



Exc.	Problem 1	Problem 2	Problem 3	Problem 4	Problem 5	Sum
max.	6	6	6	6	6	30
pts.						

.....
Problem 1. (*General concepts within W-CDMA and HSPA technologies*)

Answer to the following questions:

- (a) In UTRAN architecture some interfaces are “open”. Explain briefly what is an “open interface”, and why “open interfaces” are introduced in UTRAN.
- (b) What is the purpose of using spreading codes and scrambling codes in W-CDMA? What are the main differences between spreading and scrambling code usage in both, W-CDMA uplink and downlink?
- (c) Why is it important for user terminals to be able to receive in a proper way the *primary common pilot channel* (P-CPICH) of a W-CDMA network?
- (d) Name and describe at least three important differences between W-CDMA downlink and HSDPA.

.....
Problem 2. (*Multi-antenna methods in W-CDMA/HSPA/LTE/LTE-Advanced*)

Are the following statements right or wrong? Answer just T/F (i.e., True or False). No justification of the chosen alternative is required.

- (a) The HSDPA open-loop transmit-diversity method provides both, diversity gain and coherent combining gain.
- (b) In W-CDMA/HSDPA conventional beamforming, the control overhead is decreasing as the number of fixed beams grows.
- (c) The HSDPA closed-loop transmit-diversity method needs two orthogonal P-CPICH for channel estimation.
- (d) In HSDPA, up to four transmit antennas can be used for closed-loop transmit-diversity purposes.
- (e) In both LTE and LTE-Advanced, the number of *spatial multiplexing* (SM) *multiple-input multiple-output* (MIMO) data streams in uplink can be four.
- (f) In HSDPA, closed-loop transmit-diversity methods always outperform open-loop transmit-diversity methods for users in rural areas.

(g) In LTE the number of SM-MIMO data streams can be four in downlink, while in LTE-Advanced it can be up to eight.

(h) Multiuser MIMO (MU-MIMO) is not supported by LTE, but it is supported by LTE-Advanced.

Evaluation criterion:

8 correct answers → 6 points, 7 correct answers → 5 points,
 6 correct answers → 4 points, 5 correct answers → 3 points,
 4 correct answers → 2 points, 3 correct answers → 1 points,
 less than 3 correct answers → 0 points.

Problem 3. (*HSPA link budget*)

Fill missing fields (A)-(F) of Table 1, for a 512 [kbps] service on HS-DSCH. Give your results in the answer paper, and explain how were they obtained.

Table 1: HSPA link budget (HS-DSCH 512 [kbps])

Transmitter Characteristics	
Transmitter power on HS-DSCH [Watts]	10.00
Transmitter power on HS-DSCH [dBm]	(A)
Tx antenna gain [dBi]	17.40
Tx cable loss [dB]	2.00
Transmitter EIRP [dBm]	(B)
Receiver Characteristics	
Thermal noise density [dBm/Hz]	-173.98
Receiver noise figure [dB]	8.00
Receiver noise density [dBm/Hz]	-165.98
Receiver noise power [dBm]	-100.13
Spreading gain [dB]	(C)
SINR [dB]	5.00
Receiver sensitivity [dBm]	(D)
Load factor [%]	80.00
Interference margin [dB]	(E)
Rx antenna gain [dBi]	3.00
Rx body loss [dB]	0.00
Diversity gain [dB]	0.00
Fast fading margin [dB]	0.00
Soft handover gain [dB]	0.00
Indoor penetration loss [dB]	20
Shadow fading margin [dB]	8.00
Allowed propagation loss [dB]	(F)

Problem 4. (*HSPA and LTE concepts*)

(a) Describe briefly the principle of maximum *carrier-to-interference* power ratio (CIR) scheduler and *proportional fair* (PF) scheduler. Why do these methods usually give a better performance in LTE rather than in HSDPA?

(b) Explain the principle of *hybrid automatic repeat request* (H-ARQ) protocol, and describe briefly how *incremental redundancy* algorithm and *chase combining* algorithm work.

(c) User data rate is doubled in LTE uplink without changing the modulation and coding scheme. What happens to the user bandwidth?

(d) Why is SC-FDMA receiver usually more complex than OFDMA receiver?

.....
Problem 5. (*LTE-Advanced concepts*)

Answer briefly to the following questions:

(a) *Coordinated multipoint* (CoMP) transmission: Describe *joint processing* and *coordinated scheduling/beamforming*. What is the main difference between both techniques?

(b) *Carrier aggregation* (CA): Describe *intra-band aggregation* with contiguous carriers, *intra-band aggregation* with non-contiguous carriers, and *inter-band aggregation*. Which case is simpler to implement in practice? Justify your answer in a simple, but clear way.

(c) Relaying: Describe *in-band relaying* and *out-band relaying*. What are the main differences between both types of relaying approaches?

.....
Some Abbreviations

HS-DSCH = High Speed Downlink Shared Channel,
MU = Multi-User,
MIMO = Multiple-Input Multiple-Output,
P-CPICH = Primary Common Pilot Channel,
SM = Spatial Multiplexing,
UTRAN = Universal Terrestrial Radio Access Network.