Economic Operation & Control of Power Systems (EE632A)

Lecture: Course Project

Dr. Swathi Battula
Assistant Professor
EED, IIT Kanpur

Objectives

Provide hands-on experience on the concepts studied

Provide exposure to the methods of conducting research work

Encourage independent and innovative ideas

Introducing academic writing

Components

- Problem Formulation
- Execution
- Case Studies, Analysis & Insights
- Reporting Outcomes

Evaluation Policy

Assignments	10
Quizzes	10
Course Project	**25**
Mid Sem. Exam	25
End Sem. Exam	30
Total	100

Grading is based on relative performance

Attendance is given additional 5% weightage

Plagiarism should be avoided

Evaluation of Course Project

Component	**Weightage**
Problem Formulation	5
Execution (with a simple test case)	5
Test cases, analysis & insights	10
Final Presentation & Report	5
Total	**25**

SCUC Objective Function

$$\min \underbrace{\sum_t \sum_i z_{it} F_{it}}_{Fixed\,(no\text{-}load)\,Costs} + \underbrace{\sum_t \sum_i g_{it} C_{it}}_{Production\,Costs} + \underbrace{\sum_t \sum_i y_{it} S_{it}}_{Startup\,Costs} + \underbrace{\sum_t \sum_i x_{it} H_{it}}_{Shutdown\,Costs}$$

- Decision variables are z_{it}, g_{it}, y_{it}, x_{it}
- z_{it}, y_{it}, x_{it} are discrete, g_{it} is continuous

g_{it} is the MW produced by generator *i* in period *t*,
z_{it} is 1 if generator *i* is dispatched during *t*, 0 otherwise,
y_{it} is 1 if generator *i* starts at beginning of period *t*, 0 otherwise,
x_{it} is 1 if generator *i* shuts at beginning of period *t*, 0 otherwise,

F_{it} is no-load cost ($/period) of operating generator *i* in period *t*,
C_{it} is prod. cost ($/MW/period) of operating gen *i* in period *t*;
S_{it} is startup cost ($) of starting gen *i* in period *t*.
H_{it} is shutdown cost ($) of shutting gen *i* in period *t*.

Note: The contents of the slide are taken from Prof. McCalley's Lecture Notes on SCUC formulation

SCUC Problem Formulation

$$\min \quad \underbrace{\sum_t \sum_i z_{it} F_{it}}_{Fixed\,(no\text{-}load)\,Costs} + \underbrace{\sum_t \sum_i g_{it} C_{it}}_{Production\,Costs} + \underbrace{\sum_t \sum_i y_{it} S_{it}}_{Startup\,Costs} + \underbrace{\sum_t \sum_i x_{it} H_{it}}_{Shutdown\,Costs}$$

Subject to

power balance	$\sum_i g_{it} = D_t = \sum_i d_{it}$	$\forall t,$	(2)	**Power balance at each period t.**
reserve	$\sum_i r_{it} \geq SD_t$	$\forall t,$	(3)	
min generation	$g_{it} \geq z_{it} MIN_i$	$\forall i,t,$	(4)	**Max gen, min gen, reserves.** (4), (5), (6)
max generation	$g_{it} + r_{it} \leq z_{it} MAX_i$	$\forall i,t,$	(5)	
max spinning reserve	$r_{it} \leq z_{it} MAXSP_i$	$\forall i,t,$	(6)	
ramp rate pos limit	$g_{it} \leq g_{it-1} + MxInc_i$	$\forall i,t,$	(7)	**Max increase and max decrease. This reflects ramp rates.** (7), (8)
ramp rate neg limit	$g_{it} \geq g_{it-1} - MxDec_i$	$\forall i,t,$	(8)	
start if off-then-on	$z_{it} \leq z_{it-1} + y_{it}$	$\forall i,t,$	(9)	**Start constraint**
shut if on-then-off	$z_{it} \geq z_{it-1} - x_{it}$	$\forall i,t,$	(10)	**Shut constraint**
normal line flow limit	$\sum_i a_{ki}(g_{it} - d_{it}) \leq MxFlow_k$	$\forall k,t,$	(11)	**Transmission normal constraint**
security line flow limits	$\sum_i a_{ki}^{(j)}(g_{it} - d_{it}) \leq MxFlow_k^{(j)}$	$\forall k,j,t,$	(12)	**Transmission security constraint**

D_t is the total demand in period t,
SD_t is the spinning reserve required in period t,
$MxInc_i$ is max ramprate (MW/period) for increasing gen i output
$MxDec_i$ is max ramprate (MW/period) for decreasing gen i output
a_{ij} is linearized coefficient relating bus i injection to line k flow

$MxFlow_k$ is the maximum MW flow on line k
$a_{ki}^{(j)}$ is linearized coefficient relating bus i injection to line k flow under contingency j,

$MxFlow_k^{(j)}$ is the maximum MW flow on line k under contingency j
$MAXSP_i$ is maximum spinning reserve for unit i

Questions?