

## 2023년도 1학기 확률및랜덤프로세스 (EECE574-01) 강의계획서

## 1. 수업정보

|             |                                                                                                                                                                                                        |      |         |      |      |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|---------|------|------|
| 학수번호        | EECE574                                                                                                                                                                                                | 분반   | 01      | 학점   | 3.00 |
| 이수구분        | 전공선택                                                                                                                                                                                                   | 강좌유형 | 강의실 강좌  | 선수과목 |      |
| 포스텍이안 핵심 역량 | <input type="checkbox"/> 대인관계역량 <input type="checkbox"/> 글로벌시민역량 <input type="checkbox"/> 지식탐구역량 <input type="checkbox"/> 디지털리터러시역량<br><input type="checkbox"/> 자기관리역량 <input type="checkbox"/> 창의융합역량 |      |         |      |      |
| 강의시간        | 화, 목 / 11:00 ~ 12:15 / LG연구동 강의실 [102호]                                                                                                                                                                |      | 성적취득 구분 | G    |      |

## 2. 강의교수 정보

|              |                    |          |                                      |
|--------------|--------------------|----------|--------------------------------------|
| 이름           | 조준호                | 학과(전공)   | 전자전기공학과                              |
| 이메일 주소       | jcho@postech.ac.kr | Homepage | http://cisl.postech.ac.kr/cisl/jcho/ |
| 연구실          |                    | 전화       | 279-2377                             |
| Office Hours | by appointment     |          |                                      |

## 3. 강의목표

This course provides the foundations for modeling uncertainties in Communications, Signal Processing, and Information Theory.

## 4. 강의선수/수강필수사항

Under-graduate level:  
Probability and Random Processes, Digital Communications

It is assumed that you are well acquainted with the undergraduate-level probability,

<https://plms.postech.ac.kr/local/ubion/course/syllabusV.php?id=7094>

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random variables, and vectors.

In this graduate-level course, we supplement it for you to have a graduate-level knowledge on the topics mentioned above and additionally on the random processes.

## 5. 성적평가

1. Quiz 1: 10 %
  2. Midterm exam: 20 %
  3. Quiz 2: 10%
  4. Final exam: 30 %
  5. Homework: 30 %
  6. Attendance: On/Off (More than 1/4 unexcused absences will lead to F according to the University rule.)
- Voluntary Final Report: one-step (+,0,-) up

## 6. 강의교재

| 도서명                                                                 | 저자명                         | 출판사         | 출판년도 | ISBN |
|---------------------------------------------------------------------|-----------------------------|-------------|------|------|
| Probability, Random Variables and Stochastic Processes, 4th edition | A. Papulis and S. U. Pillai | McGraw Hill | 2002 |      |
| Digital Communications, 5th ed.                                     | J. G. Proakis               | McGraw-Hill | 2007 |      |

## 7. 참고문헌 및 자료

B. Hajek, Random Processes for Engineers, Cambridge Univ. Press, 2015.  
 Peyton Peebles Jr., Probability, Random Variables and Random Signal Principles, 4th edition. McGraw-Hill  
 Leon-Garcia, Probability, Statistics, and Random Processes For Electrical Engineering, 3rd edition.

## 8. 강의진도계획

<https://pims.postech.ac.kr/local/ubion/course/syllabusV.php?id=7094>

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23. 2. 21. 오전 10:23

확률및랜덤프로세스 (2023-090\_01402575\_01663283): 강의 계획서

The following schedule is tentative.

1. Axioms of Probability and Quick Review of Undergraduate Prob. and RPs
  - Conditional probability and statistical inference
  - Expectation and Information Theory
2. Statistical Inference: Detection and Estimation
  - Applications to Communications, Signal Processing, and Information Theory
  - Equalization: linear and nonlinear, MLSD, BCJR
3. Real and Complex Random Variables, Vectors, Matrices
  - Pseudo-/complementary correlation/covariance
  - Maximally improper random variables and vectors
  - Proper- and improper-complex Gaussian
  - Widely-linear filtering
  - Real composite vs. linear-conjugate (LCL) preprocessor followed by a linear filter
  - Special case: WL estimation of real-valued parameters
  - Applications to Communications, Signal Processing, and Information Theory
4. Real and Complex Random Processes
  - Complex baseband equivalent to a real bandpass signal/RP
  - Time-domain and frequency-domain characterizations
  - PSD of digitally modulated signals
  - WSSUS channel model
  - Spectral correlation: PSD vs. 2-D PSD
  - Vector-valued complex RPs and PSD matrix
  - Improper-complex RPs and Widely-linear filter
  - Cyclostationary RPs and Frequency-Shift (FRESH) filtering
  - Applications to Communications, Signal Processing, and Information Theory

## 9. 수업운영

본 과목은 S/U로 수강 신청할 경우 B-미만은 모두 U로 성적을 부여할 계획입니다. 따라서 S/U로 신청시 유의하시기 바랍니다.

