**DERS ÖĞRETİM PLANI**

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| **Dersin Adı** | Matematiksel Modelleme |
| **Dersin Kodu**  | IE 213 |
| **Dersin Türü** | Zorunlu |
| **Dersin Seviyesi** | Lisans |
| **Dersin AKTS Kredisi**  | 7 |
| **Haftalık Ders Saati** | 4 |
| **Haftalık Uygulama Saati**  | 0 |
| **Haftalık Laboratuvar Saati** | 0 |
| **Dersin Verildiği Yıl** | Her yıl |
| **Dersin Verildiği Yarıyıl** | Güz |
| **Dersin Öğretim Üyesi** | Doç. Dr. İbrahim Akgün |
| **Öğretim Sistemi** | Örgün öğretim |
| **Eğitim Dili** | İngilizce |
| **Dersin Ön Koşulu Olan Ders** |  |
| **Ders İçin Önerilen Diğer Hususlar** |  |
| **Staj Durumu** | Yok |
| **DERSİN AMACI** | Ders, öğrencilere matematiksel modelleme sürecini öğretmeyi hedeflemektedir. Özellikle, öğrencilere gerçek hayat problemini tespit etme, bu sistem/problem için uygun olan matematiksel modeli formüle etme, matematiksel modeli kodlama ve GAMS, CPLEX, EXCEL SOLVER, EXPRESS, GUROBI gibi uygun olan bir yazılım ile çözme ve modellerden elde edilen çözümlerden çıkarım yapma kabiliyetlerinin kazandırılması amaçlanmaktadır. Derste, modelleri çözmek için kullanılan algoritmalardan ziyade, problemleri modelleme ve çözme üzerine odaklanılacaktır. |
|  **ÖĞRENME ÇIKTILARI** | Bu dersi tamamlayan bir öğrenci, |
| 1. Sözle ifade edilmiş bir problemi yorumlama ve uygun değişkenler, parametreler, amaç fonksiyonu ve kısıtları seçerek matematiksel dile çevirme becerisi.
 |
| 1. ”gölge fiyatlar” dahil olmak üzere duyarlılık analizi ile sonuçlarını yorumlama becerisi.
 |
| 1. Bir doğrusal programlama probleminin dualite problemini türetme ve dualite doğrusal program ile ilk doğrusal programın formülasyonları ve çözümleri arasındaki bağlantıları kurma becerisi.
 |
| 1. İlgili mühendislik problemlerini ulaştırma ve ağ modellerinin türevleri olarak formüle etme.
 |
| 1. Kesikli değişkenler içeren bir problemi ikili değişkenler, büyük M yöntemi gibi yöntemler de dahil olmak üzere tamsayılı program olarak formüle etme becerisi.
 |
| **DERSİN İÇERİĞİ** | * Genel Modelleme
* Doğrusal Programlama Modelleri
* Tamsayılı Programlama Modelleri
* Ağ Akış Modelleri
* Doğrusal Olmayan Programlama Modelleri
* Girdi-Çıktı Modelleri
* Karar Analizi Modelleri
* Simülasyon Modelleri
 |
| **HAFTALIK AYRINTILI DERS İÇERİĞİ** |  **HAFTA** | **KONULAR** |
| **Teorik Dersler** | **Uygulama** |
| **1** | Yöneylem araştırmasına giriş |  |
| **2** | Doğrusal programlamaya giriş |  |
| **3** | Doğrusal programlama için grafiksel çözüm prosedürü, doğrusal programlama model formülasyonu, kısa sınav |  |
| **4** | Duyarlılık analizi |  |
| **5** | Duyarlılık analizi ve dualite |  |
| **6** | Ulaşım problemi |  |
| **7** | Aktarma problemi, ara sınav |  |
| **8** | Atama problemi |  |
| **9** | Ağ modelleri |  |
| **10** | Tamsayılı programlamaya giriş, kısa sınav |  |
| **11** | Tamsayılı doğrusal programlama problem formülasyonu ve çözüm teknikleri |  |
| **12** | Deterministik Envanter Modelleri |  |
| **13** | Farklı alanlarda matematiksel modelleme |  |
| **14** | Proje sunumları |  |
| **15** | Final haftası (ders yok) |  |
| **16** | Final sınavı |  |

