

**MIDDLE EAST TECHNICAL UNIVERSITY NORTHERN CYPRUS CAMPUS  
CIVIL ENGINEERING PROGRAM**

**CVE-471 (3-0)3 WATER RESOURCES ENGINEERING  
2011-12 Fall**

**SYLLABUS**

**Instructor:**

Assist. Prof. Dr. Bertuğ Akıntuğ  
Office: R-206  
Phone: 0392 661 2924  
email: [bertug@metu.edu.tr](mailto:bertug@metu.edu.tr)

**Course Schedule:**

Wednesday 10:40 – 12:30  
Thursday 8:40 – 9:30

**Office Hours:**

Monday 13:40-16:30  
Wednesday 13:40-16:30  
Thursday 10:40-12:30

**Main Text:**

- Yanmaz, A. Melih. Applied Water Resources Engineering, 3<sup>rd</sup> Edition, METU Press, Ankara, Turkey, 2006.

**Auxiliary Texts:**

- Chin, David A., Water Resources Engineering, Pearson Prentice Hall, 2006. (TC160.C52 2006).
- ASCE, Climate Variations, Climate Change, and water resources engineering, 2006. (TD353.C545 2006).
- Milanoviac, Petar T., Water Resources Engineering in Karst, CRC Press, 2004. (GB843.M55 2004).
- Purcell, Patrick J., Design of Water Resources Systems, Thomas Telford, 2003. (TC405.P87 2003).

**Grading:**

First Mid-Term Exam	: 25%
Second Mid-Term Exam	: 25%
Final Exam	: 35%
Assignments	: 10%
Attendance	: 5%

**Course Web Site:**

Relevant course materials such as lecture notes, assignments and announcements will be posted in the webpage of the course. Check the web site <http://www.metu.edu.tr/~bertug> regularly.

**Attendance:**

**Minimum 60%** attendance is mandatory. If your attendance is below 60% at the end of the term, you will be graded as **NA**.

Participation in lectures is part of the overall grading (5%). The attendance will be taken at the end of each lecture hour by instructor. During the term there will be 42 lectures. The allocation of 5% will be as follows: Attending between 25-27 lectures: 1%, 28-30 lectures: 2%, 31-33 lectures: 3%, 34-36 lectures: 4%, 37-42 lectures: 5%. Note that this point system is designed to encourage participation in the lectures.

**Assignments:**

Home assignments must be solved **individually**. You are welcome to discuss problems with instructor. It is also acceptable to discuss with a fellow student. However, home assignments should not be solved in groups. Direct copying of a fellow student's solution will be considered as cheating and will be treated accordingly. Your assignments should represent **your** efforts, not that of another person.

**Late Policy:** Late assignments will **NOT** be accepted.

**A Note on Cheating, Deception, and Plagiarism:**

Academic code of ethics defines cheating, deception, and plagiarism. You can reach these definitions through <http://www.ncc.metu.edu.tr/academic/acadcode-of-ethics.php>

Please aware that violations of the academic code of ethics may result in disciplinary actions, ranging between a "Warning" and "Dismissal from the University".

**Catalog Content:**

Introduction to water resources. Reservoirs. Classification of dams. Failure and rehabilitation of dams. Types of spillways, energy dissipation facilities, crest gates. Water uses and quantities, water quality, water treatment. Elements of water transmission and distribution. Design and construction of sewer systems. Land classification for irrigation, soil-water relations. Design of classical irrigation networks. Characteristics of land drainage, design of surface and subsurface drainage systems. *Prerequisite: CVE 372 and CVE 376.*

(Available at [http://www.ncc.metu.edu.tr/academic/Academic\\_Catalog.pdf](http://www.ncc.metu.edu.tr/academic/Academic_Catalog.pdf))

**Course Objectives:**

The objective of the course is to teach students the fundamental concepts of some important topics of water resources engineering such as type of dams, water supply, waste water collection, irrigation and drainage of land, and hydropower energy through a combination of classroom discussions, tutorials, and computer applications.