HW은 analytical problem 외에 MATLAB programming 문제가 출제됩니다.

MATLAB programming 문제의 경우, C나 Python 등 어떤 프로그래밍 언어 및 앱을 사용하여 프로그램해도 좋으나, 적어도 결과는 MATLAB figure와 유사한 결과를 내는 package를 써서 출력하여 제출하여야 합니다.

## 10. 학습법 소개 및 기타사항

Official course web page:

<http://cisl.postech.ac.kr/class/eece574/>

<https://pims.postech.ac.kr/local/ubion/course/syllabusV.php?id=7094>

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23. 2. 21. 오전 10:23

확률및랜덤프로세스 (2023-090\_01402575\_01663283): 강의 계획서

It is your responsibility to check Schedule/Downloads  
 (<http://cisl.postech.ac.kr/class/eece574/schedule.htm>).

## 11. 장애학생에 대한 학습지원 사항

- 수강 관련: 문자 통역(청각), 교과목 보조(발달), 노트필기(전 유형) 등
- 시험 관련: 시험시간 연장(필요시 전 유형), 시험지 확대 복사(시각) 등
- 기타 추가 요청사항 발생 시 장애학생지원센터(279-2434)로 요청

It is your responsibility to check Schedule/Downloads  
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[Announcements](#)
[Syllabus](#)
[Schedule/Downloads](#)

### Syllabus for Spring 2023 (Last update: 02/21/23)

- **Course Title:**  
EECE574 Probability and Random Processes (3-0-3)  
EECE574 확률 및 랜덤 프로세스 (3-0-3)
- **Class Meetings:**  
Class meetings from 11:00 till 12:15 on every Tuesday and Thursday.  
For detailed meeting schedule, see [Schedule/Downloads](#).
- **Instructor:** Professor Joon Ho Cho

Office) LG 409

Phone) +82-54-279-2377

E-mail) jcho(at) postech(dot) ac dot kr

Office Hours: by appointment.

- **TA:**

|                                               |
|-----------------------------------------------|
| 최지욱                                           |
| Office) LG 418                                |
| E-mail) jiwook (at) postech (dot) ac (dot) kr |

- **Homepage:** <http://cisl.postech.ac.kr/class/eece574/>  
It is your responsibility to check [Schedule/Downloads](#).

- **Text:**

A. Papulis and S. U. Pillai, *Probability, Random Variables and Stochastic Processes*, 4th edition, McGraw Hill, 2002.

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- **References:**

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Re-grade requests must be filed in writing **within one week** after the graded quiz has been returned to students.

If the instructor suspects academic dishonesty, the instructor will notify the student(s) and follow the procedure to report to the Graduate School without any exception. Students have the responsibility to be knowledgeable about the consequences of dishonesty.

## Schedule/Downloads

The schedule is tentative and subject to change. (Last update: 02/21/23.)

| Topics | Details | Week | Date and Lecture Video | CM# and PDF |
|--------|---------|------|------------------------|-------------|
|        |         | 1    | 2/21                   | 01          |

(i) a random variable

(ii) jointly distributed (finite number of) random variables  $\Leftarrow$  a multi-variate random variable.

(11) " " infringe 2, " " "

