Kainan University, Department of Business and Entrepreneurial Administration

semester (fall/spring) 2007 year

Course Code No.	Course Title	Instructor	Subject	Level of Course	Credits	Hours per Week
≥≥10M1010 ᵒ1	Chinese: 研究方法	曾國雄 Gwo-Hshiung Tzeng	■ required ☐ elective	Year: 2007 Class: Graduate Student	3	4
	English: Research Methods	Course Prerequisites	No			

Course Objective: The purpose/objective of this course "**Research Methods for problems-solving**" is to teach the **whole methods** in "**techniques of logic reasoning and thinking systems**" for students to **understand, solve, and treat all possible problems**. Then the students can **promoting** and **expanding** the **competence sets** to enhance the **work ability and skill** for **solving** and **treating all faced problems** in different fields/domains in the employment and life. Therefore, this course is aimed at individual issues/objects by using "**multivariate statistical analysis and data mining**" for data process analysis" to understand the existing problems for prospecting the future, then at the understood problems to proceed with "**multi-objective programming**" for plan/design and/or with "**multi-criteria evaluation**" for choose/selection/improvement, propose to solve and analyze the problems in feasible alternatives for finding the "problems-solving".

Course Outlines: When we solve any problems, do any researches, or make any decisions, we must use the numerical data as a basis for data-analysis/data-mining, forecasting, planning, and evaluation. The data can be crisp or exist fuzzy/vagueness or subjectively multidimensional data by natural language/linguistics. Therefore, in this course the data sets are included crisp data sets, fuzzy data sets, rough sets, grey hazy sets and so on for treating and solving problems. The contents are included: (1) statistical & multivariate analysis and data mining (including evolutionary computation) for analyzing the data sets to retrieve the patterns/classifiers and forecasting in treating, finding and solving problems, (2) multiple objective decision making to plan and design the optimal problems for achieving aspired/desired level, and (3) multiple attribute decision making to evaluate/select and improve the best alternative for reducing the gaps in each attribute to achieve aspired/desired level. Fuzzy theory is included five parts: (1) fuzzy sets, (2) fuzzy numbers, (3) fuzzy relations, (4) fuzzy measures, and fuzzy reasoning (fuzzy inferences).

Contents of Course as follows:

1. **Statistical & Multivariate Analysis and Data Mining for data processes**

(1) Data processes in statistical and multivariate analysis

This part includes: (a) data collections by using sampling survey based on multi-attribute/ multi-objective sampling design; (b) statistical testing in single- and multivariate; (c) principle component analysis and factor analysis (including quantification III & IV, MDS, including fuzzy theory), AHP (including fuzzy AHP); (d) cluster analysis (including C-means or called K-means,

including fuzzy theory), discriminant analysis (including quantification II, Conjoint analysis, Logit model, Probit analysis, ANN discriminant, including fuzzy theory and fuzzy integral); (e) relation model for forecasting, such as multi-regression analysis, fuzzy regression, time series and fuzzy time series (including ARIMA, fuzzy ARIMA, etc.), fuzzy piecewise regression, interval regression by quadratic programming, quantification I, fuzzy quantification I, grey foresting and grey possibility forecasting, Chaos forecasting, Kalman Filtering forecasting, GMDH, Canonical analysis including fuzzy theory.

(2) Evolutionary computation and soft computing for classification and identification/patterns

These new methods are developed by computer advance that is the most revolutionary useful tool in the 20th century. These new methods can relax and improve many assumptions in traditional methods, such as assumed independence, linear, etc. in variables/attributes/criteria (statistical & multivariate) for suiting the real world situations. These methods include such as artificial neural network (ANN), genetic algorithm (GA), genetic programming (GP), genetic network programming (GNP), support vector machine (SVM), rough set theory, etc. for classification and identification/ patterns.

3) Logic reasoning including fuzzy reasoning and rough set theory for partitions and identification/ patterns.

