INSTRUCTIONS:

Fill out the hazard analysis and risk assessment below
HA-001 should be for the lane departure warning function as di
HA-002 should be for the lane keeping assistance function as d
Then come up with your own situations and hazards f
When finished, export your spreadsheet as a pdf file s

Hazard ID			
	Operational Mode	**Operational Scenario**	**Environmental Details**
HA-001	OM03 - Normal Driving	OS05-Mountain Pass	EN06 - Rain (slippery Road)
HA-002	OM03 - Normal Driving	OS04-Highway	EN01 - Normal Conditions
HA-003	OM03 - Normal Driving	OS03-County road	EN04 - Snowfall (degraded view)
HA-004	OM03 - Normal Driving	OS04-Highway	EN01 - Normal Conditions

scussed in the lecture.

liscussed in the lecture.

'or the lane assistance system. Fill in the HA-003

o that a reviewer can easily see your work.

Situational Analysis		
Situation Details	**Other Details (optional)**	**Item Usage (function)**
SD03 - Normal Acceleration	Driving at normal accelaration but in rainy weather and mountains while loose a control could be highly unmanageable	IU01 - Correctly Used
SD02 - High speed	Car is entering construction site area on highway, lanes merge together and change lane line color to yellow.	IU01 – Incorrectly Used
SD02 - High speed	Snowfall make a limted view for driver and system	IU01 – incorrectly Used
SD03 - Normal Acceleration	Car is entering construction site area on highway, lanes merge together and change lane line color to yellow.	U02 - Incorrectly Used

and HA-004 rows.

Situation Description	Function	Deviation
Normal driving on mountain pass during rain (slippery road) with normal speed and in correctly used system.	Lane departure warning system (LDW) shall apply an oscillating steering torque to provide the driver with haptic feedback	DV04 – Actor effect is too much
Normal driving on highway during normal condition 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	DV03 – function always activated
Normal driving on county side during snowfall with high speed and incorrectly used system.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV19 – sensor detection is wrong
Normal driving on highway during normal condition with normal accelaration and incorrectly used system.	Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV19 – sensor detection is wrong

Hazard Identification		
Deviation Details	**Hazardous Event (resulting effect)**	**Event Details**
LKA function is always activated	EV00 - Collision with other vehicle	High haptic feedback can affect driver's ability to steer as intended. The driver could lose control of the vehicle and collide with another vehicle or with road infrastructure.
LKA function is always activated	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.
Camera sensor is not able to find correct lane – snow and incorrect identification	EV04 - Car comes of off the road	Driver does not react fast enough to prevent car from leaving road, because of incorrect lane detection.
Camera sensor could not able to detect lane merge situation – at construction site and continued to follow lane margin.	EV02 – Side collision with other traffic	Driver does not see exsitant car on lane, ego lane gets merged Into.

Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)
The LDW function applies too high an oscillating torque to he steering wheel (above limit).	E3 - Medium Probability	Driving on a mountain during rain can happen once a month or more depending on driver's location.
The LKA function is always activated and the driver stops focusing on driving the car.	E2 - Low Probability	Driving on highway at normal speed happen occassionaly, accident can happen due to others mistake or surround situations – construction roads etc. Driver is misusing a system
LKA mixes up lane line with edge of road / pavement due to fallen snow.	E2 - Low Probability	Driving on country roads during snowfall only occurs a few times a year (in our region).
LKA steers seemlessly into merged lane provoking collision with vehicles within adjacent lane	E3 - Medium Probability	Driving on highway and encountering construction sites occurs in almost every drive on Average.

Hazardous Event Classification		
Severity (of potential harm)	**Rationale (for severity)**	**Controllability (of hazardous event)**
S3 - Life-threatening or fatal injuries	Coming off the road can imply hitting static objects or Pedestrians.	C3 - Difficult to control or uncontrollable
S2 – Severe and Life threatening injuries	In normal speed highway driving accident probablity is rare and hazard will be low if drive correctly	C2 - Normally Controllable
S3 - Life-threatening or fatal injuries	Coming off the road can imply hitting static objects or Pedestrians.	C3 - Difficult to control or uncontrollable
S3 - Life-threatening or fatal injuries	Coming off the road can imply hitting static objects or Pedestrians.	C3 - Difficult to control or uncontrollable