**Course Outline:****Text Book:**

- |  |                     |
|--|---------------------|
| <b>1. Introduction to Water Resources</b>                                      | p. 1-14             |
| <b>2. Reservoirs</b>   |                     |
| - Characteristics of reservoirs  | p. 15-18            |
| - Reservoir capacity determination   | p. 18-24            |
| - Reservoir sedimentation  | p. 24-27            |
| (All solved and exercise problems of Chapter 2 in the text book are included.) |                     |
| <b>3. Dams</b>   |                     |
| - Classification and parts of dams   | p. 41-43            |
| - Planning of dams   | p. 44-49            |
| - Dam construction (Concrete, RCC, and embankment dams)                        | p. 49-54, 66, 72-82 |
| - Concrete gravity dams  | p. 54-65            |
| - Arch dams  | p. 67-72            |
| - Cross-sectional lay-out design of dams                                       | p. 82-85            |
| - Local scour at the downstream of dams  | p. 85-87            |
| - Dam safety and rehabilitation  | p. 88               |
| (All solved and exercise problems of Chapter 3 in the text book are included.) |                     |

#### **4. Spillways**

- Introduction and spillway design flood p. 111-112
  - Overflow spillways, discharge equation p. 113-121
  - Crest gates and spillway profile p. 121-126
  - Energy dissipation facilities p. 126-139
  - Other types of spillways p. 139-144
- (All solved and exercise problems of Chapter 4 in the text book are included.)

#### **5. Water Supply**

- Characteristics of municipal water supply systems p. 260
  - Municipal water requirements and population estimation p. 260-265
  - Fluctuations in water use p. 265-267
  - Water quality and treatment p. 267-276
  - Elements of municipal water supply systems p. 276-280
  - Hydraulics and operation of gravity pipelines p. 298- 306
  - Design of transmission lines (gravity, pumped, and mixed lines) p. 308-313
  - Construction and maintenance of municipal water supply systems p. 202-203
- (The following solved problems of Chapter 7 in the text book are included: 7.5, 7.6, 7.7, 7.10, 7.13, 7.14, 7.15, 7.17)
- (The following exercise problems of Chapter 7 in the text book are included: 7.1, 7.2, 7.3, 7.4, 7.5, 7.13, 7.14, 7.15, 7.16)

#### **6. Waste Water Collection and Removal**

- Introduction and flow in sewers p. 369-373
  - Design of storm sewer systems p. 373-377
  - Design of sanitary sewer systems p. 377-380
  - Constructional details of sewer systems p. 384-389
- (All solved and exercise problems of Chapter 8 in the text book are included.)

#### **7. Irrigation**

- Introduction, land classification, soil-water relation, irrigation frequency p. 455-461
  - Determination of irrigation water demand p. 462-465
  - Irrigation water quality p. 465-468
  - Irrigation network types p. 469-476
  - System design by demand method p. 478-480
  - Limited demand method p. 480-481
- (All solved and exercise problems of Chapter 10 in the text book are included.)

#### **8. Drainage of Irrigated Lands**

- Introduction and sources of excess water p. 495
  - Surface drainage networks p. 496-497
  - Subsurface drainage networks p. 498-506
- (All solved and exercise problems of Chapter 11 in the text book are included.)

#### **9. Hydroelectric Power**

- Characteristics of electrical power plants p. 511-514
  - Terminology p. 514-518
  - Hydroelectric power plants and components p. 518-523
  - Estimation of hydropower potential; power and energy p. 523-525
- (All solved and exercise problems of Chapter 12 in the text book are included.)