2. Multiple Objective Decision Making (MODM) for planning and designing the problems

In any situations and in any time or daily activities, persons, business/enterprises, and even to nations are often the face of decision problems to be multi-dimensions of whole consideration for planning and designing the problems to achieve the aspired/desired levels. The contents include vector optimization since 1950s, goal programming since 1955 (Charnes and Cooper), compromise solution since 1970s (Yu and Zeleney), DEA since 1978 (Charnes, Cooper, and Rhodes), multi-stage multi-objective programming, bi-level and multi-level programming (including fuzzy bi-level and multi-level programming), MC^2 programming, fuzzy MC^2 programming, fuzzy multi-objective programming (including fuzzy goal, fuzzy resource, fuzzy parameters, fuzzy variables), De Novo programming, fuzzy De Novo programming, fuzzy DEA, multi-objective DEA, Genetic Algorithms for fuzzy combinatorial multi-objective decision-making, TOPSIS for MODM, habitual domain - fuzzy - dynamic multi-level multi-stage multi-objective programming.

3. Multiple Attribute Decision Making (MADM) for evaluating, selecting, or improving the problems

In any situations and in any time or daily activities, persons, business/enterprises, and even to nations are often the face of decision problems to be multi-dimensions of whole consideration for evaluating, selecting and improving the problems to achieve the aspired/desired levels. The contents include multi-attribute utility theory (including fuzzy), DEMATEL/FCM/ISM for re-structuring the structural relations for weightings (AHP, ANP, or fuzzy integral), Analytic Hierarchy Process (AHP, fuzzy AHP), Analytic Network Process (ANP, fuzzy, ANP), fuzzy integral, grey relation for evaluation, TOPSIS, VIKOR, PROMETHEE I, II, III, IV, ELECTRE I, II, III, IV, habitual domain for dynamic weightings, fuzzy ANN dynamic multi-attribute decision-making, and so on.
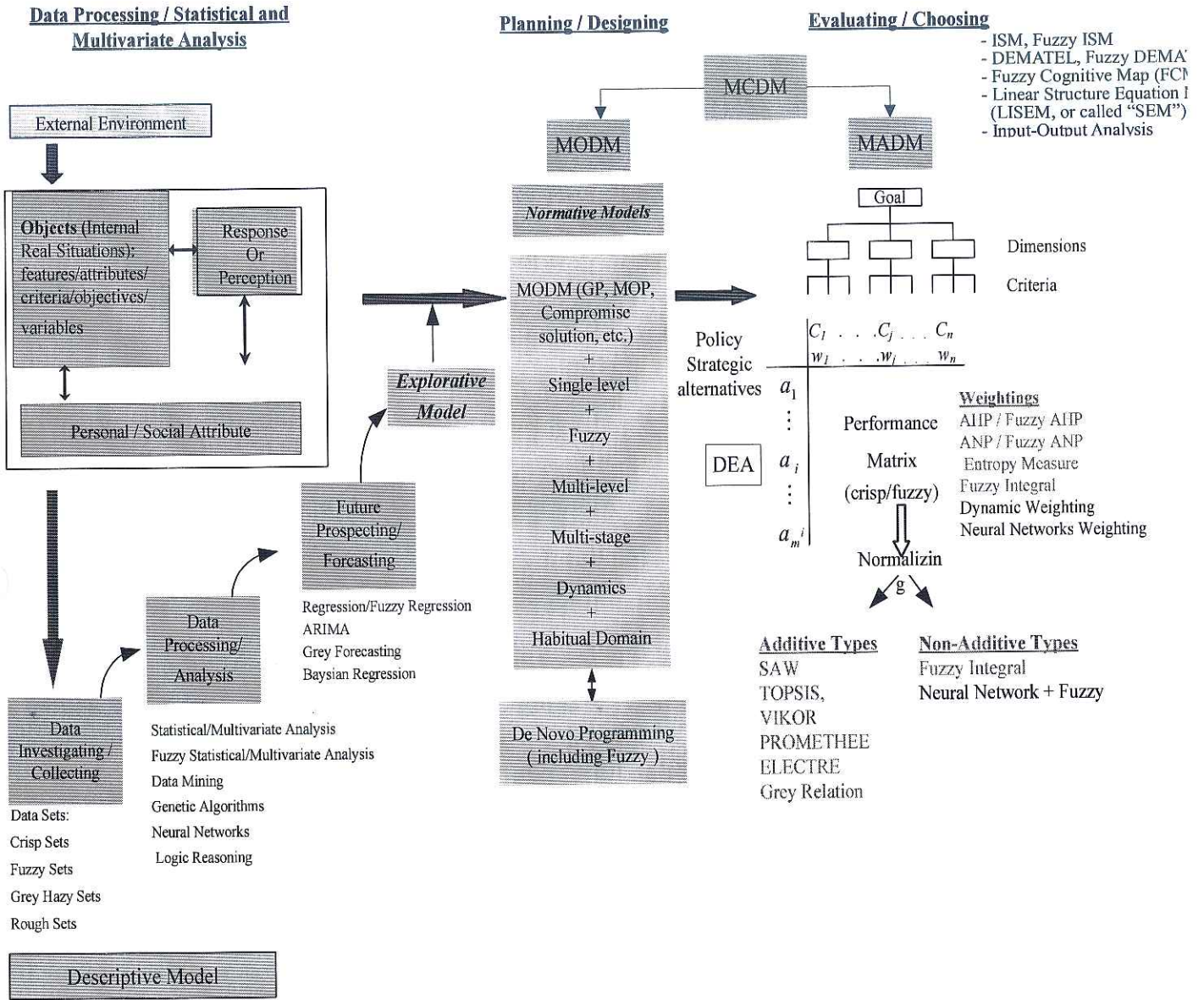
Data Processing / Statistical and Multivariate Analysis