Rationale (for controllability)	Determinat... ASIL Determination
Overreaction of wheel's vibration is very distracting and even suprising, so the most drivers won't be able to avoid harm.	C
LKA is always on, driver could take hands off the wheel and therefore looses control entirely.	QM
Driving at normal speed, driver can react when vehicle gets to close to edge of the road.	B
Driving at high speed and encountering a new situation (construction site, merging lanes, adjacent cars) requires fast and appropriate evaluation and reaction.	C

ion of ASIL and Safety Goals
Safety Goal
The oscillating steering torque from the LDW function shall be limited.
LKA function shall be time limited and the additional steering torque shall end after a given timer interval so that the driver can not misuse the system for autonomous driving
LKA function has to be deactivated if camera sensor is not able to detect lanes correctly.
LKA has to be sensible for different coloring of lane lines, reliably detect and react on merging lanes in advance.

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

Operational Scenario	Environmental Details
City Road	Normal Conditions

(Situ...)

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)

(Sit...)

ational 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 oncoming 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
Conditions at Low Speed at Night with an	Low beam illuminates the roadway in the dark

Situation Description	Function
conditions with Low speed (Night time +	Low beam illuminates the roadway in the dark
(degraded view) with Low speed (Night time + Obstacle on the road and no other illumination	Low beam illuminates the roadway in the dark
(degraded view) with High speed (Night time +	Low beam illuminates the roadway in the dark
conditions with High speed (Night time +	Low beam illuminates the roadway in the dark
Snowfall (degraded view) with High speed (Night time + Obstacle on the road and no other	Low beam illuminates the roadway in the dark

Deviation	**Deviation Details**	Hazard Id
Function not activated	Both headlights stop working	

Deviation	**Deviation Details**	Hazard Id
DV01 - Function not activated	Both headlights stop working	
DV01 - Function not activated	Both headlights stop working	
DV01 - Function not activated	Both headlights stop working	
DV01 - Function not activated	Both headlights stop working	
DV01 - Function not activated	Both headlights stop working	

Hazardous Event (resulting effect)	Event Details	Hazardous Event Description
Front collision with obstacle	the obstacle with injury	Total loss of low beam

Hazardous Event (resulting effect)	Event Details	Hazardous Event Description
EV04 - Front collision with obstacle	the obstacle with injury	Total loss of low beam
EV04 - Front collision with obstacle	the obstacle with injury	Total loss of low beam
EV04 - Front collision with obstacle	infrastructure with injury	Total loss of low beam
EV08 - Collision with other vehicle	the oncoming vechile	Total loss of low beam
EV04 - Front collision with obstacle	infrastructure with injury	Total loss of low beam

Exposure (of situation)	Rationale (for exposure)
E4 - High probability	night-driving in the city is a regular activity

Exposure (of situation)	Rationale (for exposure)
E4 - High probability	night-driving in the city is a regular activity
E1 - Very low probability	completely unilluminated roads
E2 - Low probability	driving, however, heavy snow
E4 - High probability	country driving is part of regular driving
E2 - Low probability	driving, however, heavy snow

Hazardous Event Classification	
Severity (of potential harm)	**Rationale (for severity)**
S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low

Hazardous Event Classification	
Severity (of potential harm)	**Rationale (for severity)**
S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low
S1 - Light and moderate injuries	In city traffiic, speed of vehicle is expected to be low
S3 - Life-threatening or fatal injuries	On highway speed of vehicle is expected to be high
S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be high
S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be high

Controllability (of hazardous event)	Rationale (for controllability)
C0 - Controllable in general	control the situation by applying brakes and there is additional illumination on city

Controllability (of hazardous event)	Rationale (for controllability)
C0 - Controllable in general	control the situation by applying brakes
C1 - Simply controllable	drivers usually drive at lower end of city
C2 - Normally controllable	illumination on road and hence >90%
C1 - Simply controllable	drivers are able to brake and control the road, it will be difficult for the average
C3 - Difficult to control or uncontrollable	road, it will be difficult for the average

Determination of ASIL and Safety Goals	
ASIL Determination	**Safety Goal**
QM	Total Loss of Beam Shall Be Prevented

Determination of ASIL and Safety Goals	
ASIL Determination	**Safety Goal**
QM	Total loss of low beam shall be prevented
QM	Total loss of low beam shall be prevented
A	Total loss of low beam shall be prevented
B	Total loss of low beam shall be prevented
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