INSTRUCTIONS:

Fill out the hazard analysis and risk assessment below.

HA-001 should be for the lane departure warning function as discussed in the lecture.

HA-002 should be for the lane keeping assistance function as discussed in the lecture.

Then come up with your own situations and hazards for the lane assistance system. Fill in the HA-003 and HA-004 rows.

When finished, export your spreadsheet as a pdf file so that a reviewer can easily see your work.

Hazard ID	Situational Analysis							Hazard Identification						Hazardous Event Classification						Determination of ASIL and Safety Goals	
	Operational Mode	Operational Scenario	Environmental Details	Situation Details	Other Details (optional)	Item Usage (function)	Situation Description	Function	Deviation	Deviation Details	Hazardous Event (resulting effect)	Event Details	Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)	Severity (of potential harm)	Rationale (for severity)	Controllability (of hazardous event)	Rationale (for controllability)	ASIL Determination	Safety Goal
HA-001	OM03 - Normal driving	OS04 - Highway	EN01 - Normal conditions	SD02 - High speed		IU01 - Correctly used	Normal driving on a highway during normal conditions with high speed and correctly used system.	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	DV04 - Actor effect is too much	The LDW function applies an oscillating torque with very high torque	EV00 - Collision with other vehicle	High haptic feedback can effect driver's ability to steer as intended. The driver could lose control of the vehicle and collide with another or with road infrastructure	The LDW function applies too high oscillating torque to the steering whell (above limit)	E4 - High probability	Driving on a highway could happen more than 10% of the operating time	S3 - Life-threatening or fatal injuries	Driving in high speed	C2 - Normally controllable	Driver can deactivate the system and take control of the situation	C	The Oscillating steering torque from the LDW function shall be limited
HA-002	OM03 - Normal driving	OS04 - Highway	EN01 - Normal conditions	SD02 - High speed		IU02 - Incorrectly used	Normal driving on country roads during normal conditions with high speed.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV03 - Function always activated	The lane keeping assistance function adds extra steering torque all time	EV00 - Collision with other vehicle	Driver treats the function as if it were meant for fully autonomous driving and therefore can't react on critical situations.	The LKA function is always activated and the driver stops focusing on driving the car.	E2 - Low probability	Driving at a country road and misusing the system should happen less than 1% of the operating time	S3 - Life-threatening or fatal injuries	Driving in high speed	C3 - Difficult to control or uncontrollable	Driver is using the system as an Autonomous Vehicle and no hands on the steering wheel so he couldn't be paying attention to the situation	B	The LKA function shall be time limited and the additional steering torque shall end after a given time interval so that the driver cannot misuse the system for autonomous driving
HA-003	OM03 - Normal driving	OS04 - Highway	EN01 - Normal conditions	SD02 - High speed		IU01 - Correctly used	Normal driving on a highway during normal conditions with high speed and correctly used system.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV02 - Function unexpectedly activated	The LKA function is unexpectedly activated	EV00 - Collision with other vehicle	The LKA function is unexpectedly activated. The driver could lose control of the vehicle and collide with another or with road infrastructure	The LKA function activates unexpectedly due to a mulfunction.	E4 - High probability	Driving on a highway could happen more than 10% of the operating time	S3 - Life-threatening or fatal injuries	Driving in high speed	C3 - Difficult to control or uncontrollable	As the function is unexpectedly activated .The wrongly applied torque could cause to driver override to be difficult.	D	LKA function activation must be only triggered by the used and there must be multiple accessible ways to deactivate the function
HA-004	OM03 - Normal driving	OS04 - Highway	EN07 - Snow (slippery road)	SD02 - High speed		IU01 - Correctly used	Normal driving on a highway during Snow (slippery road) with high speed and correctly used system.	Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	DV04 - Actor effect is too much	The LDW function applies an oscillating torque with very high torque	EV00 - Collision with other vehicle	High haptic feedback can effect driver's ability to steer as intended. The driver could lose control of the vehicle and collide with another or with road infrastructure	The LDW function applies too high oscillating torque to the steering whell (above limit)	E2 - Low probability	Driving on a highway with snow could happen less than 1% of the operating time	S3 - Life-threatening or fatal injuries	Driving in high speed	C3 - Difficult to control or uncontrollable	Difficult to control due to slippery road	B	The Oscillating steering torque from the LDW function shall be limited

EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTIONS - H

Hazard ID	
	Operational Mode
HA-001	Normal Driving

MORE EXAMPLES - Headlamp System

Hazard ID	
	Operational Mode
HA-001	OM03 - Normal Driving
HA-002	OM03 - Normal Driving
HA-003	OM03 - Normal Driving
HA-004	OM03 - Normal Driving
HA-005	OM03 - Normal Driving