Planning / Designing

Evaluating / Choosing

- ISM, Fuzzy ISM
- DEMATEL, Fuzzy DEMA'
- Fuzzy Cognitive Map (FCN
- Linear Structure Equation I (LISEM, or called "SEM")
- Input-Output Analysis

MCDM

MODM

MADM

External Environment

Objects (Internal Real Situations): features/attributes/ criteria/objectives/ variables

Response Or Perception

Normative Models

Goal

Dimensions

Criteria

Personal / Social Attribute

Explorative Model

MODM (GP, MOP, Compromise solution, etc.)
+
Single level
+
Fuzzy
+
Multi-level
+
Multi-stage
+
Dynamics
+
Habitual Domain

Policy Strategic alternatives

DEA

$$
\begin{array}{c}
C_1 \ \ldots \ C_j \ \ldots \ C_n \\
w_1 \ \ldots \ w_j \ \ldots \ w_n \\
a_1 \\
\vdots \\
a_i \\
\vdots \\
a_m{}^i
\end{array}
$$

Performance

Matrix

(crisp/fuzzy)

Weightings
AHP / Fuzzy AHP
ANP / Fuzzy ANP
Entropy Measure
Fuzzy Integral
Dynamic Weighting
Neural Networks Weighting

Normalizin
g

Future Prospecting/ Forecasting

Regression/Fuzzy Regression
ARIMA
Grey Forecasting
Baysian Regression

Data Processing/ Analysis

Statistical/Multivariate Analysis
Fuzzy Statistical/Multivariate Analysis
Data Mining
Genetic Algorithms
Neural Networks
Logic Reasoning

De Novo Programming (including Fuzzy)

Additive Types
SAW
TOPSIS,
VIKOR
PROMETHEE
ELECTRE
Grey Relation

Non-Additive Types
Fuzzy Integral
Neural Network + Fuzzy

Data Investigating / Collecting

Data Sets:

Crisp Sets

Fuzzy Sets

Grey Hazy Sets

Rough Sets

Descriptive Model

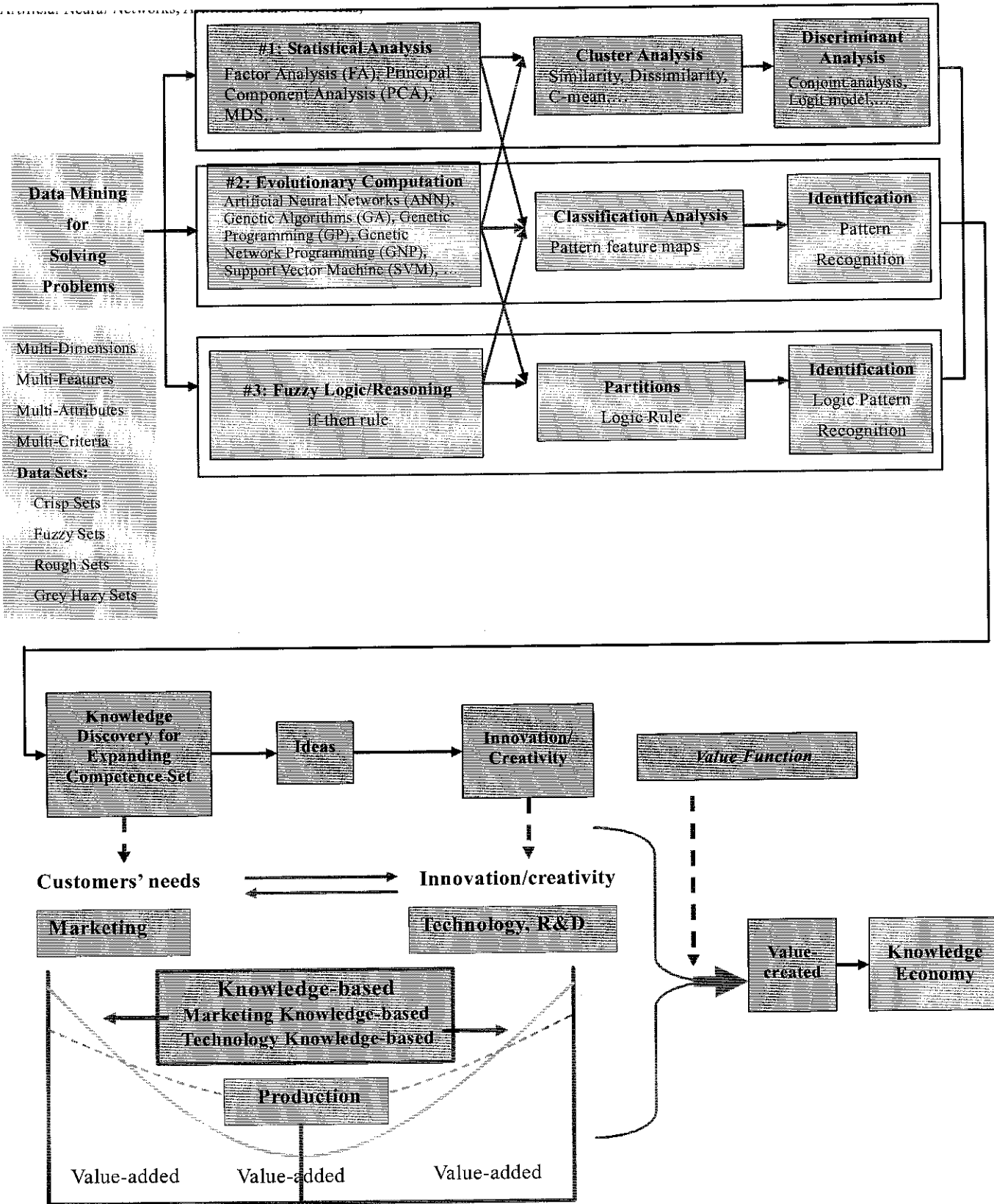**Fig. 1 Concepts of Course Systems in "Research Methods"**

Fig.2 Data Mining Concepts of Intelligent Computation in Knowledge Economy

Grading and Evaluation Criteria	midterm _____% final _____% class participation _____% other _____% (details _____)