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| **DERS KİTABI/MALZEMESİ/ÖNERİLEN KAYNAKLAR** | **DERS KİTABI:****YARDIMCI KİTAPLAR:*** *Model Building in Mathematical Programming* by H. Paul Williams, 5th Edition, John Wiley&Sons Ltd, 2013.
* *Operations Research: A Model-Based Approach* by H.A. Eiselt and C.-L. Sandblom, Springer, 1st Edition, 2010.
* *Applied Mathematical Programming by Bradley, Hax, and Magnanti, Addison-Wesley, 1977.*
* *Optimization Modelling: A Practical Approach by R.A. Sarker and C.S. Newton, Taylor&Francis Group, 2008.*
* *Spreadsheet Modeling & Decision Analysis* by Cliff T. Ragsdale, Thomson South-Western, 5th Edition, 2007.
* *Operations Research: Applications and Algorithms* by Wayne L. Winston, 4th Edition, Thomson Brooks/Cole, 2004.
* *Introduction to Operations Research* by F.S. Hillier and G.J. Lieberman, 9th Edition, McGraw-Hill, 2009.
* *Operations Research: An Introduction* by Hamdy A. Taha, 9th Edition, Prentice Hall, 2010.
* *Operations Research* by P.Rama Murthy, New Age International, 2nd Edition, 2007.
* *Optimization Modeling with Spreadsheets* by Kenneth R. Baker, John Wiley & Sons, 2nd Edition, 2011.
* *Optimization Models for Decision Making:Volume 1 Junior Level Self Teaching Web-Book* by Katta G. Murthy, downloadable from the Internet.
* *Practical Management Science by W.L.Winston and S.C. Albright, South-Western CENGAGE Learning, 3rd Edition, 2009.*

**ÇEVRİMİÇİ KAYNAK:** |
| **DEĞERLENDİRME** |
| **Yarıyıl (Yıl) İçi Etkinlikleri** | **Sayısı** | **Katkı Yüzdesi %** |
| **Ödevler** | 5 | 10 |
| **Küçük sınav(quiz)** | 5 | 10 |
| **Ara Sınav** | 1 | 15 |
| **Poster Sunumu** | 1 | 10 |
| **Derse devam/katılım** | 1 | 5 |
| **Proje** | 1 | 30 |
| **Final Sınavı** | 1 | 30 |
| **TOPLAM** | **110** |
| **Yarıyıl İçi Etkinliklerinin Başarı Notuna Katkısı** | 80 |
| **Yarıyıl Sonu Sınavının Başarı Notuna Katkısı** | 30 |
| **TOPLAM** | **110** |

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| **Dersin Öğrenme, Öğretme ve Değerlendirme Etkinlikleri Çerçevesinde İş yükünün Hesaplanması** |
| **Etkinlikler** | **Sayısı** | **Süresi****(saat)** | **Toplam İş Yükü****(saat)** |
| **Teorik Ders Anlatımı** | 14 | 4 | 56 |
| **Ara Sınav ve Sınava Hazırlanma** | 1 | 25 | 25 |
| **Dönem Sonu Sınavı ve Sınava Hazırlanma** | 1 | 25 | 25 |
| **Ödev Çalışması**  | 5 | 6 | 30 |
| **Derste Anlatılanların Tekrarlanması** | 14 | 2 | 28 |
| **Dönem Projesi Çalışması** | 1 | 50 | 50 |
| **TOPLAM**  | 36 | 112 | 214 |
| **AKTS KREDİSİNİN HESAPLANMASI**  | **214/30** | **7** |