**ERRATA LIST IN THE TEXT BOOK  
APPLIED WATER RESOURCES ENGINEERING (3<sup>rd</sup> Edition)**

Page	Erroneous term	Correct term																																																																																																																																																
92, Free-body diagram	Uplift distribution is shown as trapezoidal	Uplift distribution is triangular																																																																																																																																																
96, Table 3.7	<table border="1"> <thead> <tr> <th>h</th> <th>FS<sub>2</sub></th> <th>FS<sub>0</sub></th> <th>FS<sub>1st</sub></th> <th>σ<sub>1st</sub></th> <th>σ<sub>right</sub></th> </tr> </thead> <tbody> <tr><td>100</td><td>0.61</td><td>1.28</td><td>9.23</td><td>132.5</td><td>1353</td></tr> <tr><td>90</td><td>0.79</td><td>1.47</td><td>11.00</td><td>287.3</td><td>1033.2</td></tr> <tr><td>80</td><td>1.01</td><td>1.70</td><td>13.26</td><td>643.4</td><td>777.2</td></tr> <tr><td>70</td><td>1.32</td><td>1.96</td><td>16.17</td><td>942.8</td><td>577.7</td></tr> <tr><td>60</td><td>1.72</td><td>2.27</td><td>19.93</td><td>1192.7</td><td>427.9</td></tr> <tr><td>50</td><td>2.26</td><td>2.64</td><td>24.77</td><td>1400</td><td>320.5</td></tr> <tr><td>40</td><td>2.96</td><td>3.08</td><td>30.87</td><td>1572</td><td>248.5</td></tr> <tr><td>30</td><td>3.84</td><td>3.62</td><td>38.15</td><td>1715.7</td><td>204.8</td></tr> <tr><td>20</td><td>4.83</td><td>4.31</td><td>45.85</td><td>1838.1</td><td>182.4</td></tr> <tr><td>10</td><td>5.75</td><td>5.24</td><td>52.23</td><td>1946.4</td><td>174.2</td></tr> <tr><td>0</td><td>6.30</td><td>4.91</td><td>54.94</td><td>2484.9</td><td>264.4</td></tr> </tbody> </table>	h	FS <sub>2</sub>	FS <sub>0</sub>	FS <sub>1st</sub>	σ <sub>1st</sub>	σ <sub>right</sub>	100	0.61	1.28	9.23	132.5	1353	90	0.79	1.47	11.00	287.3	1033.2	80	1.01	1.70	13.26	643.4	777.2	70	1.32	1.96	16.17	942.8	577.7	60	1.72	2.27	19.93	1192.7	427.9	50	2.26	2.64	24.77	1400	320.5	40	2.96	3.08	30.87	1572	248.5	30	3.84	3.62	38.15	1715.7	204.8	20	4.83	4.31	45.85	1838.1	182.4	10	5.75	5.24	52.23	1946.4	174.2	0	6.30	4.91	54.94	2484.9	264.4	<table border="1"> <thead> <tr> <th>h</th> <th>FS<sub>2</sub></th> <th>FS<sub>0</sub></th> <th>FS<sub>1st</sub></th> <th>σ<sub>1st</sub></th> <th>σ<sub>right</sub></th> </tr> </thead> <tbody> <tr><td>100</td><td>0.63</td><td>1.28</td><td>9.53</td><td>150</td><td>1371</td></tr> <tr><td>90</td><td>0.81</td><td>1.47</td><td>11.34</td><td>254</td><td>1066</td></tr> <tr><td>80</td><td>1.04</td><td>1.69</td><td>13.65</td><td>599</td><td>822</td></tr> <tr><td>70</td><td>1.35</td><td>1.95</td><td>16.61</td><td>889</td><td>631</td></tr> <tr><td>60</td><td>1.76</td><td>2.25</td><td>20.42</td><td>1132</td><td>488</td></tr> <tr><td>50</td><td>2.31</td><td>2.62</td><td>25.30</td><td>1334</td><td>386</td></tr> <tr><td>40</td><td>3.01</td><td>3.05</td><td>31.40</td><td>1503</td><td>317</td></tr> <tr><td>30</td><td>3.89</td><td>3.58</td><td>38.60</td><td>1644</td><td>276</td></tr> <tr><td>20</td><td>4.86</td><td>4.27</td><td>46.13</td><td>1766</td><td>254</td></tr> <tr><td>10</td><td>5.76</td><td>5.20</td><td>52.32</td><td>1874</td><td>246</td></tr> <tr><td>0</td><td>6.30</td><td>4.91</td><td>54.94</td><td>2485</td><td>264</td></tr> </tbody> </table>	h	FS <sub>2</sub>	FS <sub>0</sub>	FS <sub>1st</sub>	σ <sub>1st</sub>	σ <sub>right</sub>	100	0.63	1.28	9.53	150	1371	90	0.81	1.47	11.34	254	1066	80	1.04	1.69	13.65	599	822	70	1.35	1.95	16.61	889	631	60	1.76	2.25	20.42	1132	488	50	2.31	2.62	25.30	1334	386	40	3.01	3.05	31.40	1503	317	30	3.89	3.58	38.60	1644	276	20	4.86	4.27	46.13	1766	254	10	5.76	5.20	52.32	1874	246	0	6.30	4.91	54.94	2485	264
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99, third line from top	W <sub>2</sub> =5720.4, M <sub>2</sub> =268907.42	W <sub>2</sub> =5724, M <sub>2</sub> =269085.2																																																																																																																																																
99, starting from 9 <sup>th</sup> line from bottom	$E_w=1340.74$ , $M=22095.4$ $\Sigma H=13290.29$ , $\Sigma M_0=555242.3$ $e=1.23$ $F.S_1=1.22$ , $F.S_0=1.97$ , $F.S_{1st}=24.87$ $\sigma_{max}=470.85$ , $\sigma_{min}=354.82$ a) 1.82, b) $\sigma_{1st}=287.5$ , $\sigma_d=544.2$	$E_w=938.56$ , $M=15467.42$ $\Sigma H=12887.90$ , $\Sigma M_0=548583$ $e=0.92$ $F.S_1=1.26$ , $F.S_0=1.99$ , $F.S_{1st}=25.65$ $\sigma_{max}=456.37$ , $\sigma_{min}=369.28$ a) 1.85, b) $\sigma_{1st}=309$ , $\sigma_d=523$																																																																																																																																																