First Stage: Final examination for testing the concepts of "Research Methods for Problems-Solving and Applications" (50%)

- **Final examination: December 19, 2007**

Second Stage: "Research Methods" for Problems-Solving and Applications in real cases (50%)

Term Paper (submitted date) (50%)

- **Language: English is better.**
- **Abstract and proposal: December 5, 2007**
- **Full paper: January 16, 2008**
- **Final Revised Paper: January 30, 2008**

Prescribed Book(s) and Reference Books：

Tzeng, Gwo-Hshiung and Huang, Jih-Jeng (2007), *New Frontiers of Multiple Objective Decision Making*, Kai University.

Tzeng, Gwo-Hshiung and Huang, Jih-Jeng (2007), *New Frontiers of Multiple Attrative Decision Making*, Kai University.

曾國雄編著，「統計學問題範例」，鴻儒堂書局，17 頁，民國 70 年。

曾國雄編著 ，「多變量解析應用實例」，民國 69 年，台北市，中興管理顧問，415 頁。

曾國雄編著，「多變量解析與其應用」，民國 67 年，台北市，華泰圖書文物公司，402 頁。

曾國雄編著，「現代統計學」，台北市，鴻儒堂書局，513 頁，1978 年修正。

曾國雄、鄧振源，「多變量分析(一):理論應用篇」，民國 75 年 5 月，松崗電腦圖書公司，491 頁。

曾國雄，個人論文發表文獻。如個人資料(Tzeng's VITA, Journal publications)。

曾國雄等編著，多目標決策分析(I)：多屬性效用之理論與應用講義。

曾國雄等編著，多目標決策分析(II)：多評準決策之理論與應用講義。

國雄等編著，多目標決策分析(III)：多目標規劃之理論與應用講義。

中山弘隆、谷野哲三（1994），多目的計劃法之理論與應用，計測字動制御學會。

Keeney, Ralph L. and Raiffa, Howard, (1976), *Decision with Multiple Objectives: Preference and Value Tradeo* John Wiley & Sons.

Hwang, Ching-Lai and Masud, Abu Syed Md. (1979), *Multiple Objective Decision Making: Methods Applications*, Springer-Verlag.

Saaty, Thomas L. (1980), *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocati* McGraw-Hill, Inc.

Hwang, Ching-Lai and Yoon Kwangsum (1981), *Multiple Attribute Decision Making : Methods and Applicatic* Springer-Verlag, New York.

Chankong, Vira and Haimes, Yacov Y. (1983), *Multiobjective Decision Making: Theory and Methodolc* North-Holland.

Yu, Po-Ling (1985), *Multiple-Criteria Decision Making: Concepts, Techniques, and Extensions*, Plenum Press.

Steuer, Relph E. (1986), *Multiple Criteria Optimization: Theory, Computation, and Application*, Wiley.

Hwang, Ching-Lai and Lin M. J. (1987), *Group Decision Making Under Multiple Criteria*, Springer-Verlag, N

York.

Seo, Fumiko and Sakawa, Masatoshi (1987), *Multiple Criteria Decision Making Analysis in Regional Planni Concepts, Methods, and Application*, D. Reide Publishing Company.

Haimes, Yacov Y., Tarvainen, K., Shima, T. And Thadathil, J. (1990), *Hierarchical Multiobjective Analysi: Large-Scale Systems*, Hemisphere Publishing Corporation.

Yu, Po L. (1990), *Forming Winning Strategies: An Integrated Theory of Habitual Domains*, Springer-Verlag.

Romero, Carlos (1991), *Handbook of Critical Issue in Goal Planning*, Pergamon Press.

Chen, Shu-Jen and Hwang, Ching-Lai, (1992), *Fuzzy Multiple Attribute Decision Making: Methods Applications*, Springer-Verlag, New York.