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| **Program ve Öğrenme Çıktıları İlişkisi\*** |
| **Ders Öğrenme Çıktıları** | **Program Çıktıları** |
| **PÇ1** | **PÇ2** | **PÇ3** | **PÇ4** | **PÇ5** | **PÇ6** | **PÇ7** | **PÇ8** | **PÇ9** | **PÇ10** | **PÇ11** | **PÇ12** | **PÇ13** | **PÇ14** | **PÇ15** | **PÇ16** | **PÇ17** | **PÇ18** |
| **ÖÇ1** | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 5 | 4 | 5 | 3 | 5 | 4 | 5 | 5 | 5 |  5 | 2 |
| **ÖÇ2** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 5 | 2 | 3 | 4 | 3 | 5 | 2 |
| **ÖÇ3** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 5 | 2 | 3 | 4 | 3 | 5 | 2 |
| **ÖÇ4** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 4 | 2 | 4 | 2 | 5 | 2 | 4 | 5 | 5 | 5 | 2 |
| **ÖÇ5** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 4 | 2 | 4 | 2 | 5 | 2 | 4 | 5 | 5 | 5 | 2 |

**\*Katkı düzeyi:** 1 Çok Düşük, 2 Düşük, 3 Orta, 4 Yüksek, 5 Çok yüksek

**INDIVIDUAL COURSE DESCRIPTION**

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| **Course Unit Title** | Mathematical Modelling |
| **Course Unit Code** | IE 213 |
| **Type of Course Unit** | Compulsory |
| **Level of Course Unit** | B.Sc |
| **Number of ECTS Credits Allocated** | 6 |
| **Theoretical (hour/week)** | 4 |
| **Practice (hour/week)** | 0 |
| **Laboratory (hour/week)** | 0 |
| **Year of Study**  | Every year |
| **Semester when the course unit is delivered** | Fall |
| **Name of Lecturer(s)** | Assoc. Prof. İbrahim Akgün |
| **Mode of Delivery** | Face-to-face |
| **Language of Instruction** | English |
| **Prerequisites and co-requisites** |  |
| **Recommended Optional Programme Components** |  |
| **Work Placement** | None |
| **OBJECTIVES OF THE COURSE** | The course intends to teach the students the process of mathematical modeling. Specifically, the objective is to equip the students with the capability of abstracting a real-world system/problem conceptually, formulating and building mathematical models that are appropriate for the system/problem, coding and solving a mathematical model by using available off-the-shelf software e.g. GAMS, CPLEX, EXCEL SOLVER, EXPRESS, GUROBI and interpreting the solutions obtained from the models in terms of real-world system. The emphasis is placed on modeling and solving the problems rather than teaching the algorithms used to solve the models. |
| **LEARNING OUTCOMES** | A student who completes this course will be able to |
| 1. Ability to interpret a worded problem and translate it into mathematical language by appropriate choice of variables, parameters, objective function and constraints.
 |
| 1. Ability to interpret the solution by sensitivity analysis, including the “shadow prices”.
 |
| 1. Ability to derive the dual problem of an LP and draw the connections between the formulations and solutions of the dual LP and the primal LP.
 |
| 1. An ability to formulate relevant engineering problems as variants of the transportation and network models and to implement their customized solution/analysis techniques.
 |
| 1. Ability to formulate a problem involving discrete variables as an integer program, including such techniques as using binary variables, the big-M method, etc.
 |
| **COURSE CONTENT** | * Modeling in General
* Linear Programming Models
* Integer Programming Models
* Network Flow Models
* Non-Linear Programming Models
* Input-Output Models
* Decision Analysis Models
* Simulation Models
 |
| **WEEKLY DETAILED COURSE CONTENT** | WEEK | SUBJECTS |
| Theoretical |  **Practice** |
| 1 | Introduction to Operations Research |  |
| 2 | Introduction to Linear programming |  |
| 3 | Linear Programming Graphical Solution Procedure, Linear Programming Model Formulation, Quiz |  |
| 4 | Sensitivity Analysis  |  |
| 5 | Sensitivity Analysis and Duality |  |
| 6 | The Transportation Problem |  |
| 7 | The Transshipment Problem, Midterm |  |
| 8 | The Assignment Problem |  |
| 9 | Network Models |  |
| 10 | Introduction to Integer Programming, Quiz |  |
| 11 | Integer Linear programming problem formulation and solving techniques. |  |
| 12 | Deterministic Inventory Models |  |
| 13 | Mathematical Modelling in Different Areas |  |
| 14 | Project Presentations |  |
| 15 | Finals week (no lecture) |  |
| 16 | Final Exam |  |

