

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

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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.

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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.

spread multiple

(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?

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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?

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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.