Keeney, Ralph L. (1992), *Value-Focused Thinking: A Path to Creative Decision Making*, Harvard University Pre

Lai, Young-Jou and Hwang Ching-Lai, (1992), *Fuzzy Mathematical Programming: Methods and Applicatic* Springer-Verlag.

Sakawa, Masatoshi (1993), *Fuzzy Sets and Interactive Multiobjective Optimization*, Plenum Press.

Lai, Young-Jou and Hwang, Ching-Lai, (1994), *Fuzzy Multiple Objective Decision Making: Methods Applications*, Springer-Verlag.

Saaty, Thomas L. (1994), *Fundamentals of Decision Making and Priority Theory with the Analytic Hierar Process*, RWS Publication, Pittsburgh.

Tzeng, G. H., Wang, H. F., Wen, W. P., and Yu, P. L. (1994), *Multiple Criteria Decision Making: Expand Enrich the Domains of Thinking and Application*, Springer-Verlag.

Sakawa, M. (2000), *Large Scale Interactive Fuzzy Multiobjective Programming*, Physica-Verlag, Heidelberg.

Ehrgott, M. (2000), *Multicriteria Optimization*, Springer-Verlag, Berlin, Heidelberg.

Nishizaki, I. and Sakawa, M. (2001), *Fuzzy and Multiobjective Games for Conflict Resolution*, Physica-Ver Heidelberg.

Deb, K. (2001). *Multi-Objective Optimization using Evolutionary Algorithms*, John Wiley & Sons, England.

Osyczka, A. (2002), *Evolutionary Algorithms for Single and Multicriteria Design Optimization*, Physica-Ver Heidelberg.

rlsson, C. and Fuller, R. (2002), *Fuzzy Reasoning in Decision Making and Optimization*, Physica-Ver Heidelberg.

Sakawa, M. (2002), *Genetic Algorithms and Fuzzy Multiobjective Optimization*, Kluwer Academic Publish Norwell, MA.

Course Description (including outline and course schedule):

September

- Sept. 10-15 (Monday-Saturday) "Evolutionary Technology and Applications: Intelligent Manufacturi Systems", by Professor M. Gen (Waseda University)
   Time: 9:30am ~ 12:30pm & 1:30pm ~ 4:30 daily

- Sept. 19 (Wednesday) Over-views
- Sept. 26 (Wednesday) Concepts of Course Systems in "Research Methods"
- Oct. 3 (Wednesday) Fuzzy Set & Crisp Set & Rough Set、Grey Hazy Sets
- Oct. 17 (Wednesday) PCA 主成份分析、Lagrange & Makov Chain
- Oct. 24 (Wednesday) Regression、Fuzzy Regression & *statistics*
- Oct. 31 (Wednesday) Path analysis、SEM、ISM & Dematel

- Nov. 7 (Wednesday) Dematel、AHP、ANP、Gray Relation、Topsis、VIKOR
- Nov. 14 (Wednesday)PROMETHEE、數量化
- Nov. 21 (Wednesday) DEA(Data Envelopment Analysis)、De-Novo、Win-Win Theory
- Nov. 28 (Wednesday) ARIMA(Autoregressive Integrate Moving-Average Model)、
- Dec. 5 (Wednesday)   Submitted abstract and proposal
- Dec. 12 (Wednesday) Logit 模式、Neural Network Logit 模式、Logic 推論 Logit 模式
- Dec. 19 (Wednesday)   Final examination, 1:00pm ~ 11.00pm
- Dec. 26 (Wednesday) Genetic Algorithm、Two-Stage Genetic Programming (2SGP)
- Jan. 2 (Wednesday) Paper presentation(1)
- Jan. 9 (Wednesday) Paper presentation(2)
- Jan. 16 (Wednesday)   Submitted full paper
- Jan. 23 (Wednesday)   Paper presentation(3)
- Jan. 30 (Wednesday)   Submitted to final revised paper

Nov. 14 (Wednesday)

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※ Should the course be lecturing in English, please tick one of the following options:
This course will be one of the IMBA courses. Yes ☐   No ☐

Signature：_____   Date：_____