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| **RECOMMENDED/REQUIRED****READING SOURCES** | **TEXTBOOK:****RECOMMENDED BOOKS:*** *Model Building in Mathematical Programming* by H. Paul Williams, 5th Edition, John Wiley&Sons Ltd, 2013.
* *Operations Research: A Model-Based Approach* by H.A. Eiselt and C.-L. Sandblom, Springer, 1st Edition, 2010.
* *Applied Mathematical Programming by Bradley, Hax, and Magnanti, Addison-Wesley, 1977.*
* *Optimization Modelling: A Practical Approach by R.A. Sarker and C.S. Newton, Taylor&Francis Group, 2008.*
* *Spreadsheet Modeling & Decision Analysis* by Cliff T. Ragsdale, Thomson South-Western, 5th Edition, 2007.
* *Operations Research: Applications and Algorithms* by Wayne L. Winston, 4th Edition, Thomson Brooks/Cole, 2004.
* *Introduction to Operations Research* by F.S. Hillier and G.J. Lieberman, 9th Edition, McGraw-Hill, 2009.
* *Operations Research: An Introduction* by Hamdy A. Taha, 9th Edition, Prentice Hall, 2010.
* *Operations Research* by P.Rama Murthy, New Age International, 2nd Edition, 2007.
* *Optimization Modeling with Spreadsheets* by Kenneth R. Baker, John Wiley & Sons, 2nd Edition, 2011.
* *Optimization Models for Decision Making:Volume 1 Junior Level Self Teaching Web-Book* by Katta G. Murthy, downloadable from the Internet.
* *Practical Management Science by W.L.Winston and S.C. Albright, South-Western CENGAGE Learning, 3rd Edition, 2009.*

**ONLINE SOURCES:** |
| **ASSESSMENT** |
| **Term Learning Activities**  | **Quantity** | **Weight, %** |
| **Homework** | 5 | 10 |
| **Quizzes** | 5 | 10 |
| **Midterm Exam** | 1 | 15 |
| **Poster Presentation** | 1 | 10 |
| **Attendance/Participation** | 1 | 5 |
| **Project** | 1 | 30 |
| **Final Exam** | 1 | 30 |
| **TOTAL** | **110** |
| **Contribution of Term Learning Activities to Success Grade** | 80 |
| **Contribution of Final Exam to Success Grade** | 30 |
| **TOTAL** | **110** |

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| **Planned Learning Activities, Teaching Methods, Evaluation Methods and Student Workload** |
| **Activities** | **Quantity** | **Duration****(hour)** | **Total Work Load****(hour)** |
| **Lectures** | 14 | 4 | 56 |
| **Midterm Exam Preparation** | 1 | 25 | 25 |
| **Final Exam Preparation** | 1 | 25 | 25 |
| **Homework Studies** | 5 | 6 | 30 |
| **Repetition of the Topics** | 14 | 2 | 28 |
| **Semester Project Studies** | 1 | 50 | 50 |
| **TOTAL** | 36 | 112 | 214 |
| **ECTS CREDITS** | **214/30** | **7** |

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| **Contribution of Learning Outcomes to Programme Outcomes\*** |
| **Learning Outcomes** | **Programme Outcomes** |
| **PÇ1** | **PÇ2** | **PÇ3** | **PÇ4** | **PÇ5** | **PÇ6** | **PÇ7** | **PÇ8** | **PÇ9** | **PÇ10** | **PÇ11** | **PÇ12** | **PÇ13** | **PÇ14** | **PÇ15** | **PÇ16** | **PÇ17** | **PÇ18** |
| **LO1** | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 5 | 4 | 5 | 3 | 5 | 4 | 5 | 5 | 5 |  5 | 2 |
| **LO2** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 5 | 2 | 3 | 4 | 3 | 5 | 2 |
| **LO3** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 5 | 2 | 3 | 4 | 3 | 5 | 2 |
| **LO4** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 4 | 2 | 4 | 2 | 5 | 2 | 4 | 5 | 5 | 5 | 2 |
| **LO5** | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 4 | 2 | 4 | 2 | 5 | 2 | 4 | 5 | 5 | 5 | 2 |

**\*Contribution level:** 1 Very Low, 2 Low, 3 Medium, 4 High, 5 Very High