□ 2 types of infinity

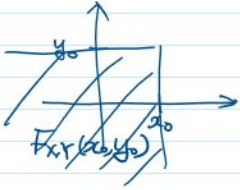
infinity  $\nabla$  countable  $\rightarrow$   $\left\{ \begin{array}{l} \{m \in \mathbb{N} : X_m\} \\ \{m \in \mathbb{Z} : Y_m\} \\ \{m \in \mathbb{Z} : Z_{2m+1}\} \end{array} \right.$   $\{Y_m\}_{m \in \mathbb{Z}}$   $y_m$

uncountable  $\rightarrow$   $\{t \in \mathbb{R} : W_t\}$   $\{W(t)\}_{t \in \mathbb{R}}$   $w(t)$

$$\{t \in \mathbb{R} : W_t\} \quad \{W(t)\}_{t \in \mathbb{R}} \quad W(t)$$

□ jointly distributed 2 random variables

$$F_{X,Y}(x,y) \quad \text{joint CDF of } X \& Y \\ \triangleq P(X \leq x, Y \leq y)$$



$$\text{ex) } X \sim N(0,1) \\ Y \sim N(0,1)$$

$$\square F_{X,Y,Z}(x,y,z) = \int_{-\infty}^x \int_{-\infty}^y \int_{-\infty}^z f_{X,Y,Z}(\alpha,\beta,\gamma) d\alpha d\beta d\gamma \\ F_{X_1, \dots, X_{106}}(x_1, x_2, \dots, x_{106})$$

□ Countably infinite # of **jointly distributed** RVs,  $\{X_n\}_{n \in \mathbb{N}}$

Kolmogorov's extension theorem  
existence



a DT RP  $\{X(n)\}_{n \in \mathbb{N}}$   
a discrete-parameter RP

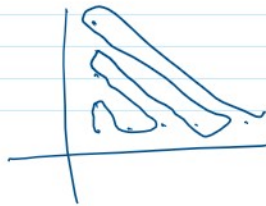
Def. 1st-order CDFs  
2nd-order CDFs  
...  
nth-order CDFs  
of a RP.

$$F_{X_1}(x_1), F_{X_2}(x_2), F_{X_3}(x_3), \dots \\ F_{X_m, X_n}(x_m, x_n), \quad m \in \mathbb{N}, n \in \mathbb{N}$$

Def. "Countably infinite RVs  $\{X_n\}_{n \in \mathbb{N}}$   
are jointly distributed" means  
(i) Any nth-order CDF exists.  
(ii) The CDFs must be consistent.

$$F_{X_1, X_2}(x_1, \infty) = F_{X_1}(x_1) \\ F_{X_1, X_2, X_3}(x_1, x_2, 0) = F_{X_1, X_2}(x_1, x_2)$$

$$F_{X_1, X_2, X_3, \dots}(x_1, x_2, x_3, \dots) \quad (?)$$



□ uncountably infinite # of **jointly distributed** RVs

← a CTRP  $\{W(t)\}_{t \in \mathbb{R}}$

Def. The uncountably infinite # of RVs  
 $\{W_t\}_{t \in \mathbb{R}}$  are jointly distributed if  
(i) Any finite-order **joint** CDF of  $W(t)$  exists.

← a continuous-parameter RP

$$\text{ex) } F_{W_t}(w), \quad t \in \mathbb{R}$$

$$F_{W_{t_1}, W_{t_2}}(a,b) \quad (t_1, t_2) \in \mathbb{R}^2$$

$$F_{W(t_1), W(t_2)}(x,y) \dots$$

(ii) They are all consistent.

□ a random field

$$\begin{matrix} x & X \\ \underline{x} & \underline{X} \end{matrix}$$

$$[X, \mathbf{r}]$$

□ a random field

$$\begin{array}{ccc} x & X \\ \underline{x} & \underline{X} \\ x[n] & X[n] & X[n] = \begin{bmatrix} X_1[n] \\ X_2[n] \\ X_3[n] \end{bmatrix} \\ x(t) & X(t) & \underline{X}(t) \\ v(x,y) & V(x,y) \\ ax^2+bx+c & V_{x,y} \\ & A \rightarrow B \rightarrow C \\ (E,V) & \rightarrow \text{random graph} \dots \end{array}$$

□ 2 DT RP are jointly distributed?

Def.

(i) Any  $n$ th order joint CDF exists  
 $\begin{pmatrix} F_{X_1[n]}(x_1) \\ F_{X_2[n]}(x_2) \end{pmatrix}$   
 2nd  
 Any  $(m+n)$ th-order joint CDF exists where  
 $F_{X_1[m_1], X_2[m_2], \dots, X_1[m_m], X_2[m_1], X_2[m_2], \dots, X_2[m_m]}(\dots)$   
 $m \geq 0$   
 $n \geq 0$   
 $m+n \geq 1$

(ii) They are all consistent.

□ 2 CT RPs are jointly dist-

□  $n$  DT "s " " "  
 $n$  CT " " " "