U6E TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Time Series Analysis *(Elective III) (CE78505)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Explain time series data with examples. Discuss the applications of time series analysis in water resources engineering. [2+4]

2. Differentiate between stationary and non-stationary time series. Explain the split record test for detecting stationarity in mean and variance of a time series data. [3+5]

3. (a) The duration of a monsoon storm is a random variable whose pdf is given by [2+2+2]

$f(x) = kx^2$ for $0 \leq x \leq 3h$
$f(x) = k(6-x)^2$ for $3 \leq x \leq 7h$
$f(x) = 0$ elsewhere

Find the value of k. Determine the corresponding CDF. What is the probability that the duration of the storm is less than 2h?

(b) Explain marginal probability. Rainfall data considered as random variable has a mean of 20 and variance of 16 and unknown probability distribution. Find the least probability with which it lies between 12 and 28. [2+4]

4. (a) Derive Yule-Walker's equations for Autoregressive (AR) model. What is the application of these equations in time series modeling? [8]

(b) The first 10 autocorrelation coefficients computed from 100 years of annual flow record at a river site are: 0.15, 0.09, 0.02, -0.12, -0.11, 0.05, 0.07, -0.1, -0.08, 0.02 [8]
Making a plot of correlogram, test the flow series for independence at 95% confidence level.

5. (a) Following is a form of a time series model fitted to a data set.

$(X_t - \mu) = 0.9(X_{t-1} - \mu) + e_t + 0.4e_{t-1}$

What is the type of the above model? Also mention the order of the model. Verify whether the model is stationary. [4]

b) Following are the annual flow values (m^3/s) of a river for 10 years:
290, 248, 323, 292, 294, 236, 225, 263, 213, 190
Assuming AR(1) model to be good fit for the above data, find out the parameter of the model. Instead of AR(1) model, if you want to select MA(1) model for the data, what will be the value of its parameter? [10+2]

6. (a) Explain the concept of spectral analysis. [2]

(b) Generate synthetic seasonal flows for 4 seasons for a year using the following statistical parameters by using Thomas-Fiering model. [12]

Season	Mean flow (m^3/s)	Standard deviation	Correlation with previous season	Z_t: N(0,1)
1	13	9	0.67	0.35
2	25	12	0.61	-1.52
3	54	50	0.18	0.24
4	10	7	0.07	0.15

6 E TRIBHUVAN UNIVERSITY
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2073 Magh

Exam.	New Back (2066 & Later Batch)		
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Programme	BCE	Pass Marks	32
Year / Part	IV / II	Time	3 hrs.

Subject: - Time Series Analysis *(Elective III) (CE78505)*

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1. Discuss the time series model. What are the advantages and limitations of such model? [6]
2. Explain trend, periodicity and jump in time series data with examples and sketches. [6]
3. a) Describe conditional distribution, marginal distribution and derived distribution. [6]
   b) The annual runoff of a stream has a mean of 510 and standard deviation of $90m^3/s$ respectively. Find the ranges within which the runoff will lie with a probability of at least 0.5. Use Chebyshev's inequality. [6]
4. a) Define autocorrelation and list the equations used for its computation. How can you use the autocorrelation analysis in the time series analysis? [4+4]
   b) Autocorrelation coefficient from lag 1 to lag 5 of a variable is given below.
   0.5 0.3 0.0 0.0 0.0
   Making a plot of correlogram, suggest an appropriate order of MA model. [6]
   c) A hydrologic variable is described by an AR(1) model with mean = 120, variance = 950, first serial correlation coefficient = 0.5. Compute the standard deviation of the random process. [4]
5. a) Discuss the nature of autocorrelation function of AR(1) and AR(2) model with sketches. [4]
   b) The mean, standard deviation, first and second serial correlation coefficients of observed annual flows of a stream are estimated as 900 Mm^3, 280 Mm^3, 0.7 and 0.5 respectively. Generate a sequence of 3 annual flows asuming that the flows are normally distributed and taking the chain of 3 standard normal random numbers as 1.45, -1.16 and 0.087. Use AR(2) model. [12]
6. a) Explain the Yevjevich and Quimpo model for generating daily flows. [8]
   b) The first and second serial correlation coefficients of observed annual rainfall are 0.7 and 0.5 respectively. Assuming ARMA (1,1) model is a good fit, find the parameters of the model. [6]
7. Describe the methods for the generation of uniformly distributed random numbers. [8]

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1. What is the time series modeling and List the applications of time series modeling in water resources engineering. [6]
2. a) Differentiate the following: [4]
   (i) Stationary and non-stationary time series
   (ii) Trend and periodicity
   b) Discuss any two methods for the detection of trend. [4]
3. a) Where does the stochasticity come from in a hydrological process? [2]
   b) State and prove the Chebyshev's inequality. [2+4]
   c) The pdf of normal distribution is given by $f(x)=\frac{1}{\sigma\sqrt{2\pi}}e^{\frac{(x-\mu)^2}{2\sigma^2}}$. Find the parameters μ and σ by method of maximum likelihood. [4]
4. a) What is cross-correlation and auto correlation? How is correlation different from regression? [2+2+2]
   b) From a data set of 30 years flow, the auto correlation coefficient r_k = [0.66, 0.31, 0.01, 0.0, 0.01, 0.0] for k = 1 to 6. Plot the ACF (not necessary to the scale) and state how many lag times would you consider to fit a time series model to the data. [6]
5. The $\bar{x}, s_x, r_1, r_2$ of the observed annual flows of a stream are estimated as 875 Mm^3, 262 Mm^3, 0.8 and 0.46 respectively. Generate a sequence of 3 annual flows assuming that the flows are normally distributed and taking the chain of three uniform random number as 0.3781, 0.63702, 0.98343. Use AR (2) model. [14]
6. Write down Thomas-Fiering model for generation of seasonal flows. Explain the significance of each term in the model and explain clearly how the non-stationarity and cyclicity of the seasonal flows are preserved. [14]
7. a) Generate a chain of 5 uniformly distributed random numbers using mid-square and mid-product techniques. Assume the seed. [6]
   b) Explain how do you fit a time series using spectral analysis. [8]

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