000 and H.O.T Tivar .....	31
5.3. Fatigue Crack Propagation behavior of UHMWPE 1000 and H.O.T Tivar .....	34
CONCLUSION .....	43
6.1. Conclusion.....	43
6.2. Future Works.....	43
REFERENCES.....	45
APPENDICES .....	47
Appendix 1. Fatigue crack propagation testing of UHMWPE 1000 at R=0.1..	47
Appendix 2. Fatigue crack propagation testing of UHMWPE 1000 at R=0.3..	49
Appendix 3. Fatigue crack propagation testing of UHMWPE 1000 at R=0.5..	51
Appendix 4. Fatigue crack propagation testing of UHMWPE H.O.T at R=0.1	52
Appendix 5. Fatigue crack propagation testing of UHMWPE H.O.T at R=0.3	55
Appendix 6. Fatigue crack propagation testing of UHMWPE H.O.T at R=0.5	57
Appendix 7. Tensile testing of UHMWPE H.O.T (length-direction).....	59
Appendix 8. Tensile testing of UHMWPE H.O.T (width-direction).....	59
Appendix 9. Tensile testing of UHMWPE 1000 (length-direction) .....	59
Appendix 10. Tensile testing of UHMWPE 1000 (width-direction).....	60
Appendix 11. Compact-Tension specimen after testing .....	60



## LIST OF FIGURES

Figure 3.1 Chemical structure of Ethylene and Polyethylene (Kurtz, 2004).....	11
Figure 3.2 Wear rate of HDPE and UHMWPE (Kurtz, 2004).....	13
Figure 3.3 Mode of loading (Hertzburg, and Vinci, 2012).....	15
Figure 3.4 Representative FCP data on a log-log scale, showing three regimes of observation (Medel, and Furmanski, 2016) .....	17
Figure 4.1 Dogbone Specimen, Dimensions in Millimeters .....	19
Figure 4.2 Compact-Tension Specimen, Dimensions in Millimeters.....	19
Figure 4.3 Variation of Specimens Designs Available (ASTM D638 – 03, 2003) .....	20
Figure 4.4 Dogbone specimen of UHMWPE H.O.T (left) and 1000 (right) .....	21
Figure 4.5 Standard Compact-Tension Specimen (ASTM E647, 2000) .....	21
Figure 4.6 Middle Tension Specimen (ASTM E647, 2000).....	22
Figure 4.7 Notch and Precracking Configuration (ASTM E647, 2000).....	22
Figure 4.8 Compact-Tension specimen of UHMWPE H.O.T Tivar (left) and UHMWPE 1000 (right).....	23
Figure 4.9 Pearson and Panke Equipment Universal Testing Machine.....	24
Figure 4.10 Shimadzu Hydraulic Servopulser Testing Machine .....	24
Figure 5.1 Stress-strain curve of UHMWPE H.O.T .....	32
Figure 5.2 Stress-strain curve of UHMWPE 1000.....	33
Figure 5.4 Stress-strain curves comparison of UHMWPE H.O.T and UHMWPE 1000.....	33
Figure 5.5 Effect of load ratio (R=0.1) on fatigue crack behavior of UHMWPE 1000 .....	37
Figure 5.6 Effect of load ratio (R=0.3) on fatigue crack behavior of UHMWPE 1000 .....	37
Figure 5.7 Effect of load ratio (R=0.5) on fatigue crack behavior of UHMWPE 1000 .....	38