109, Answers of Problem 3.4																																																																																																																																																		
109, Answer of Problem 3.7	Height of rectangular part at top is 10 m	Height of rectangular part at top is 8.2 m																																																																																																																																																
146, Solution table	First value of Q <sub>0</sub> =352.24	First value of Q <sub>0</sub> =324.82																																																																																																																																																
249, Problem 6.4	Missing information for part a	Assume that C <sub>0</sub> =2.18 and ignore possible downstream effects																																																																																																																																																
250, Problem 6.4, answer of c	F.S <sub>1st</sub> =1.51	F.S <sub>1st</sub> =1.59																																																																																																																																																
302, Figure 7.41-b	Q=0.907 m <sup>3</sup> /s, H <sub>D</sub> =108.2 m	Q=0.95 m <sup>3</sup> /s, H <sub>D</sub> =107.5 m																																																																																																																																																
302, Figure 7.41-c	h <sub>w</sub> =10 m	h <sub>w</sub> =15 m																																																																																																																																																
347, Example 7.14	L <sub>CD</sub> =L <sub>DE</sub> =L <sub>EF</sub> =2000m, 10 mm increment	L <sub>CD</sub> =L <sub>DE</sub> =L <sub>EF</sub> =1000m, 10 cm increment																																																																																																																																																
351, Solution table of Example 7.15	Computational mistake in C <sub>a</sub> values, which range in 277343.75-1763.42	Correct values of C <sub>a</sub> range in 290894.20-15191.70																																																																																																																																																
352, Last line before Example 7.16	0.8 (pipe size)	0.75																																																																																																																																																
355, Figure 7.82	L <sub>DB</sub> =500 m	L <sub>DB</sub> =1360 m																																																																																																																																																
362, Problem 7.4, answer a	26 years after 1990	26 years after 2000																																																																																																																																																
400, 2 <sup>nd</sup> line from top	Q <sub>low</sub> /Q <sub>full</sub> =104.82/264, d/D=0.5, O.K.	Q <sub>low</sub> /Q <sub>full</sub> =104.82/379, d/D=0.43 (slightly less than 0.5). So design is acceptable if a proper flushing system is used.																																																																																																																																																
404, Problem 8.5	Answer of part d) 0.0323 m <sup>2</sup>	Answer of part d) 0.047 m <sup>2</sup>																																																																																																																																																
494, Problem 10.8	Answer of part a) 9989600 m <sup>3</sup>	Answer of part a) 9889600 m <sup>3</sup>																																																																																																																																																
501, 3 lines above Eq. (11.3)	C=Ka <sup>2</sup> /2	C=KD <sup>2</sup> /2																																																																																																																																																
509, Problem 11.6	t=20°C	t=28°C																																																																																																																																																
518, last line	"...regime. Run-of-river plants can be..."	"...regime and run-of-river plants cannot be..."																																																																																																																																																
539, Example 12.7	Energy unit price is 0.07 \$/KWh	Energy unit price is 0.08 \$/KWh																																																																																																																																																

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