Headlamp System

Situ	
Operational Scenario	**Environmental Details**
City Road	Normal Conditions

Sit	
Operational Scenario	**Environmental Details**
OS01 - City Road	EN01 - Normal conditions
OS01 - City Road	EN04 - Snowfall (degraded view)
OS03 - Highway	EN04 - Snowfall (degraded view)
OS02 - Country Road	EN01 - Normal conditions
OS02 - Country Road	EN04 - Snowfall (degraded view)

ıational Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
Low Speed	Night time + Obstacle on the road	Correctly Used

uation Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
SD03 - Low speed	Night time + Obstacle on the road	IU01 - Correctly used
SD03 - Low speed	the road and no other	IU01 - Correctly used
SD03 - High speed	Night time + Obstacle on the road or upcoming curve	IU01 - Correctly used
SD02 - High speed	Night time + Oncoming vehicle	IU01 - Correctly used
SD04 - High speed	the road and no other	IU01 - Correctly used

Situation Description	Function	Deviation
Conditions at Low Speed at Night with an	Low beam illuminates the roadway in the dark	Function not activated

Situation Description	Function	Deviation
conditions with Low speed (Night time +	Low beam illuminates the roadway in the dark	DV01 - Function not activated
(degraded view) with Low speed (Night time + Obstacle on the road and no other illumination	Low beam illuminates the roadway in the dark	DV01 - Function not activated
(degraded view) with High speed (Night time +	Low beam illuminates the roadway in the dark	DV01 - Function not activated
conditions with High speed (Night time +	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Snowfall (degraded view) with High speed (Night time + Obstacle on the road and no other	Low beam illuminates the roadway in the dark	DV01 - Function not activated

Hazard Identification	
Deviation Details	**Hazardous Event (resulting effect)**
Both headlights stop working	Front collision with obstacle

Hazard Identification	
Deviation Details	**Hazardous Event (resulting effect)**
Both headlights stop working	EV04 - Front collision with obstacle
Both headlights stop working	EV04 - Front collision with obstacle
Both headlights stop working	EV04 - Front collision with obstacle
Both headlights stop working	EV08 - Collision with other vehicle
Both headlights stop working	EV04 - Front collision with obstacle

Event Details	Hazardous Event Description	Exposure (of situation)
the obstacle with injury	Total loss of low beam	E4 - High probability

Event Details	Hazardous Event Description	Exposure (of situation)
the obstacle with injury	Total loss of low beam	E4 - High probability
the obstacle with injury	Total loss of low beam	E1 - Very low probability
infrastructure with injury	Total loss of low beam	E2 - Low probability
the oncoming vechile	Total loss of low beam	E4 - High probability
infrastructure with injury	Total loss of low beam	E2 - Low probability

Hazardous I	
Rationale (for exposure)	**Severity (of potential harm)**
night driving in the city is a regular activity	S1 - Light and moderate injuries

Hazardous I	
Rationale (for exposure)	**Severity (of potential harm)**
night driving in the city is a regular activity	S1 - Light and moderate injuries
completely unilluminated roads	S1 - Light and moderate injuries
driving, however, heavy snow	S3 - Life-threatening or fatal injuries
country driving is part of regular driving	S3 - Life-threatening or fatal injuries
driving, however, heavy snow	S3 - Life-threatening or fatal injuries

Event Classification

Rationale (for severity)	Controllability (of hazardous event)
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general

Event Classification

Rationale (for severity)	Controllability (of hazardous event)
In city traffiic, speed of vehicle is expected to be low	C0 - Controllable in general
In city traffiic, speed of vehicle is expected to be low	C1 - Simply controllable
On highway speed of vehicle is expected to be high	C2 - Normally controllable
On country roads speed of vehicle is expected to be high	C1 - Simply controllable
On country roads speed of vehicle is expected to be high	C3 - Difficult to control or uncontrollable

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	**ASIL Determination**	**Safety Goal**
control the situation by applying brakes and there is additional illmunitation on city	QM	Total Loss of Beam Shall Be Prevented

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	**ASIL Determination**	**Safety Goal**
control the situation by applying brakes and there is additional illmunitation on city	QM	Total loss of low beam shall be prevented
drivers usually drive at lower end of city	QM	Total loss of low beam shall be prevented
illumination on road and hence >90% drivers are able to brake and control the	A	Total loss of low beam shall be prevented
road, it will be difficult for the average	B	Total loss of low beam shall be prevented
road, it will be difficult for the average	B	Total loss of low beam shall be prevented

