1. **Course Number and Course Title**
   COE 49412 – Neural Networks and Deep Learning

2. **Credit Hours**
   3-1-3

3. **Prerequisites and/or Co-Requisites:**
   Prerequisites: CMP 220 (Programming II) and MTH 221 (Linear Algebra)

4. **Name and Contact Information of Instructor:**
   Dr. Imran Zualkernan
   Office: ESB-2066
   Email: izualkernan@aus.edu
   Phone: (06)515-2953
   Office Hours: Posted on office door

5. **Course Description (Catalog Description):**
   Covers tensors, neural network modelling, gradient descent optimization and loss functions, feature engineering, and evaluation of neural networks. Focusses on various types of neural networks including feedforward networks, auto-encoders, convolutional neural networks, recurrent neural networks. Discusses topics in generative deep learning.

6. **Textbook and other Supplemental Material:**

   Textbook:
   - François Chollet, Deep Learning with Python, November 2017, Manning Press.

   Other supplemental material:
   - Ian Goodfellow, Yoshua Bengio, and Aaron Courville, Deep Learning, 2016, The MIT Press.
   - Aurélien Géron, Hands-On Machine Learning with Scikit-Learn and TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems, 2017, O'Reilly Media.

7. **Learning Outcomes:**
   Upon completion of the course, students will be able to:

   1. Describe and build feedforward neural networks
   2. Demonstrate an understanding of issues in feature modelling and overfitting
   3. Describe and apply neural network evaluation techniques
   4. Design, build and analyze auto-encoders
   5. Design, build and analyze convolution neural networks
   6. Design, build and analyze recurrent neural networks
   7. Apply generative deep learning techniques to create synthetic data

8. Teaching and Learning Methodologies:

Methods include lectures; problem and project-based learning methods (homework, simulation-based projects) and class discussions.

9. Course Topics and Schedule:

Topic	Weeks
Introduction and history of neural networks	0.5
Review of linear algebra	0.5
Bootcamp in Python	1
Introduction to Keras	1
Feedforward neural networks	2
Feature engineering and autoencoders	1
Evaluation of neural network models	2
Convolution neural networks and applications	2
Recurrent neural networks and applications	2
Generative deep learning and applications	2
Evaluation and Assessment	2
Total:	**16**

10. Schedule of Laboratory and other Non-Lecture Sessions:

Labs	Tentative Due Date
Python	Week 2
Feedforward neural network	Week 3,4
Autoencoders	Week 5,6
Convolution neural networks	Week 7,8,9
Recurrent neural networks	Week 10,11,12
Generative deep learning	Week 13,14

11. Out-of-Class Assignments with Due Dates:

Assignments	Tentative Due Date
Feedforward neural network	Week 2
Autoencoders	Week 4
Convolution neural networks	Week 8
Recurrent neural networks	Week 10
Generative deep learning	Week 12

12. Student Evaluation:

Assessment	Weight	Tentative Due Date
Class project	30%	Week 15
Midterm Exam 1	10%	Week 6
Midterm Exam 2	10 %	Week 9
Final Exam	30 %	TBA
Lab and Homework	20%	About every other week

13. Course Project Description:

The class project requires students to apply what they learnt in the course to a relatively large data set. The focus of the project will vary from semester to semester. The project will assess learning outcomes 2 and 3 every semester, and one or more of outcomes 4 to 7 depending on the project focus each semester. The students work in teams of two or three students.

14. Assessment Instruments:

Assessment	Course Learning Outcomes
Class project	O2-O7
Midterm Exam 1	O1-O4
Midterm Exam 2	O5-O7
Final Exam	O1-O7
Lab and Homework	O1-O7

15. Contribution of Course to Program Outcome:

This course contributes to the accomplishment of the following program outcomes:

BSCS Program Outcomes	Emphasis in this course	Course Learning Outcomes
(1) Analyze a complex computing problem, and to apply principles of computing and other relevant disciplines to identify solutions.	◑	3, 4, 5, 6, 7
(2) Design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.	◑	3, 4, 5, 6, 7
(3) Communicate effectively in a variety of professional contexts.	○	1
(4) Recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.		
(5) Function effectively as a member or leader of a team engaged in activities appropriate to the program's discipline		
(6) Apply computer science theory and software development fundamentals to produce computing-based solutions	○	2

Emphasis: ● High; ◑ Medium; ○ Low; Blank – Nothing Specific Expected

BSCoE Program Outcomes	Emphasis in this course	Course Learning Outcomes
(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.	◑	3, 4, 5, 6, 7
(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors		
(3) an ability to communicate effectively with a range of audiences	○	1
(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts		
(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives		
(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw	◑	2

conclusions		
(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	◯	4, 5, 6, 7

Emphasis: ● High; ◑ Medium; ○ Low; Blank – Nothing Specific Expected

16. Grading Scheme:

Grade	Range of total score
A	>= 93
A-	>=89 and <93
B+	>=84 and <89
B	>=80 and <84
B-	>=75 and <80
C+	>=70 and <75
C	>=66 and <70
C-	>=60 and <66
D	>=50 and <60
F	<50