Deviation

ID	Deviation (Guideword)	Remarks
DV01	Function not activated	Activation error
DV02	Function unexpectedly activated	Activation error
DV03	Function always activated	Activation error
DV04	Actor effect is too much	Quantitative error
DV05	Actor effect is too less	Quantitative error
DV06	Actor action too early	Timing error
DV07	Actor action too late	Timing error
DV08	Actor action before	Sequence error
DV09	Actor action after	Sequence error
DV10	Actor effect is reverse	Logical error
DV11	Actor effect is wrong	Logical error
DV12	Sensor sensitivity is too high	Quantitative error
DV13	Sensor sensitivity is too low	Quantitative error
DV14	Sensor detection too early	Timing error
DV15	Sensor detection too late	Timing error
DV16	Sensor detection before	Sequence error
DV17	Sensor detection after	Sequence error
DV18	Sensor detection is reverse	Logical error
DV19	Sensor detection is wrong	Logical error
DV20	N/A	not applicable or not relevant

Hazardous Events (possibe effects)

ID	Hazardous Event	Remarks
EV-07	None	
EV-06	Front collision with oncoming traffic	
EV-05	Front collision with ahead traffic	
EV-04	Front collision with obstacle	
EV-03	Rear collision with trailing traffic	
EV-02	Side collision with other traffic	
EV-01	Side collision with obstacle	
EV00	Collision with other vehicle	
EV01	Collision with train	
EV02	Collision with pedestrian	
EV03	Car spins out of control	
EV04	Car comes off the road	
EV05	Car catches file	
EV06	N/A	

Reference
DV01 - Function not activated
DV02 - Function unexpectedly activated
DV03 - Function always activated
DV04 - Actor effect is too much
DV05 - Actor effect is too less
DV06 - Actor action too early
DV07 - Actor action too late
DV08 - Actor action before
DV09 - Actor action after
DV10 - Actor effect is reverse
DV11 - Actor effect is wrong
DV12 - Sensor sensitivity is too high
DV13 - Sensor sensitivity is too low
DV14 - Sensor detection too early
DV15 - Sensor detection too late
DV16 - Sensor detection before
DV17 - Sensor detection after
DV18 - Sensor detection is reverse
DV19 - Sensor detection is wrong
DV20 - N/A

Reference
EV-07 - None
EV-06 - Front collision with oncoming traffic
EV-05 - Front collision with ahead traffic
EV-04 - Front collision with obstacle
EV-03 - Rear collision with trailing traffic
EV-02 - Side collision with other traffic
EV-01 - Side collision with obstacle
EV00 - Collision with other vehicle
EV01 - Collision with train
EV02 - Collision with pedestrian
EV03 - Car spins out of control
EV04 - Car comes off the road
EV05 - Car catches file
EV06 - N/A

Exposure

ID	Description
E0	Incredible
E1	Very low probability
E2	Low probability
E3	Medium probability
E4	High probability

Severity

ID	Description
S0	No injuries
S1	Light and moderate injuries
S2	Severe and life-threatening injuries
S3	Life-threatening or fatal injuries

Controllability

ID	Description
C0	Controllable in general
C1	Simply controllable
C2	Normally controllable
C3	Difficult to control or uncontrollable

Duration (of situation)
Not specified
<1 % of average operating time
1 % to 10 % of average operating time
>10 % of average operating time

Remarks
No injuries
Light and moderate injuries
Severe and life-threatening injuries (survival probable)
Life-threatening injuries (survival uncertain), fatal injuries

Remarks
Controllable in general
99 % or more of all drivers or other traffic participants are usually
90 % or more of all drivers or other traffic participants are usually
Less than 90 % of all drivers or other traffic participants are usua

Frequency (of situation)	Reference
	E0 - Incredible
Occurs less often than once a year for the great majority of drive	E1 - Very low probability
Occurs a few times a year for the great majority of drivers	E2 - Low probability
Occurs once a month or more often for an average driver	E3 - Medium probability
Occurs during almost every drive on average	E4 - High probability

Probability of Injuries	Reference
AIS 0 and less than 10 % probability of AIS 1-6	S0 - No injuries
More than 10 % probability of AIS 1-6 (and not S2 or S3)	S1 - Light and moderate injuries
More than 10 % probability of AIS 3-6 (and not S3)	S2 - Severe and life-threatening injuries
More than 10 % probability of AIS 5-6	S3 - Life-threatening or fatal injuries

	Reference
	C0 - Controllable in general
able to avoid harm	C1 - Simply controllable
able to avoid harm	C2 - Normally controllable
lly able, or barely able, to avoid harm	C3 - Difficult to control or uncontrollable

Controllability	Exposure	Severity		
		S0	S1	S2
C1	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	QM
	E4	QM	QM	A
C2	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	A
	E4	QM	A	B
C3	E1	QM	QM	QM
	E2	QM	QM	A
	E3	QM	A	B
	E4	QM	B	C

S3
QM
QM
A
B
QM
A
B
C
A
B
C
D